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ABSTRACT

This paper presents aspects of a study that aims to describe and make sense of changes over time in the intellectual field of mathematics education research. Drawing on the work of B. Bernstein, especially his essay on intellectual fields and knowledge structures, the paper seeks to raise questions about the field's standing in the wider field of intellectual knowledge production, the position of the field's actors in their own field, and their positioning vis-à-vis the official and public discourses and everyday school practice. Underpinning these questions is the view that changes in power relations are inscribed in the form of research activity that shapes the field, and that such changes are expressed in the mode of regulation that affects the identities of actors in the field. To study changes in the form of specialization of research activity and to give a systematic yet critical account of the field, researchers produced an empirical description and at the same time attempted to generate a language capable of showing the effects of that which it describes. The method of working was to look at a representative sample of published papers in the field to develop a tool for recording and analyzing these texts, and to create a model to help interpret the data. As well as presenting and demonstrating the usefulness of the analytical tool in the resulting description of the data, the paper sketches a provisional picture about the state of the field that captures the changing nature of its discourse, and depicts the positions it creates for the actors in the field, through the resources it makes available to them. This provides evidence to argue that researchers' identities in mathematics education research bear the mark of a historical turn in educational studies, the knowledge structure of teacher education, toward its "technologizing," and also the marks of the current mode of its regulation, which tends to produce identities with products that have an exchange value either in their own field or the field of supposed application. Three appendixes contain supplemental information in table form. (Contains 11 tables and 32 references.) (SLD)

A Sociological Description of Changes in the Intellectual Field of Mathematics Education Research: Implications for the Identities of Academics

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Abstract

Changing patterns of knowledge production, accumulation and use is today, more than ever, a major issue that concerns not only those who produce knowledge, but also different kinds of users, among which are policy makers in their double capacity: to use the knowledge and influence its production. This paper presents aspects of our study which, acknowledging this historical contingency, aims to describe and make sense of changes over time in the intellectual field of mathematics education research. One of our inspirations has been in the knowledge that school mathematics is a gate-keeper in compulsory schooling and beyond, yet the field of study that theorizes and researches this subject constitutes a small field. Furthermore, the general field of educational studies, in which it is located, is currently under threat, its sub-fields becoming detached and insulated from one another.

Drawing on Bernstein's work, especially his essay on intellectual fields and knowledge structures, we seek to raise questions concerning the field's standing in the wider field of intellectual knowledge production, the position of the field's actors in their own field and their positioning vis-à-vis the official and public discourses and everyday school practice. Underpinning these questions is the view that changes in power relations are inscribed in the form of research activity that shapes the field, and that such changes are expressed in the mode of regulation which affect the identities of the actors in the field.

In order to study changes in the form of specialization of the research activity, and to give a systematic yet critical account of the field, we produced an empirical

description and at the same time we attempted to generate a language capable of showing the effects of that which it describes. The method of working was to look at a representative sample of published papers in the field, to develop a tool of recording and analyzing these texts, and to create a model to help us interpret the data. As well as presenting and demonstrating the usefulness of the analytical tool in the resulting description of the data, we sketch a provisional picture about the state of the field which captures the changing nature of its discourse, and depicts the positions it creates for the actors in the field, through the recourses that it makes available to them. This provides us with evidence to argue that researchers' identities in mathematics education research bear the mark of a historical turn in educational studies - the knowledge structure of teacher education - towards its technologising; and also the marks of the current mode of its regulation, which tends to produce identities whose products have an exchange value either in their own field, or the field of its supposed application.

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A Sociological description of changes in the intellectual field of mathematics education research: Implications for the identities of academics

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Background to the project

Knowledge production, use and accumulation in different sectors is currently a major policy concern, and understanding why advances in human know-how has been spectacular in some fields but very limited in areas such as education has, supposedly, been part of the solution of describing a strategy to close the gap between sectors with different rates of knowledge accumulation processes (Foray and Hargreaves, 2003). If the language in which this concern is expressed makes it appear socially neutral, it is rather difficult today not to link it to the wider context in which education research, as all academic research and the Universities in which it is carried out, has been under considerable pressures. New policies aiming at re-organising research seem to be spreading in many different countries on the globe. Research studies documenting the effects of these policies on the institutions, on academics and on quality of knowledge production have been also proliferating, forming a rich and useful stock of knowledge, and perhaps a new sub-field of research. Reading through this body of literature, and oversimplifying, we distinguish between two types of research orientations. One type or perspective sees such attempts at reform in general, and (education) research in particular, as 'disciplinary tactics' (Ball, 2001a) which, drawing on forms of performativity (Ball, 2001b), attempt to change not only what academics do but who they are, their 'social identity' (Bernstein, 1996, p. 73). Many studies in this category emphasise that the changing conditions of academic work have placed a premium on the professional identity of the university teacher as *researcher*, capable of attracting external funds within an increasingly competitive research culture (e.g., Nixon, 1996; Blackmore, 2001). The other perspective consists of designing and carrying out focused and detailed empirical research studies in an attempt to trace the 'impact' of education research on policy and practice: indeed to

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show and assert its usefulness. Here we would include recent initiatives by the British Educational Research Association to map in a systematic way and review rigorously the research activity in specific areas of study in order to both assess their contribution to aspects of education and make their findings available to different kinds of users. (See for instance the work of the British Educational Research Association Early Years Special Group, 2003; see, also, Research Intelligence, 2001, 17-25). We would, also, include studies and projects initiated and funded by the European Commission or national governments which aim to identify/assess research studies, or to compile research findings to assist in the development and implementation of policies in various areas of concern to policy makers.

In this paper we present aspects of our research project concerned with describing and making sense of changes overtime in the intellectual field of mathematics education research. We see this study as being influenced by both orientations in its overall concerns but also, in some senses, as distinct from them. We could rather argue that both types of research form some of the background or context for us, but our own context has also been shaped by the following concerns and considerations:

First, we wish to bring sociology of education, Bernstein's theory in particular, to bear upon issues that are raised in a specialised field of educational studies, in this case mathematics education research. This entails an attempt to meet the concerns of a sociologist, as well as those of mathematics education researchers, issue which has preoccupied us all along. We should add here that the question of what theory would be appropriate for such a task has also been a concern in this and previous projects (see Lerman & Tsatsaroni, 1998, Morgan,Tsatsaroni & Lerman 2002, Tsatsaroni & Chrysafi, 2002); and our preference for Bernstein's theory, as will be argued in the theoretical section of this research report, stems from our view that this theory has a great potential to bring together analyses of the structures of knowledge, and of the (re)production of social relations.

Secondly, a more specific concern of the project has been to do an empirical, descriptive study and at the same time to generate a language capable of showing the effects of that which it describes. Put differently, we are seeking to develop a way of making sense of and explaining our findings.

Thirdly, through and within this project we attempt to be reflective - in the sense given to the term by many developments - and, at the same time, to see this inwards looking gesture not simply as a legitimate activity in its own right and for academics, but as a *research* activity. By this we mean research practice which, going beyond the overview of an academic field of research, constructs a legitimate object of investigation; and research practice the descriptions of which cannot be easily co-opted by interests that, for example, go under the name of accountability[1].

Aims of the project

The broad aim of our research project[2] is to analyse the processes whereby mathematics educational 'theories' are produced and the circumstances whereby they become current in the mathematics education research field, are recontextualised, and are acquired by teacher educators and teachers. We aim to construct a representation of the field of mathematics education research through which we will explore the reproduction of identities, as positions, of researchers and teacher educators in the field, the recontextualisation of pedagogic knowledge and the reproduction of identities of mathematics teachers. We wish to explore, as sub-questions, who produces theories in mathematics education, with what methodologies and to what consequences for research and for school practice? Through examining the structure of the knowledge-discourse in its field of production we aim to explore the conditions and factors that affect the movements of the positions within the discourse thereby exploring questions such as the following: who are managed, whose identities are produced and who are the managers of these identities (e.g. the funding agents, journal publishers etc.). We are intending to talk about identities of academics, and changes in those identities over time and place. We are looking both at the intersections of the mathematics education research community with other research communities, such as science education research, educational research, psychologists, sociologists and mathematicians; and also with other 'stakeholders' of mathematics education research such as central and local education authorities concerned with education policy, parents, teachers and others.

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[1] Accountability has been the Theme of the 2003 Annual Meeting of the American Education Research Association, where this research report was presented at, and being able to engage critically with this theme has also being our preoccupation in writing the report. On this see our remarks in the concluding section of the paper.

[2] The full text of the project proposal and other research papers are at http://www.lsbu.ac.uk/~lermans/ESRCProjectHOMEPAGE.html

Our method of working to create this picture is to look first at specialised texts of the research field, namely a representative sample of the papers in the *Proceedings of the International Group for the Psychology of Mathematics Education* (PME), and of two journals: *Educational Studies in Mathematics* (ESM) published by Kluwer Academic which is based in Holland; and *Journal for Research in Mathematics Education* (JRME) published by National Council of Teachers of Mathematics in the USA. We have interviewed editors of leading journals although these have not yet been analysed. We intend to follow this analysis by constructing data on the recontextualisation of the mathematics education research field in texts produced for teacher education courses and for professional development courses such as MAs.

In this paper we report on the development of a tool for recording and analysing the specialised texts of the first category. We shall try especially to make clear how our theoretical approach and our aims, as stated here, lead to an approach to coding information. We shall also present our initial analysis of the data, as well as our first attempt to interpret this data, and sketch a provisional picture about the state of the field.

The politics of knowledge (re)production

Looking at changes in the research field of mathematics education over a period of time, as depicted in publications in journals and in conference proceedings, one would expect to notice a great deal of changes. Indeed, a number of studies reviewing the field with different questions in mind appeared in the last decade, and they give a taste of changes that have occurred.

Kieran's (1995) retrospective look at mathematics education research on learning presents interviews with two leading researchers looking back over that period, followed by an analysis of articles published in JRME in its first 25 years building on the remarks of the researchers in the first section. She argues that there has been a shift towards integrating learning with understanding and studying them together, as well as an increasing orientation towards interactionist studies drawing on Vygotskian ideas. Niss (2000) develops an account of the field "based on sample observations obtained from probing into research journals, ICME *(International Congress on Mathematical Education)* proceedings and other research publications from the last third of the 20th century" (pp 1-2, italics added). Niss gives examples from these

publications in his review of issues and questions; objects and phenomena; research methods; results; and emerging problems and challenges, the latter he presents his thoughts as being more speculative than on the other issues. Whilst Niss does not claim to have been systematic, the structure he provides enables him to trace developments across the years from curriculum and how to teach, to classroom studies and then beyond to outside influences on the classroom. Chassapis (2002) searched the ERIC database for mathematics education-related publications between 1971 and 2000, a total of 13,999 articles altogether, for reference to social class, ethnicity, gender, minority or disadvantaged groups. His study expanded on an earlier study by Lubienski and Bowen (2000), which looked at the ERIC database for 1982-1998 and concluded that "in comparison with research on ethnicity, class, and disability, research on gender was more prevalent and integrated into mainstream US mathematics education research" (p. 626). Hanna & Sidoli (2002) looked back through ESM's past on the occasion of the publication of the fiftieth volume. Following an account of the contributions of past editors the authors presented a statistical profile of articles by 4 categories: content area; educational issue; level of schooling; and research method. They also gave an account of the themes, editors and structure of the Special Issues.

As we can see the concerns of these studies vary from being mainly pedagogical to sociological, and also attempt to capture qualities to do with the research activity characteristic of the field. These studies contribute to sketching a rough picture of the field, pointing to some of its developments over time. Developments and changes in a field of research, one would argue, are natural. After all, "Educational research is located in a knowledge-producing *community*" (Usher, 1996, p. 34). The award of research grants, the choice of candidates for doctoral supervision, the examination and award of doctorates, and of course the acceptance or rejection of articles in refereed journals and conferences, are judgements made by people. Over time the values and styles and the openness, or otherwise, to new (or old) theories of these gate-keepers of the community change as the people move on or develop their own ideas. It is common place to say that mathematics education researchers are engaged in a social science, which is always a hermeneutic activity, although sociologists of scientific knowledge have convincingly shown why this is also the case in natural science (Biagioli, 1999). Each editor/reviewer/examiner has her or his own interests and

concerns, and her or his own trajectory of development as researcher, and these experiences are reflected in how one reads research, what one considers valid, and therefore what one allows to enter through the gates of this particular academic discipline. At the same time the trends in theoretical/empirical/official orientations in research within the field also affect how reviewers read research and therefore what is allowed to enter. Of course, the review of articles by three people with moderation subsequently by the editor, or the programme committee in the case of conferences, and the examination of PhDs by more than one examiner, will have the effect of slowing down the rate and softening the edges of change. People's choices and the pattern of change might also be influenced both by the fact that their paper is for a conference not for a refereed journal, or vice versa, and there are therefore different refereeing practices, and by the material circumstances of the location of the conference, the likely number of papers being submitted, or indeed the location of a journal as affects its appeal internationally, and so on.

To talk about changes over time in a field of research in terms of changes in the priorities, understandings and interpretations given by people in positions of power is, at the same time, to acknowledge a number of other aspects: the structures and social relations constituting the field as well as, perhaps, the changing strength of the boundary separating this sub-field from other research subfields within education research; changes in the relations between education research and other fields within the overall arena of research production; the wider picture of power and control relations which affect the (relative) autonomy of the intellectual field of knowledge production, establishing certain forms of social relations between, on the one hand, the official policy agencies and, on the other, agencies and agents in the field (in our case of mathematics education) of knowledge transmission, dissemination, use and reproduction (Bernstein, 1990; Morgan, Tsatsaroni and Lerman, 2002).

It is also crucial to acknowledge that mathematics education research, and education research more generally, are usually *located* in departments of education in HE institutions, their principal *purpose* resulting from the training of future and in-service teachers and their overall project which historically has been a commitment to the improvement of education is affected by the overall *political context* (cf. Dale, 2001). This for example is evident today in the competing demands of having to act as a career academic and as a teacher educator.

This picture is further complicated once we consider that educational publishing which is a crucial agency in the process of validation, authorisation and dissemination of research productions, has multiple dependencies resulting from: its symbolic control function (specialisation in discursive resources which shape consciousness); its location within the cultural field but driven/constrained by economic imperatives; and its hierarchical location in the division of labour – as not only *diffusers* but also *shapers* of knowledge, in the sense that they influence what counts as developments or changes within sciences (Bernstein, 1990, pp.133-145).

All the above affect the degree of authorial agency, the author as intellectual researcher and as somebody who balances the priorities/demands of the journals, the official policy or research accounting procedures, while keeping her/his credibility amongst teachers (Nixon, 1999). Furthermore, developments towards electronic publishing might further change the relations between publications, publishing and its publics.

The theoretical perspective implied in the preceding description places our approach, broadly speaking, in the field of sociological theories of cultural reproduction - as developed in Bourdieu and Bernstein's work over many years. In addition, Bernstein's more recent work on intellectual fields and knowledge structures - which is the last stage in a cumulative and progressive movement of his theory through analyses of the reproduction, recontextualization and production of knowledge (Bernstein, 1996, 1999; Moore and Maton 2001) - allows us to see the field, as we shall argue in discussing our theoretical considerations further on in this section, as a series of positions, as a horizontal knowledge structure with a weak grammar, but also as a region (Morgan *et al*, 2002). It is therefore important for us to explore this internal structure and its grammar, as well as its external relations, and to be able to answer the following questions:

- How is the field of mathematics education shaping up?
- What changes are observable over time in the field?
- Are there any clearly constituted positions within the field?
- Who is defining what is mathematics education?
- Does it have strong boundaries *vis à vis* other areas of educational inquiry and social inquiry?

- What are the field's relations to agencies such as the State, and schools? In particular, does the field position itself critically *vis à vis* State power/knowledge?
- What are its predominant topics, issues, priorities, and emphases?
- What changes are there over time in the perceived addressees (teachers, policy makers, researchers talking to themselves, to other academic researchers, etc.)?

Our thinking has fundamentally been shaped by three kinds of assumptions and theoretical considerations:

(a) It is possible to envisage a situation where mathematics education (research and mathematics education as a discourse contributing to the training of teachers) has, in principle, an intellectual/theoretical/research orientation which is far removed from the practical concerns of the classroom. This theoretical possibility has, then, to be weighed against other such possibilities, as well as empirically available cases.

(b) The assumption above can be elaborated if we take on board Bernstein's (1990, p. 161-163) analysis on the changes over time effected upon the discourses which support and shape the training of teachers. Bernstein argues that the organisation of knowledge in colleges for the training of teachers entailed, first, the distinction between two discourses: a general discourse concerned with a body of knowledge called education, and specific discourses called professional subjects; that is the study of the subjects the student was expected to teach in schools (e.g. mathematics). The content of education varied, as did the discursive base of those who taught it. In England, in particular, Bernstein distinguishes the following stages in the transformation of these discourses. (1) a situation where the same lecturer covered both 'education' and professional subjects, (2) where lecturers where specialised to one or the other of the two discourses, (3) where 'education' itself consists of specialised discourses taught by specialists (philosophy, psychology, sociology, history), (4) when a new body of recontextualised knowledge is inserted between 'education' and professional subjects, 'curriculum studies' (technical in focus and in aspiration). According to Bernstein, a fifth (5), perhaps, stage is when the specialised disciplines which constituted 'education' in

stages 3 & 4 have been weakened as political, cultural and academic sites. Such weakening of the disciplines left only psychology, which with curriculum studies ensures a dominant technical training of teachers. Finally, he remarks, there were signs at the time of his writing that shows a movement to a sixth (6) stage where professional studies, carried out almost wholly in the schools, will be for the first time the dominant discursive base for the training of teachers. So Bernstein notes, as we move from stage 1 to stage 6 we move from the integration of education and professional discourses where education is dominant, taught by one college-based lecturer, to the dominance of professional studies located in the schools and managed by teachers. Furthermore, he notes, 'education' as Trivium was concerned with specialising the consciousness of the teacher, whereas professional studies as Quadrivium was concerned with specialising the performance of teaching in various subjects taught in schools[3]. The former was dominant in regulating the theory and setting limits on the practice in stage 1. Consequently, the technical was embedded in moral positioning. Stage 3 represents the period of the most obvious subordination of the Quadrivium of teacher training to its Trivium. The rise of 'curriculum studies' and its insertion between 'education' and 'professional studies' represents the beginning of the technologizing of teacher training and the shift to the importance of the Quadrivium of professional studies. Bernstein also makes some interesting points about 'curriculum studies', the dominance of which has also been marked by its close relationships to the state, at a time when the state began its move towards explicit control over the contents of the school. According to Bernstein's account, this is accompanied by the rise of the dominance of policy, management and assessment. The increasing technologising of teacher training, and the change of its discursive base, represents a major shift towards a secular concept of teacher education and perhaps is a condition for the shift to the 'regionalisation' of knowledge, defined as "the interface between disciplines (singulars) and the technologies they make possible" (Bernstein, 1996, p.65). Bernstein completes his analysis with the remark that the movement perhaps is going to be completed

[3] In the medieval university the Trivium consisted of grammar, logic and rhetoric, and the Quadrivium consisted of arithmetic, astronomy, geometry and music. See on this the very interesting twist that Bernstein (2000, pp. 81-86) gives to Durkheim's analysis of the discourses, social structure and social relations of the medieval university in his study of the evolution of education in France.

with the dissolution of the Trivium education and the dominance of the Quadrivium as school-based professional training.

(c) This historically sensitive and sociologically sharp analysis of education knowledge underpinning teachers' formation, we believe, can be further elaborated by considering the changes that have occurred in the organisation of knowledge by recent moves of the state to exercise control over not simply the reproduction but also the production of knowledge, and not just in education but in all intellectual fields of study. Also by considering the influences exerted upon knowledge by the location of a given field and its relationships to other intellectual or research fields; that is to say by the specificities of fields of intellectual production (Bernstein, 1999; Moore & Maton, 2001). Thus one crucial question of the field of study called 'mathematics education', as with every field of intellectual/academic/research production to a greater or lesser extent, is whether knowledge claims are legitimated on the basis of external relations of power or by principles intrinsic to knowledge itself. In Moore and Maton's (2001) terms, central to the form taken by intellectual fields is whether knowledge is addressed in terms of 'relations to' or 'relations within'.

In our research perspective then, formed by our main assumption and theoretical considerations, the study of the research activity in the intellectual field of mathematics education has to be conducted by developing ways of: capturing the changing nature of its discourse, locating its possible contradictions; and ultimately reading the positions that it creates for the researchers in the field through the resources that it makes available to them.

Methodology

In the context of this project journal articles and conference papers are seen as instances/representations of the research activity in the field under consideration. Despite the many criticisms directed to constructionism, and 'the textual turn' more specifically, and despite the new emphasis on more realist epistemological approaches to knowledge in recent years, few would want to dispute the view that to understand an intellectual field and its activities requires paying attention to the processes by which textual products are created, stabilised and bounded. This problematic has been developed most clearly in the field of the Social Studies of Science which has both

asserted the significance of studying scientific texts to understand science, and extended the model of text to describe it; especially to understand the boundary work accomplished with and by texts, processes which serve to sustain a social boundary (Tsatsaroni & Cooper, 2001).

We have already mentioned the categories of texts out of which our data were formed[4]. Whilst the choice of years of publications to analyse is to some extent arbitrary, it is based on two factors: we wanted to bring the analysis up to the present day; and we are most interested in the years since the entry of more social theories into the field (see Lerman, 2000). Given the size of the task, even just analysing the two journals ESM and JRME and the Proceedings of PME over 12 years it was necessary to make a systematic selection. In relation to ESM we have chosen to examine every article from every second 'book' (using the term 'volume' or 'issue' risks confusion). We consider that, in terms of randomness, the articles published bear no relation to each other or to authors' names, except for the Special Issues. In these cases, we conjecture that the only category affected would be the topic since methodologies, theories and all the other elements of our analysis will vary across these articles as much as in any other book. We have also examined the Special Issues separately for topic. For JRME, we have examined every article from every other book, and for PME the articles we chose were every tenth research report from each of the proceedings. Were there time, we would have liked to look back across the whole 50 volumes of ESM, the 33 volumes of JRME and the 27 years of PME and we expect that the changes would be quite substantial. We certainly expect less changes over a 12 year period but our project's focus is the field of mathematics education research more as shaped now, and on its future possibilities and prospects.

We have developed a tool of recording and analysing the specialised texts of the research community, not by using any existing methods of textual analysis, but by drawing broadly on Basil Bernstein's work; and as already mentioned, our thinking has been shaped in particular by his latest work on intellectual fields and knowledge

[4] Within the field itself, there are a number of other international journals with different orientations, including: Journal of Mathematics Teacher Education; International Journal of Computers for Mathematical Learning; Journal of Mathematical Behaviour; Journal of Mathematical Thinking and Learning, International Journal of Science and Mathematics Education and others. Authors may choose one of these if they wish their research to be read by members of the community with more specialised research interests. Alternatively, there are journals in other specialised fields such as assessment, sociology of education, educational psychology, and curriculum studies, where mathematics education researchers might choose to publish.

structures. For example, as indicated earlier, we have a view about the field as a series of positions, as a horizontal knowledge structure. We would therefore view new theories as, in general, positioned alongside other theories and not replacing them, as one might expect to happen in the development of theories in science. This tool has changed as we interrogated more articles and found our categories inadequate or requiring modification. A key factor has been the development of justifications for judgements, what Bernstein (2000) calls recognition and realisation rules, for what makes us place an aspect of an article in one category or another in an explicit manner. We are concerned that this project should be an empirical, descriptive study, and at the same time to generate a language capable of showing the effects of that which it describes.

Certain structural features, drawn from a variety of places, have been used to construct the tool (see Appendix 1). To start with, we have made a distinction between an orientation towards the theoretical or towards the empirical, according to which domain has been privileged. In recording the information, then, first we asked whether the authors drew on any theories or not. If they did, then we would look at what theory they drew on and whether they drew on theory explicitly or implicitly. After this, we would make a distinction between the orientation of the paper, towards the theoretical or towards the empirical. Articles in the first category may move to the empirical to illustrate the theory, but in this category the intention of the article is to present and perhaps to develop theory. Similarly, articles that are orientated towards the empirical may well draw on theory, but their orientation is towards describing and perhaps informing school practice, policy, or other site of practice. We then analyse how theory is used, whether it is supported or modified, and whether theories from other fields are used. If the orientation of a research paper was towards the empirical we looked at what was the focus of the empirical, whether school practice, researchers' practice, etc., and what methodology, data collection and analysis have been used. We also looked at the relationship between theory and the empirical, in the sense of whether the theory informs the empirical, is informed by the empirical, or there is a dialectic between them.

The next two categories of the tool, 'researchers' aims' and 'ideological affiliations' are used with the intention, first, to capture the purpose of the research and if this is in some sense pedagogic, the mathematical topic and the sector of education the article

is concerned with; secondly, to identify the addressees of the article, such as other researchers, researchers and teachers, etc; and thirdly to explore the question of whether the author(s) overtly adopt a particular ideological affiliation, such as feminist, post-modern, or other.

The final category examines the pedagogical model projected/promoted in the paper of the authors, where one has been identified. Here we have been influenced by Bernstein's classification of performance and competence models, and their subdivisions: within the former what Bernstein has identified as old and new performance models, and within the latter what he has named liberal-progressive, cultural-populist and political-emancipatory modes, each with its distinct ideology (Bernstein, 1996). The justifications used for distinguishing between different pedagogical models and modes are: (a) whether the authors look to competence of pupils, i.e. what the students know, based on what they say and write, or performance, i.e., directly on how they perform; (b) whether the focus of the authors was on groups or individuals, and (c) whether or not there was a concern for cognitive, cultural or political empowerment. Additional sub-categories have been derived from Morgan, *et al* (2002); and as seen in the item 5 of the analytical tool (Appendix 1), the category "pedagogical models" includes three sub-questions: The first is whether the orientation is towards a knowledge mode or towards pupils, the knower mode (see also Lerman & Tsatsaroni, 1998 and Maton, 2000). The second sub-question concerns the strategy (cf. Dowling, 1998, cf Brown, 1999), whether the authors look towards what is present or absent in students' texts and whether they make comments which present mathematics as a specialised or as a localised activity. For example, where everyday examples were used, we examined whether these were harnessed into the esoteric language of school mathematics or remained in everyday language and meanings. The third sub-question concerns the nature of the boundary between the everyday and specialised mathematics discourse and whether the boundary is presented as strong or weak.

The analytical tool has provided us with data on each text, which have been recorded in a database. This, also includes the usual reference, a summary of the topic of the research and, where supplied, the authors' keywords (we will use the plural 'authors' throughout the rest of this paper).

We will now take, as an example one article at random and indicate the rules by which we allocate classificatory criteria. We invite readers to follow and critique those rules. The article was published in volume 28 of ESM and the authors are Ma Tzu-Long Yang and Paul Cobb (1995). Looking first at theory, the authors are **explicit** about their use of Vygotskian theory (p. 4) and of finding inspiration in Bishop's work on enculturation (p. 3) in particular. It is a paper orientated to the **empirical** in that it looks to a study of Taiwanese and USA children to create theories for differences in competence in arithmetical thinking (p. 4). The empirical is privileged; explanations for differences in learning emerged by conjecturing influences from a reading of the data, not from within the theory. Its focus is on **school** practice and, further, looks at pupils' cognition. **Theory informs the empirical** as the researchers develop sociocultural explanations for the differences the two studies reveal (pp. 27-30). The authors address **teachers**, in providing implications for classroom practice (p. 31) but also **researchers** in their emphasis on what is revealed by their theoretical orientation (p. 29). The authors draw on Vygotskian theory, an intellectual resource beyond traditional psychology and mathematics. Below we will indicate that our classification of the theories authors have used takes mathematics and traditional psychology as the typical and records engagement with theories other than those. The authors do not seek to modify or critique the theory they have used. We categorise the location of their research as **using theory**. The article is not addressed to policy makers or official agencies but to the mathematics education community. Finally, giving a positive answer to the question of whether this article promotes a particular pedagogical model, we have identified its pedagogical orientation as being towards individual pupils, aiming at their cognitive development, and supported by a liberal-progressive ideology. Furthermore, the pedagogical discourse constructed draws a strong boundary between mathematics and the everyday, mathematics is presented as a specialised discourse and its pedagogy is that of what Bernstein has called invisible pedagogy, whereby the focus of the teacher is on what is present in a pupil's text-answer, leaving implicit the criteria for its evaluation.

Entering the data on a database provides us with the opportunity to look across the texts, to build a picture of changes over time and to assess the significance of different moves and debates. Thus we have aimed to answer the following main questions:

How is the field of mathematics education research shaping up, as represented in these specialised texts? Are there any clearly identified positions in the field of mathematics education research? Who are managed, whose identities are produced, who are the managers of these identities?

We feel that the work we have done enables us to make some interesting comments in relation to these questions. Two key reservations must be made, however. First, researchers, in choosing a forum for the dissemination of their research, make assumptions about the type of audience constituted by the participants at a conference or the readers of a particular journal, and their particular interests and orientations (Burton & Morgan, 2000). They are likely to orientate their style accordingly. From the analysis so far we cannot comment in an informed way on how researchers do change their writing for different perceived audiences[5]. Furthermore and relatedly, our footnote 4 concerning the authors' choices of journals should also be taken into consideration.

A final comment as to the overall methodological approach is here in order. If it is generally accepted today that all data is theory-laden, being explicit about one's own theory has been one of the basic principles shaping our methodological stance in this study. In developing the categories and sub-categories of the methodological tool we have, as already indicated, drawn on Bernstein's theoretical approach to the study of the different kinds of social activity and forms of practice. What is distinct about this theory is that, as Moore (2001a) remarks, it can provide a theory about theories. Following this theory also commits us to following its central methodological principle, according to which a theoretically informed, principled and detailed description is a necessary but not sufficient condition of research practice; that theory, in fact, has to be used independently in two directions, from the theoretical to the empirical and the reverse (Moore, 2001a; Brown & Dowling, 1998). In Bernstein's own terms, one has to strive to move from an external to an internal language of description; a language which can generate possibilities not yet realised in experience, and which can yield plausible interpretations and explanations about that aspect of the world with which the theory is concerned (Bernstein, 2000, pp. 131-141; Moore,

[5] In the on-going development of this project we intend to produce data by looking at articles of journals which are addressed to particular kinds of audience, such as teachers; and also by conducting a case study of MA and research students in mathematics education, to study the recontextualizations of

2001b). It is indeed this need to move to an internal language of description that has presented a challenge to us in the context of this study, but also some confidence about the way we have been going about making sense of our data.

Analysis of data

As already pointed out we have been particularly interested and challenged by the methodological problems in this research study. In the description of our findings we have struggled especially with the criteria by which we categorised aspects of the specialised texts under consideration. Furthermore, much greater have been the difficulties in our attempt to construct an interpretative schema to help us move our analysis beyond the first description; to create a language of description which would assist in the systematic analysis not just of this particular set of data but any set of such data and help us to address the research questions as formulated in the context of this project. In what follows then, first, we shall rely on our analytical tool of description to report on our data. Data will be discussed under the following three headings: 'Theories and research orientations', 'Research aims, addressees and ideological affiliations' and 'pedagogical models'. In the final subsection we shall present a schema that is emerging from the interaction between the theoretical and the empirical fields of our inquiry, and we shall exemplify its usefulness in the interpretation of the data.

Theories and Research Orientations

Under this heading we are addressing aspects of our data recorded in our tool of analysis as items (1) Theory & (2) Orientation (see Appendix 1): orientation to theoretical or empirical inquiry, whether the theories used have changed over time, whether researchers revisit the theories used in their studies, the relationships established between the theoretical and the empirical, the focus and the methodology of the studies. We shall also be able to draw on this data and on the initial details of publications recorded under (0) in the research tool, to start sketching a picture of the relationships of this field to other research fields as inscribed in the studies reported in the texts under analysis, and also to give a snapshot of the dynamics of the field, by looking at the researchers' engagement in debates within their community.

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research for these particular audience. The comparative analyses of the existing and this new data would enable us to investigate in more depth the issue in question.

Our analysis shows that (see Appendix 2, table 1 and table 2) 70.1% of all articles in ESM have *an orientation* towards the empirical, with a further 8.5% moving from the theoretical to the empirical, and 21.5% presenting theoretical papers. This has changed little over the years. Most of the papers use theory (92.7%), and more than four-fifth (86.4%) are explicit about the theories they are using in the research reported in the article. Again this has not varied across the years. Similarly, 86.2% of all articles in the journal JRME have an orientation towards the empirical, with a further 2.2% moving from the theoretical to the empirical, and 11.6% presenting theoretical papers. This has changed little over the years. Most of the papers use theory (83.3%), with a relatively higher percentage of papers that do not use any theory, compared to the other two journals considered here. Three-quarters (75.4%) are explicit about the theories they are using in the research reported in the articles. Again this has not varied across the years. Finally, 84.5% of all papers in the PME proceedings have an orientation towards the empirical, with a further 6.8% moving from the theoretical to the empirical, and 8.8% staying in the theoretical. This has changed little over the years. Furthermore 89.9% of the papers use theory, with 10.1% not using any theory, and more than four-fifth (82.4%) are explicit about the theories they are using in the research reported in the article. Again this has not varied across the years.

Some interesting changes have been depicted concerning the item '*theory type*'. The predominant theories throughout the period examined for all three types of text are traditional psychological and mathematics theories, but there is an expanding range of theories used from other fields. After a first listing of the theories used, table 3 (Appendix 2) was constructed out of the following categories: psycho-social studies, sociology/sociology of education/socio-cultural studies & historically orientated studies, linguistics/social linguistics & semiotics, philosophy/philosophy of mathematics, educational theory/educational research/neighbouring fields of mathematics education & curriculum studies. In the Table there is also space to record those cases where no theory has been used. To enhance readability, the data obtained from each type of text were grouped into two time periods (1990-1995 & 1996-2001), though detailed year by year tables are also available. The first interesting point to notice is that, as already said, the predominant fields from which researchers draw in all three journals are traditional psychological & mathematical theories, though the

percentage in JRME, in the first period, is substantially lower, compared to the other two. Over the two period spans papers drawing on traditional psychology and mathematics have decreased in PME and ESM (from 73.1% to 60.5% for PME; and from 63.4% to 51.6% in ESM), but have increased in the case of JRME (from 54.8% to 57.9%). As seen in table 3, this finding must be linked to the substantially higher percentage of JRME papers which exhibit an 'empiricism', i.e., did not draw on any theory in the first period (24.2%, compared to 6.0% in PME, and 9.8 in ESM), while in the second period there is a substantial drop in the papers that are found not to use theories at all from 24.2% to 10.5%. There is a drop also in ESM papers, but not substantial and a slight increase in PME papers that do not draw on any theory; though the numbers of the papers considered is small to allow any hypotheses. The second point to notice is that a good number of papers in all three types of text draw on psycho-social theories, including re-emerging ones, and that this is on the increase in ESM & JRME over the two time periods (from 9.8% to 20.0% and from 6.5% to 13.2%, respectively), with a very slight decrease in PME texts (from 11.9% to 9.9%). The papers drawing on sociological and socio-cultural theories are also on the increase (from 3.0% to 9.9% in PME, from 3.7 to 11.6% in ESM, and from 1.6 to 7.9 in JRME) but they are all below 12%; and there is a noticeable increase, over the two time periods, in the use of linguistics, social linguistics and semiotics in all three types of text, though the number of papers drawing on these are still very small. Finally, it is worth noticing that very few papers draw on the broader field of educational theory and research, and on neighbouring fields of science education and curriculum studies, and if anything percentages are falling.

In our analysis of *how authors have used theories* (see Table 4 in Appendix 2) we have looked at whether, after the research, they have revisited the theory and modified it, expressed dissatisfaction with the theory, or expressed support for the theory as it stands. Alternatively, authors may not revisit the theory at all; content to apply it in their study. We have found that in ESM 76.3% fall into this last category, 15.3% revisit and support the theory, whilst a little more than one percent (1.1%) propose modifications. No authors in our sample ended by opposing theory. This pattern has not changed over the years. Similarly, in JRME we have found that 73.9% have not revisited the theory at all, 7.2% revisit and support the theory, whilst only 1.5% propose modifications. Only one author in our sample ended by opposing theory. This

pattern has not changed over the years. In PME proceedings we have found that 76.4% have not revisited the theory, 7.4% revisit and support the theory, whilst 5.4% propose modifications. Here, too, only one author in our sample ended by opposing theory. This pattern has not changed over the years.

Regarding *the relationship between the theory and the empirical study* (see Table 5 in Appendix 2), in 65.5% of articles in ESM the theory informs the empirical, in 2.3% the empirical informs the theoretical and in a further 4.0% we determine that the relationship is dialectical. 7.3% did not refer to a theory either explicitly or implicitly. In JRME, in 71.7% of articles the theory informs the empirical, in 0.7% the empirical informs the theoretical but there are no cases in which we determine that the relationship is dialectical. 16.7% did not refer to a theory either explicitly or implicitly. In PME proceedings, in 79.1% of articles the theory informs the empirical, in 4.7% the empirical informs the theoretical and in a further 0.7% we determine that the relationship is dialectical. 10.1% did not refer to a theory either explicitly or implicitly.

Of the 67 theoretical papers across ESM, JRME and PME proceedings analysis of the *purposes* of the authors provides some interesting data (see Table 8* in Appendix 2.). The substantial majority (86.6%) engage with just two issues, 35 of the papers (52.2%) with improving research in the community whilst 23 (34.3%) are concerned with improving pedagogy. Just 3 (4.5%) study or engage with changing policy and the same number with improving teacher education. 2 papers (3.0%) engage with improving curriculum and 1 paper (1.4%) with studying teachers. As we will discuss in the final section of the paper these two main concerns typify the major orientation of the mathematics education research community, that of looking to research and to pedagogy at the same time.

We recorded information on the item *focus of research* by considering all papers which moved from the theoretical to the empirical and all empirical papers (see Table 6 in Appendix 2). Here we have used the following categories: researchers' practice; student teachers' practice; policy; and school practice, with a further category for other foci if they appeared. School practice is further split between agent/person, as teacher or pupil, and content, with content being sub-divided again into Bernstein's three message systems, termed *transmission*, *acquisition*, and *evaluation*.

There are very few articles in our sample of ESM from 1990 focusing on researchers' practice although there is a small increase in frequency since 1996. Similarly there have been very few articles focusing on student teachers' practice and an even smaller number on policy. The main two categories have been pupils as agents, an average of 32.4% of articles, and acquisition, an average of 38.1%. Teachers as agents had an average of 10.1% and transmission just 7.9%. Apart from a Special Issue on assessment, only 2 articles appeared in our sample focusing on evaluation. The emphasis on pupils from a content point of view (33.3% for 1990-1995 and 31.6% for 1996-2001) and on acquisition (38.1% for 1990-1995 and 38.2% for 1996-2001) has remained constant. In our sample from JRME, there have been, again, few papers from 1990 focusing on researchers' practice (2.5%); an average of 9.8% of papers have focused on student teachers' practice, with an increase in recent years, and 4.1% on policy. The main two categories have been acquisition, an average of (36.9%) and transmission (16.4%). Pupils as agents had an average of (15.6%) of articles, teachers as agents an average of 9.8%, and (4.9%) focused on evaluation. Finally, there have been few papers in our sample from PME proceedings from 1990 focusing on researchers' practice 3.7%; an average of 6.7% of papers have focused on student teachers' practice, with an increase in recent years (4.8% for 1990-1995 and 8.3% for 1996-2001), and no papers on policy. Main categories have been pupils as agents, an average of 51.1% of articles, and acquisition, an average of 11.9%. Teachers as agents had an average of 15.6% and transmission just 8.9%. Only 0.7% focused on evaluation. The emphasis on pupils from a content point of view has remained high (57.1% for 1990-1995 and 45.8% for 1996-2001) and on acquisition has increased substantially in the last 6 years (from 1.6% in 1990-1995 increased to 20.8% in 1996-2001).

Looking at the data from the point of view of *the methods* used in reports on empirical studies in our sample, we observe that, on average, there is a major emphasis in PME and ESM on qualitative types of inquiry (63.7% and 62.6% respectively), with 16.3% and 15.8% quantitative, and 20.0% and 21.6% mixed methods respectively. JRME places equal emphasis on quantitative (43.4%) and qualitative (41.0%), while 15.6% in the sample uses mixed methods (see Table 7, in Appendix 2). In order to discuss the pattern of change over time we have collapsed the data as before into two (6-year) time periods, a further justification being that the number of ESM articles with an

emphasis on quantitative methods falls off dramatically in 1996. We should note here that we have looked at equal sized samples in each journal/conference proceedings each year and that we weight papers from proceedings at same level as the two journals and therefore we have produced unweighted totals. As shown in Table 7 (Appendix 2):

1. There is a decrease over time (the two periods) in the number of articles that use quantitative methods in both journals, but an increase in PME.
2. There is an increase in the number of articles using qualitative methods in the two journals but not in PME.
3. The percentage of articles with quantitative and qualitative methods are the same in JRME, but qualitative methods are higher in both PME and ESM.

To account for this pattern of change we, first, contrast journal articles with the proceedings and on the basis of it we can argue that there appears to be a policy or regulative mechanism in place in the two journals that encourages researchers to move from quantitative to qualitative methods. Such a drive is not evident in PME. By comparing, secondly, the differences/similarities between the proceedings, on the one hand, and each of the journals, on the other, a policy of a balanced use of qualitative and quantitative methods can be hypothesised for PME and JRME, but not for ESM. Thus given the initial emphasis on qualitative methods in PME, the existence of such regulation explains the increase in PME of quantitative, and not of qualitative, research over the two periods. Similarly, given the initial emphasis of JRME on quantitative research, such policy explains the increase in qualitative research, and the balance overall over the two time periods[6]. Finally in comparing the similarities and differences between the two journals, the influence of context (USA vs Europe) must be considered. JRME, as already shown moves from an initial emphasis on quantitative to qualitative with achieving a more balanced use of methods. In contrast ESM's commitment to qualitative research appears to be stable over the two periods. Tradition and fashion in Europe could account for this preference and commitment to qualitative kinds of inquiry. One could also venture the interpretation that this commitment to qualitative research on the part of ESM (e.g. its

[6] While we use 'regulation here we do not simply refer to editors' actions. Rather we point to the need to investigate the whole process of demand/supply of papers, e.g. through the analysis of our interviews

editors)[7] might also be evidence of the existence of pockets of resistance to external attempts to regulate the field, which are at present witnessed in educational and social research more generally. Thus a balanced use of methods might be but an imposed measure, a social control mechanism which appears as a plea for more realistic or pragmatic approaches to social inquiry. Or according to other social theorists, this is the era of re-emerging 'positivity' where there is a subtle critique and commentary still to be undertaken, yet on the whole one feels that many of the disputes and dualisms have run out of steam; that the very idea of coherent, boxed up and incommensurable 'paradigms' as a way of classifying and dealing with theoretical and methodological disputes in the social sciences no longer reflects the more fluid and pragmatic way in which standard issues are addressed today (cf MacLennan, 2000).

Thus far we presented data recorded in categories (1) and (2) of the research tool. On the basis of this data and the initial details of the papers in our sample (recorded in our database under (0) in the research tool) we wish to address now the question of *what resources* researchers draw upon in their research as it appears in publication. This is also to address *the question of the relation between Mathematics Education Research and Other Fields*. To start with, these issues relate to our findings concerning the theory type used in the research, as presented in Table 3 (see Appendix 2). Secondly, we should emphasise that it is not uncommon to find a substantial and informed review of literature in an article, in which the range of theoretical resources drawn on by others are noted, but then for the authors not to use any theory themselves, at least explicitly. One might suggest that an element of accepted style for publication may account for this rhetorical reference to theories. Thirdly, it is important to remember our discussion in the theoretical section, according to which research in mathematics education is a horizontal knowledge structure; and it is a region (Bernstein, 2000) in that it is a field that looks inwards to theoretical fields (psychology, sociology, anthropology etc.) and outwards towards practice. New theories and perspectives

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with editors, and furthermore to obtain data on overall submissions and rejections of papers by Journals.

[7] Compare: " It also reflects an attitude amongst the ESM editors which I would describe as one of openness to different approaches, as long as there is some clear sense of intellectual discipline behind them" (Ruthven, former Editor-in-Chief of ESM, 2002, personal communication). One could argue that there is compatibility if not correlation between 'openness to different approaches' and (commitment to) 'qualitative kinds of inquiry'. Or to put it differently one could ask whether moving away from the

often develop by drawing upon different intellectual fields than those used before, or alternative aspects of those fields. They do not replace former theories but sit alongside them, and the field develops through the addition of a new language, an additional segment, rather than through achieving greater generality and integrative potential (Bernstein, 1999; Morgan *et al*, 2002). We might suggest that there is a connection here with creating identities, making a unique space from which to speak in novel ways, but we would need another study to substantiate and instantiate this claim. Therefore, the issues of resources used and of the relationships between mathematics education research and other fields are complex but it is vital to attempt to make sense of our data from this point of view. Following Kilpatrick (1992) we take psychology and mathematics as having a long history as intellectual fields at the heart of the discipline and comment on other intellectual resources as they have appeared in our sampling and recorded in detailed year by year tables. We listed the theoretical fields drawn upon by authors, and we based our judgements on authors' explicit references to them, some of whom were referring to a named authority. These fields or names represent theories used, not the frequency of their occurrence in papers. We grouped these together, using categories which are readily recognised among the members of this research community. In ESM, there is an increase in the number of fields during the period examined. It also appears that while psycho-social approaches are used steadily, quite a range of social/sociological as well as socio linguistic theories are being used increasingly by authors, though the numbers remain small. In JRME psycho-social theories appear to be constant in the authors' preferences over the whole period but here, too, a broader range of intellectual fields, mainly theories from sociology, socio-cultural studies, linguistics, social linguistics and semiotics, though in small numbers, have been used during the years examined. In PME proceedings, which traditionally is dominated by Psychology, as its name also states, there has been a substantial increase in the number of fields from 1994, although it is too early to say whether this trend will continue, as 1999 and 2000 showed a dropping off – though not in 2001. What is clear is that the range of intellectual resources today is somehow broader than the beginning of the 1990s.

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dominance of psychology/quantitative research in education and to the sociological, linguistic or feminist theories could not account for this.

If we now concentrate on the field itself, our analysis reveals few articles that engage in current *debates* within the community. All of them fall within the theoretical category. In ESM there are three (2 papers on Piaget/Vygotsky, one on embodied cognition); in PME there are 4 papers (one on the 'math wars', two on constructivism, one on structuralist versus realist didactics) and in JRME there are 6 papers (five on constructivism versus social theories and one on implementation of the Standards in the USA).

Research aims, addressees and ideological affiliations

Under this heading we shall present our data recorded in categories 3 ('researchers' aim'), and 4 ('ideological affiliation') of the research tool.

Under the category *researchers' aim* we first considered the purpose of research for which the following 11 categories were identified: Improve pedagogy; Improve evaluation; Improve curriculum; Improve teacher education; Improve research; Study students' understanding; Study students' beliefs and attitudes; Study teachers; Study or change policy; workplace mathematics; other (see Table 8, in Appendix 2). The data shows that the majority of papers report on research the aim of which was to improve pedagogy, an overall of 51.8% in the whole sample (55.4%, 50.0% and 49.3% for ESM, JRME and PME respectively). The study of students' understanding comes second in the preoccupation of researchers, an overall 13.0% in the whole sample, with PME papers being more interested in this category than the other two kinds of texts (16.2% for PME, while 11.3% and 11.6% for ESM and JRME respectively). This category is also third in the preferences of researchers in our sample publishing in ESM, while second in their preference is the category 'improve research' (14.1%, but only 8.7% and 9.5% for JRME and PME respectively; and overall of 11.0% in the whole sample). 'Improving teacher education' is also an important purpose of research, more so in JRME (10.1%) and PME (9.5%) than ESM (4.5%); and an overall 7.8% in the whole sample. Research to 'study teachers' accounts for 5.4% of research in the whole sample, with PME papers showing the greatest interest (8.1% in PME, but 4.0% and 4.4% for ESM and JRME respectively). The percentages in the rest of the categories are very small, with some of them under 1%.

To get a better picture of the general category 'aims of research', we also recorded information on the *topic* and the *educational sector* for all papers which either had an empirical focus or moved from the theoretical to the empirical; the leading question here being whether there were specific mathematical contents/topics researchers are interested in studying. An overall 21.7% of the papers were classified as 'other' (23.0%, 18.0% and 24.4% for ESM, JRME and PME respectively), indicating that a high percentage did not do research either on a specified mathematical topic, or the cognitive aspects of school mathematics (see Table 9, in Appendix 2). 'Other' included articles addressing attitudes, beliefs, teachers' pedagogical content knowledge, cultural conflicts, social interaction, reflection and communication, language for teaching and learning, etc. where no specific mathematical content was addressed or used as exemplar. An overall 12.6% of the papers in the sample had as their topic mathematics in general (15.1% in ESM, 16.4% in JRME; but only 6.7% in PME). The spread of mathematical topics is very wide, as may be expected. In ESM the most common topics are: problem solving 12.2%, Geometry 10.1%, function & graph 6.5%, algebra 5.8%, number concept 5.0%. Of interest is the evidence that problem solving has the largest focus, followed by geometry. Most of the articles on problem solving appeared between 1996-2001. For JRME, the most common topics are: problem solving 13.9%, Geometry 8.2%, fractions 7.4%, advanced mathematics 5.7%, arithmetic 5.7%, and number concepts 5.7%. Articles have a concentration on problem solving in the years between 1990-95, and a substantial decrease in the time period 1996-2001, a tendency which is opposite to the tendency in ESM. For PME proceedings, the most common topics are: problem solving 14.8%, algebra 9.6%, advanced mathematics 7.4%, function & graph 6.7%, geometry 5.2%, number concept 5.2%. Interest in problem solving is the most prominent in both time periods, but with a slight decrease in the second.

Concerning the *age-group/sector considered in the research*, secondary/high school age is the predominant interest of authors published in ESM, with 38.9% of all articles in the sample, primary/elementary being the sector considered for 25.9%, with a further 7.9% addressing the overlap of primary/elementary and 1.4% addressing secondary/high school age. Students at University are the focus of 6.5% of papers, with only a slight tendency towards an increase in this focus in recent years. Otherwise the pattern is consistent across the period. Primary age is the predominant

interest of authors published in JRME with 41.8% of all articles in the sample, secondary/high school being the topic for a further 20.5%, whilst 6.6% were concerned with the overlap of primary/elementary and 0.8% with secondary/high school age. A further 7.4% looked at higher education. Secondary/high school age is the predominant interest of authors published in PME proceedings, with 31.1% of all articles in the sample, primary/elementary being the topic for 24.4%, with a further 5.9% addressing the overlap of primary/elementary and 1.5% addressing secondary/high school age. Students at University are the focus of 12.6% of papers. The only change over the period has been an increase of papers on the overlap of primary/elementary and secondary/high school age.

Concerning the ideological affiliations, we looked for articles in which the author specifically announced her/his position in relation to an ideological affiliation. In fact there were very few indeed, just 4, two of which adopted a feminist affiliation (both in ESM) and two a political affiliation (one in ESM and one in PME).

An analysis of addressees is not an easy matter and requires careful consideration of criteria for classification. We have used the authors' own references, usually in the discussion or conclusions section, regarding to whom the research speaks. We have drawn on four categories here that have arisen purely pragmatically: researchers; researchers and teachers; researchers and teacher educators; and researchers and policy-makers. (see Table 10, in Appendix 2)

In the ESM journal, almost three-quarters of papers (72.3%) are addressed to researchers and teachers, almost a fifth (19.8%) to researchers alone, the remainder being to researchers and teacher educators (5.7%) and to researchers and policy makers (2.3% to). The two categories, of researchers and teachers and of researchers, appear more frequently in the last 3 years. 65.9% of articles in JRME are addressed to researchers and teachers, 10.9% have addressed researchers, 14.5% researchers and teacher educators and 8.7% have addressed researchers and policymakers. In PME, three-quarters of papers (75.7%) are addressed to researchers and teachers, 12.2% to researchers and teacher educators, 8.1% to researchers alone, and 4.1% addressed to researchers and policy makers. The category of researchers and teachers educators appears more frequently in the last 3 years.

Pedagogical models

It is common place to say that a major aspect of the legitimation process of all research activity involves the use of strategies through which researchers and their field of specialism keep their distance especially from the field which is supposed to constitute its application, though the strong or weak boundary between these two fields is relative to historical and social conditions. Whether, therefore, this research field, as it appears in publications, projects implicitly or constructs explicit models of pedagogy is what we are trying to establish here.

Our data reveals that the percentage is similar for all three specialised texts where we have identified a pedagogical model, 85.3%, 89.1% and 83.8% for ESM, JRME and PME respectively; while the percentages of those for which we cannot find evidence of pedagogical models are 14.7%, 10.9% and 16.2% respectively (see table 11 in Appendix 2). The first observation relates to the ideology that supports these models (see Bernstein, 1996; Morgan *et al*, 2002). Here it is interesting to see that the old performance models with the traditional individualistic approach to teaching and learning are hardly promoted in the three kinds of texts with an identified pedagogical model, the percentages being 1.7%, 3.6% and 4.1% for ESM, JRME and PME respectively (see Table 12, in Appendix 2). In addition, we found that what Bernstein calls new performance models are rarely acknowledged (0.7% in the whole sample). All three kinds of text promote individualistic cognitive understanding in equal respects, which are supported by a liberal progressive ideology (ESM 72.3%, JRME 70.3%, PME 73.0%). Alternative modes within the competence pedagogical model, and equally individualistic in their ideologies, such as those that aim at pupils' affective or social development are promoted only in a few papers in our sample (affective: 6.2%, 6.5%, 1.4%; social: 4.0%, 8.0% and 2.7% for ESM, JRME, and PME respectively). Other pedagogical models, more radical in their ideologies, which aim at groups' cultural or political empowerment have been identified only in PME papers, but the percentages are not significant. This is an unexpected and somewhat surprising finding (but see our note 6 above). We thus also conclude that most of the texts with an identified pedagogical model have an orientation to the knower rather than knowledge. Furthermore, the majority of papers with an identified pedagogical model are found to promote an engagement with mathematics as a specialised form of activity (Dowling, 2001), the percentages being 63.8%, 71.7% and 56.8% for ESM, JRME and PME respectively; while an overall of 9.5% in the sample construct

mathematics as a localised activity (see Table 13 in Appendix 2). Also the majority of papers promote a focus on what is present in the pupils' text, the percentages being 71.8%, 73.9% and 62.8% for ESM, JRME and PME respectively, which keeps the criteria of evaluation implicit and unknown to the pupils. Finally, the majority of papers project school mathematics as a subject with strong boundaries separating it from pupils' everyday experiences (63.3%, 68.8% and 52.7% for ESM, JRME and PME respectively). Where it was not possible to evaluate the specialised/localised, presence/absence or strong/weak boundaries the table records 'no evidence' (See Appendix 1 and Table 13 in Appendix 2).

We conclude that the everyday school practice features in a normative way in mathematics education research and that the main practice promoted is the one which is supported by a liberal-progressive ideology, aims at individual cognitive understanding, is orientated mainly to the pupil-knower and, consistent with these characteristics of the model, it indicates that the focus should be on what is present in the student's text and on mathematics as a distinct, specialised form of activity. However the feature of the strong boundary between mathematics and the everyday experiences of pupils shows some degree of inconsistency in the construction of this pedagogical model.

Discussion and concluding remarks: The mode of regulation of the mathematics education research field

In our endeavour in this project to map aspects of mathematics education research, to study the pattern of change, and the mode of (self-/other-) regulation, we in fact are seeking to analyse changes in the form of specialization of its research activity. Questions such as where is the field standing in the wider field of intellectual knowledge production, how are the field's actors positioned concerning their own productions, what is their position vis-à-vis the official education discourse and everyday school practice were the questions that orientated us in developing the analytical tool, and the recording, analysis and interpretation of data. Underpinning these questions is the view, informed by Bernstein's theory, that changes in power relations, consequently changes in the degree of (self-/other-) regulation and the form of consciousness/identity of the agents in the field, are inscribed in the form of research activity characteristic of the field.

The features of the activity that our data represent can be mapped onto two main axes (cf. Muller, 2000). The *vertical* axis gives us information on the agents' *positioning* in their activity, with *looking inwards and looking outwards* as the two sides of the axis. 'Inwards' refers to either or both the wider intellectual field, or/and their own field, while 'outwards' refers to either or both the public sphere or/and the state/school field. The *horizontal* axis gives us information on the *form of* the agents' *engagement* with the activity. This again involves either a *critical* or a *functional* stance, as the two sides of the axis. 'Critical' presupposes an engagement with intellectual resources (of their own or others) with a view to *developing* their (and other) field(s) resources of research or an engagement in activity seen as *strengthening* the public sphere (including the schools). Functional refers to an engagement with their (or others') field(s) resources which is *using* the resources to carry out /*describe* what is perceived as their task or an engagement which uses the resources to *prescribe* actions in the field perceived as the field of its application. Accordingly, four positions are derived that constitute the model: *Academic intellectual*, *career academic*, *public intellectual* and *(teacher) educator*. Needless to say we cannot expect to find in our data pure positions. They are not ideal types either, but they have been generated to assist in the description and explanation of the empirical.

The development of this tentative, as it may be, interpretative schema (model) – presented in *Figure 1* (see Appendix 3) - through a back and forth movement from the theory to our empirical material, that also involved a refining of the analytical tool, constitutes our final stage in the development of the methodology in this project (Brown and Dowling, 1998). For this (as well as practical) reason(s), instead of discussing our overall results and conclusions we shall now try to exemplify the schema by drawing upon aspects of our data and findings, and attempt to show its methodological significance.

It is very clear in our data that empirical kinds of inquiry rather than theoretical elaborations constitute the main feature of the research activity, as the majority of the papers examined engage in empirical investigations (70.1%, 86.2% and 84.5% for ESM, JRME & PME respectively; see Table 1 in Appendix 2). It is also clear that reference to some theory is a feature that the researcher has explicitly and perhaps routinely demonstrated in the process of empirical investigation. In particular, theory appears to be informing the empirical in the majority of papers (65.5% in ESM,

71.7% in JRME, 79.1% in PME; see Table 5 in Appendix 2). Our data also suggests that 76.3%, 73.9% and 76.4% for ESM, JRME & PME respectively are content with applying the theory rather than engaging with it in any other way (see Table 4 in Appendix 2). Here it is also interesting to observe that this feature appears to be constant, as we have not observed in the data any change of pattern. One can hypothesise that we have a case of a research field/community where *to be seen to be doing research using and applying theory* seems to be the main pattern. In terms of the methods of inquiry used, if our initial interpretations are sound, the drive towards balancing qualitative and quantitative types of inquiry in the three examined sites of research publication might indicate the adoption of a pragmatic attitude towards research, consistent with the overall tendency in the social sciences towards a new positivity in the '90s and beyond, as described in the relevant literature. It is worth noting though that the commitment to one's own values in research, as the findings indicate for ESM, is both a feature of a previous era in research, and of a different mode and positioning in the research field, that of the *academic intellectual researcher.* Another important feature of the research activity in this field appears to be the drive to draw on resources from other fields. Our data shows that the range of the theories researchers in the field draw on is changing, and an expanding range of theories is being used in all three kinds of texts examined. Especially interesting appears to be the finding that there is an increase in the use of broadly sociologically informed or, say, socially sensitive theories, in which we include psycho-social, sociological, socio cultural theories, and the fields of linguistics, social linguistics and semiotics (See Table 3, in Appendix 2); this is the case especially for the articles from ESM and JRME, where we found an overall increase of about 22% and 17% respectively over time. We wish to make two remarks here. First one can link the finding concerning the ESM journal to the previously commented tendency to stay consistently with qualitative research thus strengthening the positioning of the academic intellectual/researcher. But secondly, the finding that in all three kinds of text the tendency to draw on other theories, when linked to our findings on method and on how theories are used can be interpreted as a tendency to *instrumentalise* theories, including social/sociological ones. This can support the argument about a positioning in the field as a *career academic*, a positioning which might also reveal the existence of pressure exercised upon researchers to appear that by always drawing on new theories they are innovating, making unique spaces from which to speak in

novel ways: career advancement or survival strategies, no matter what. This interpretation can also be supported by the finding that very few articles have been engaged in opening debates in the period examined.

The finding that concerns the addressees of research productions is also absolutely crucial in our overall interpretation. The main addresses appear to be the category 'researchers and teachers' (72.3% in ESM, 65.9% in JRME and 75.7% in PME), with the category 'researchers' as addressee being 19.8%, 10.9% and 8.1% (see Table 10 in Appendix 2) respectively. It is also interesting to note that in PME the second category of addressee is 'researcher and teacher educator' (12.2%) and that in JRME there is a 14.5% addressed to 'researchers and teacher educators' and a 8.7% of papers addressed to 'researchers and policy makers' (see Table 10 in Appendix 2). We see here a clear tendency to positioning which looks outwards, beyond researchers, to teachers but also to teacher educators, though there is an increase in frequency of researchers being the only addressee in the last three years in ESM, and an increase in researchers and teacher educators being the addresses in the last three years in PME and JRME. Linking these findings to previously commented findings, we shall argue that the positioning constructed in ESM appears to, somehow, diversify vis-à-vis the other two cases where the main drive, and increasingly so, is to *look outwards* towards the field of, mainly, the school but also to policy.

In considering now the findings of the items researchers' aim (purpose/topic/sector) together with the items 'focus' of research and 'pedagogic model', we argue that the picture gets further elaborated. The finding that 'mathematics education' seems to define its space of activity almost exclusively around the school suggests to us that there is no sign of a positioning in the field of research where the *public intellectual* would have a role to play, that there is no value in recognition. It is interesting to note that the level of education that is considered to be the legitimate space where activity is concentrated is compulsory schooling – either secondary as in ESM (38.9%), and PME (31.1%) or primary as in JRME (41.8%). If we now link our finding that the most frequent topic investigated is problem solving and that this interest appears to be persistent as the focus of research in the period examined (12.2% in ESM, with higher percentages in the time period 1996-2001; 13.9% in JRME, with higher percentages for the period 1990-95; and 14.8% in PME, with only a very slight decrease of interest in the period 1996-2001; see Table 9, in Appendix 2), we can argue that the

overall concern over the period is with the *learner of compulsory schooling*[8]. More concretely we see that in ESM 32.4% of publications in the sample focus on pupils and 38.1% on acquisition, while in JRME they focus on acquisition 36.9% but also on transmission 16.4%; in PME we have a focus on pupils (51.1%) and acquisition (11.9%), with an increase in acquisition in recent years (see Table 6 in Appendix 2). While the latter finding might indicate some kind of impact on research of the turn to social/sociological theories, it is more likely that the interest is not, on the main, with *description* but rather with *prescription*. This view is supported by our findings on the purpose of research, where an overall of 51.8% in the sample has as its aim to improve pedagogy, and an overall of 13.0 aims to study students' understanding. We should note however that the higher percentage of ESM papers with an interest in improving research might indicate a difference in positioning.

Our interpretation that the most dominant positioning is of the *researcher as teacher educator* can be further supported if we look at our findings on the item 'pedagogical model'. Most papers explicitly construct a pedagogical model (85.3%, 89.1% and 83.8% in ESM, JRME and PME respectively; see Table 11 in Appendix 2). The model prescribed is that of the *individual learner-knower* – consistent with the interest in problem-solving as the focus of research – with almost all the features of liberal-progressive pedagogy being valued overall. Furthermore the finding that almost no political or cultural empowerment models of pedagogy are prescribed supports our view already expressed that the intellectual resources used, and expansively, serve purposes to do with the positioning of a career academic or, in the case of ESM, of an attempt, perhaps, to mobilize resources that would help one resist and/or strengthen the image of researchers in the field as academic intellectual/researchers. In this latter case it is interesting to note that the liberal-progressive model appears to be the dominant model in ESM as well (individual cognitive understanding 72.3%, orientation to what is present 71.8% (See Tables 12 & 13 in Appendix 2).

Bernstein's theory has been concerned with "how distributions of power are realized in various, and often silent, punctuations of social space which construct boundaries". It has been equally concerned with "how these boundaries are relayed by various pedagogical processes so as to distribute, shape, position and opposition [different]

[8] Interesting to note here that adults learning maths appear as a distinct area of research with its own publications and conferences and this phenomenon (of divided spheres of expertise) is worth

forms of consciousness" (Bernstein, 2000, p. xiii). Mathematics education research has been historically hetero-regulated in that it emerged in the processes that Bernstein has called the technologising of teacher training and a redrawing of the discursive topology of educational studies (see our discussion in the section "The politics of knowledge (re)production"). The identities of academics in the field bear the marks of this fundamental historical turn. The image of the career academic standing alongside the researcher as teacher educator points to Bernstein's remarks again that there are attempts currently to produce identities whose products have an exchange value either within their own field or (as experts) in prescribing action in their perceived field of application, and preferably within both; with signs of an increasing value placed upon it, and upon a short term rather than a long term commitment (e.g. to theories), upon the extrinsic rather than the intrinsic, upon the exploration of applications rather than upon the exploration of knowledge. 'Inner dedications', as he also observes, perhaps are not encouraged (Bernstein, 2000, p.69). A further consequence of creating a new stratification both of knowledge and identities, widely evident today in the field of social research, is also not far fetched as one of our possible conclusions. Finally, while the attempt to look both inwards towards one's own (and others') resources as an academic intellectual seems to contrast sharply with the outwards looking, the researcher as teacher educator *cum* expert might be partaking in processes that create today what Bernstein, also, has called a 'pathological' position, a schizoid position in the field of education (Bernstein, 2000, p.71).

Reflecting upon this study, it is difficult to deny that, to a certain extent, it is contaminated by the now dominant discourse of accountability, which affects every aspect of social activity. The crucial question relates to whether this particular response works to weaken and resist accountability talks; whether it can be read as part of a movement in educational research which attempts to subvert from within the accountability discourse (Atkinson, 2003). Here we would agree with Luke (2003), when he argues that rather than simply rejecting accountability, practitioners in a field of activity need to draw on broad intellectual resources, in order to identify the spaces in the 'double talk' of policy makers, and to engage critically with them. One important resource for the field and sub-fields of educational studies, we wish to

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investigating further; similarly for the research field called public understanding of mathematics.

argue, is Bernstein's approach and theory, as it is permeated by a fundamental value of utmost importance to developing a strategy that aims to subvert such a discourse. This value is expressed in Bernstein's view that the clearer and more efficient the language of description of social/educational realities, the more critical the resulting accounts; and the more precise the description of where and who we are as educational researchers, where and how our field is located, the richer the reservoir of critical resources in the field.

The prevailing picture of the general field of educational studies is one in which discourses constituting it have multiplied, but its sub-fields are becoming more detached and insulated from one another (cf. Ball, 1998). Within sociology of education, the traditions of which naturally make subversive discourses available, 'policy sociology' is one of the dominant currents. Despite its many strengths, one can trace an anxiety permeating its responses to the accountability discourse. In its reflections about the possibility of developing an overall explanatory schema or conceptual framework in the study of policies and practices in education, one can discern a 'crisis talk' (e.g Whitty *et al*, 2003). This is not to deny that there are some real problems in the esoteric domain of the field worth considering – as it is common place to say that sociology of education is characterized by a diversity of approaches, but not an overall consensus – such as the kind, form and status of the explanatory accounts deployed in the field. But the 'crisis talk' can also be seen as an effect of accountability discourse, a particular response of this field to an anxiety about the 'policy epidemic' (Levin, quoted in Ball, 2001a) affecting educational research, its own research practice included. Such anxiety can push research towards more 'pragmatic', consensus-based ideas and judgments. So it is in the capacity of Bernstein's theory to organize such conjectures, to direct the process of investigation, and to arrive at a systematic description of research practices in a field that we find the evidence that this theory is worth preserving and developing.

Still, there is a major question for us, the authors of this paper, which challenges us to think further: resorting to Bernstein's theory at times of anxiety within a field might, itself, be part of a pragmatic strategy of survival. At the same time, in resorting to this theory, one's account becomes more systematic and deeper. What are the essential qualities of this theory that can account for these two contrasting possibilities (Tsatsaroni & Crysafi, 2002)?

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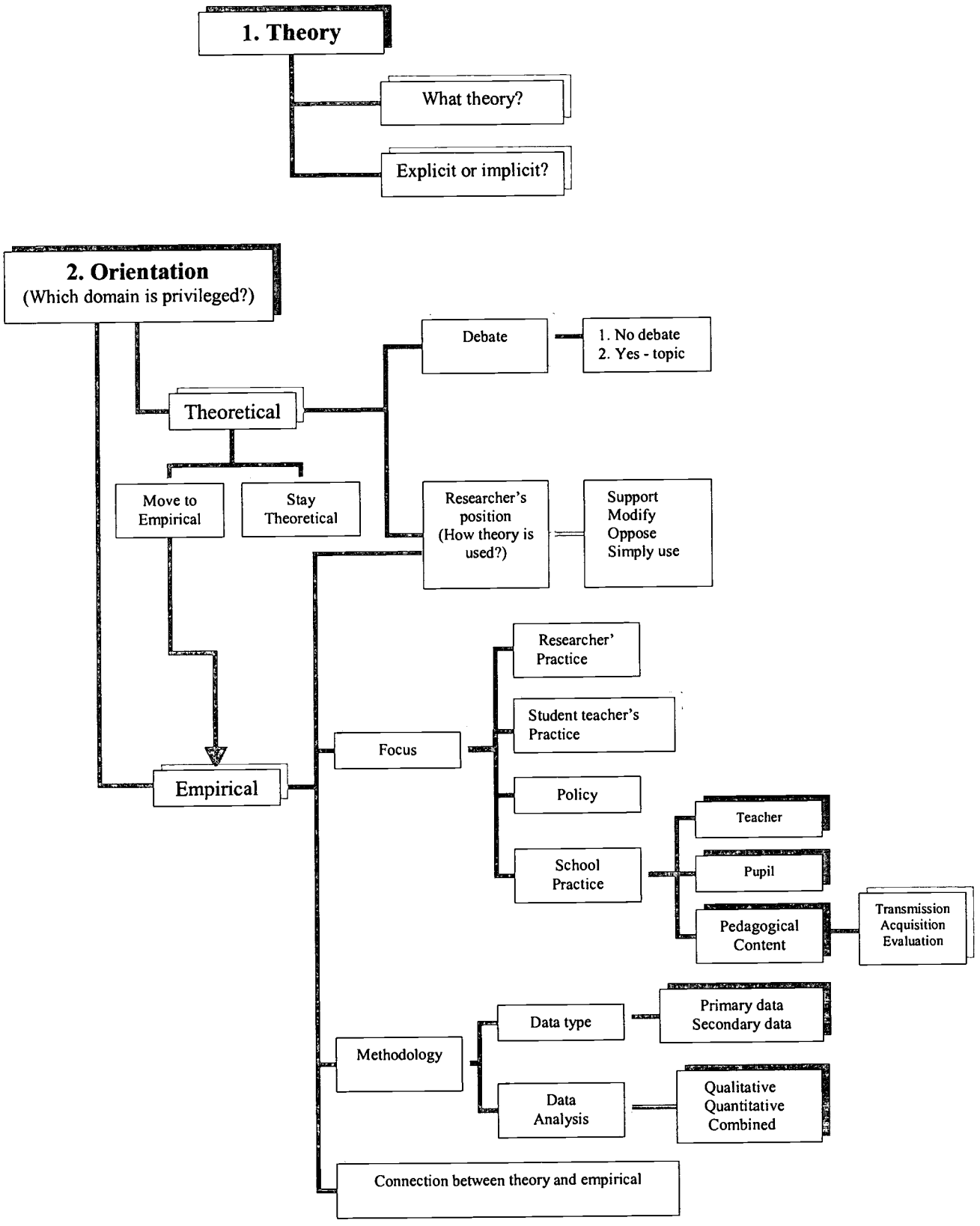
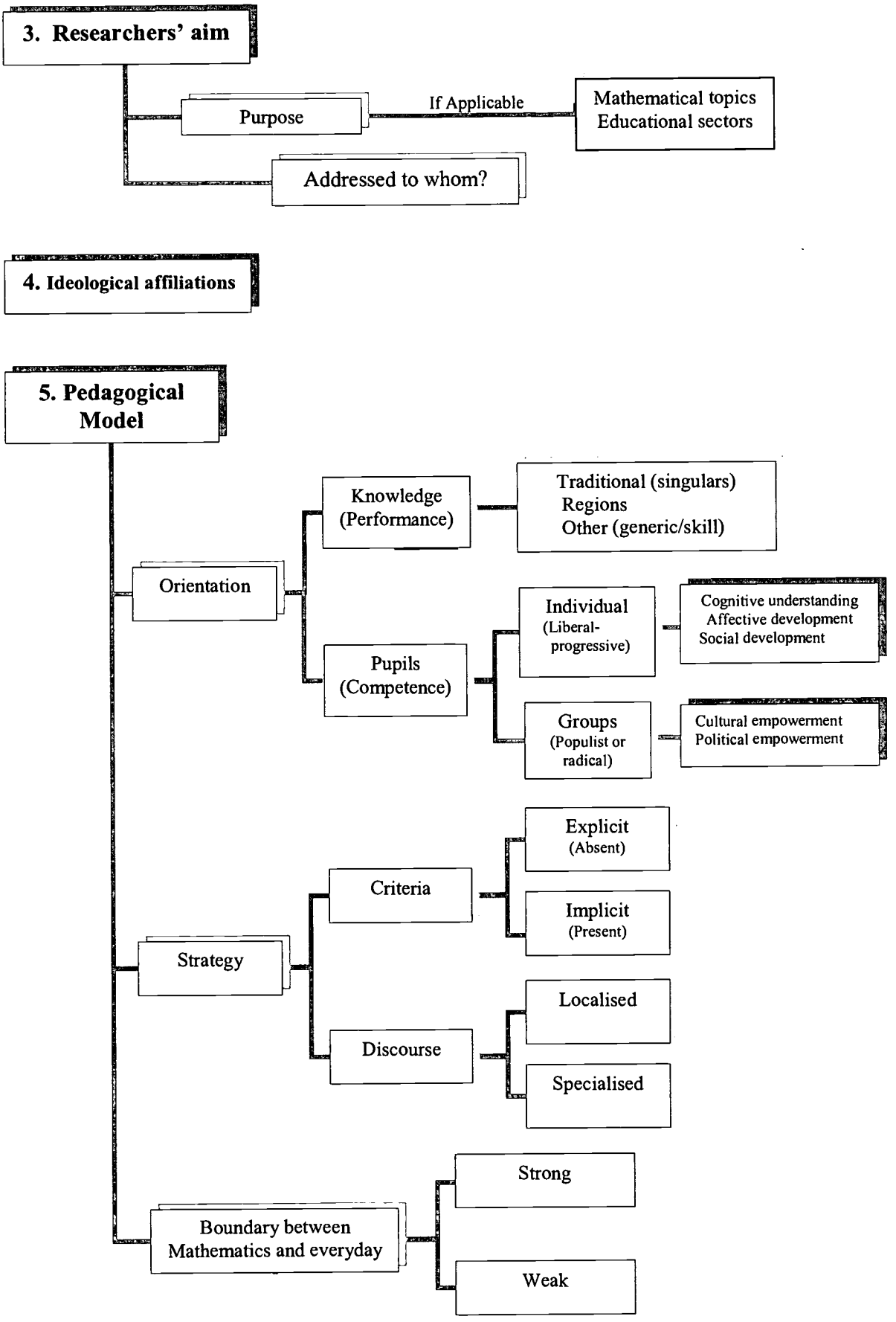
Appendix 1.

0. We listed the following: Title, Author(s), No. of the Authors, Name of the Journal, Brief description and Authors' keywords.





Appendix 2.

Table 1. Orientation

	Total	Theoretical and stay theoretical	%	Theoretical move to empirical	%	Empirical	%
PME	148	13	8.8	10	6.8	125	84.5
ESM	177	38	21.5	15	8.5	124	70.1
JRME	138	16	11.6	3	2.2	119	86.2
Total	463	67	14.5	28	6.1	368	79.5

Table 2. Use of Theory

	Total	Use theory						Do not use theory	%
		Explicit	%	Implicit	%	Sub. Total	%		
PME	148	122	82.4	11	7.4	133	89.9	15	10.1
ESM	177	153	86.4	11	6.2	164	92.7	13	7.3
JRME	138	104	75.4	11	8.0	115	83.3	23	16.7
Total	463	379	81.9	33	7.1	412	89.0	51	11.0

Table 3. Theory type

	PME				ESM				JRME			
	90 -95		96 - 01		90 - 95		96 - 01		90 - 95		96 - 01	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Traditional psychological & mathematics theories	49	73.1	49	60.5	52	63.4	49	51.6	34	54.8	44	57.9
Psycho-social, including re-emerging ones	8	11.9	8	9.9	8	9.8	19	20.0	4	6.5	10	13.2
Sociology, Sociology of Ed, socio-cultural studies & Historically orientated studies	2	3.0	8	9.9	3	3.7	11	11.6	1	1.6	6	7.9
Linguistics, social linguistics & semiotics	0	0.0	2	2.5	1	1.2	5	5.3	2	3.2	6	7.9
Neighbouring fields of Maths Ed, science ed and curriculum studies	1	1.5	0	0.0	0	0.0	0	0.0	1	1.6	0	0.0
Recent broader theoretical currents, feminism, post-structuralism and psychoanalysis	1	1.5	0	0.0	8	9.8	1	1.1	0	0.0	1	1.3
Philosophy/philo of mathematics	0	0.0	3	3.7	0	0.0	3	3.2	1	1.6	1	1.3
Ed theory and research	2	3.0	0	0.0	1	1.2	1	1.1	2	3.2	0	0.0
Other	0	0.0	0	0.0	1	1.2	1	1.1	2	3.2	0	0.0
No theory used	4	6.0	11	13.6	8	9.8	5	5.3	15	24.2	8	10.5
Total	67		81		82		95		62		76	

Table 4. Researchers' engagement with theory

	PME	%	ESM	%	JRME	%
Support	11	7.4	27	15.3	10	7.2
Modify	8	5.4	2	1.1	2	1.5
Oppose	1	0.7	0	0.0	1	0.7
Simply use	113	76.4	135	76.3	102	73.9
Do not use theory	15	10.1	13	7.3	23	16.7
Total	148		177		138	

Table 5. Connection between theory and empirical

	Total No. of papers	Theory Informs Empirical	%	Empirical Informs Theory	%	Both ways in dialectic form	%	Do not Use a theory	%
PME	148	117	79.1	7	4.7	1	0.7	15	10.1
ESM	177	116	65.5	4	2.3	7	4.0	13	7.3
JRME	138	99	71.7	1	0.7	0	0.0	23	16.7
Total	463	332	71.7	12	2.6	8	1.7	51	11.0

Table 6. Focus

	PME			ESM			JRME		
	90-01 (135)	90-95 (63)	96-01 (72)	**90-01 (139)**	90-95 (63)	96-01 (76)	**90-01 (122)**	90-95 (54)	96-01 (68)
Researcher's Practice	3.7	4.8	2.8	**4.3**	1.6	6.6	**2.5**	5.6	0.0
Student teachers' practice	6.7	4.8	8.3	**2.9**	3.2	2.6	**9.8**	7.4	11.8
Policy	**0.0**	0.0	0.0	**1.4**	3.2	0.0	**4.1**	3.7	4.4
Teacher	**15.6**	20.6	11.1	**10.1**	14.3	6.6	**9.8**	7.4	11.8
Pupil	**51.1**	57.1	45.8	**32.4**	33.3	31.6	**15.6**	11.1	19.1
Teacher & pupil	**1.5**	0.0	2.8	**1.4**	0.0	2.6	**0.0**	0.0	0.0
Transmission	**8.9**	9.5	8.3	**7.9**	6.3	9.2	**16.4**	16.7	16.2
Acquisition	**11.9**	1.6	20.8	**38.1**	38.1	38.2	**36.9**	38.9	35.3
Evaluation	**0.7**	1.6	0.0	**1.4**	0.0	2.6	**4.9**	9.3	1.5

Note: The figures in the table above are percentages based on the total number of 'Empirical' and 'Theoretical move to empirical' papers only.

Table 7. Methodologies

	PME			ESM			JRME			Total
	90-01 (135)	90-95 (63)	96-01 (72)	**90-01 (139)**	90-95 (63)	96-01 (76)	**90-01 (122)**	90-95 (54)	96-01 (68)	**90-01 (396)**
Qualitative	**63.7**	69.8	58.3	**62.6**	49.2	73.7	**41.0**	29.6	50.0	**56.3**
Quantitative	**16.3**	11.1	20.8	**15.8**	28.6	5.3	**43.4**	57.4	32.4	**24.5**
Combined	**20.0**	19.0	20.8	**21.6**	22.2	21.1	**15.6**	13.0	17.6	**19.2**

Note: The figures in the table above are percentages based on the total number of 'Empirical' and 'Theoretical move to empirical' papers.

Table 8. Purposes of research

	PME	**%**	**ESM**	**%**	**JRME**	**%**	**Overall**	
							Total	**%**
Improve Pedagogy	73	**49.3**	98	**55.4**	69	**50.0**	240	**51.8**
Improve Evaluation	2	**1.4**	2	**1.1**	5	**3.6**	9	**1.9**
Improve Curriculum	4	**2.7**	2	**1.1**	7	**5.1**	13	**2.8**
Improve Teacher Education	14	**9.5**	8	**4.5**	14	**10.1**	36	**7.8**
Improve Research	14	**9.5**	25	**14.1**	12	**8.7**	51	**11.0**
Study Student's Understanding	24	**16.2**	20	**11.3**	16	**11.6**	60	**13.0**
Study Student's beliefs or attitudes	3	**2.0**	9	**5.1**	6	**4.4**	18	**3.9**
Study teachers	12	**8.1**	7	**4.0**	6	**4.4**	25	**5.4**
Study or Change Policy	1	**0.7**	2	**1.1**	1	**0.7**	4	**0.9**
Workplace Mathematics	0	**0.0**	2	**1.1**	1	**0.7**	3	**0.7**
Other	1	**0.7**	2	**1.1**	1	**0.7**	4	**0.9**
Total	**148**		**177**		**138**		**463**	

Table 8* *Purposes* (Theoretical papers only)

Total number of papers: 67

Improve Pedagogy	Improve Evaluation	Improve Curriculum	Improve Teacher Education	Improve Research	Study Student's Understanding	Study Student's beliefs or attitudes	Study teachers	Study or Change Policy	Workplace Mathematics	Other
23	0	2	3	35	0	0	1	3	0	0

Table 9. Topics

	PME			ESM			JRME			Overall
	90-01 (135)	90-95 (63)	96-01 (72)	**90-01 (139)**	90-95 (63)	96-01 (76)	**90-01 (122)**	90-95 (54)	96-01 (68)	**90-01 (396)**
Problem solving	**14.8**	15.9	13.9	**12.2**	9.5	14.5	**13.9**	18.5	10.3	**13.6**
Number concept	**5.2**	6.4	4.2	**5.0**	6.4	4.0	**5.7**	5.6	5.9	**5.3**
Arithmetic computation	**4.4**	4.8	4.2	**3.6**	4.8	2.6	**5.7**	5.6	5.9	**4.5**
Estamation	**1.5**	1.6	1.4	**2.2**	3.2	1.3	**4.1**	7.4	1.5	**2.5**
Fraction	**2.2**	1.6	2.8	**0.7**	0.0	1.3	**7.4**	11.1	4.4	**3.5**
Ratio and Proportion	**3.0**	1.6	4.2	**2.9**	3.2	2.6	**3.3**	3.7	2.9	**3.3**
probability	**3.7**	1.6	5.6	**2.2**	3.2	1.3	**2.5**	1.9	2.9	**2.8**
Algebra	**9.6**	6.4	12.5	**5.8**	4.8	6.6	**4.9**	3.7	5.9	**6.8**
Geomatry	**5.2**	4.8	5.6	**10.1**	7.9	11.8	**8.2**	7.4	8.8	**7.8**
proof	**3.0**	3.2	2.8	**4.3**	4.8	4.0	**0.0**	0.0	0.0	**2.5**
Function and graph	**6.7**	4.8	8.3	**6.5**	6.4	6.6	**2.5**	0.0	4.4	**5.1**
Advanced maths	**7.4**	9.5	5.6	**2.9**	3.2	2.6	**5.7**	5.6	5.9	**5.3**
Statistic	**2.2**	0.0	4.2	**3.6**	0.0	6.6	**1.6**	1.9	1.5	**2.5**
Mathematics in grneral	**6.7**	6.4	6.9	**15.1**	19.1	11.8	**16.4**	14.8	17.7	**12.6**
Other	**24.4**	31.8	18.1	**23.0**	23.8	22.4	**18.0**	13.0	22.1	**21.7**
Computer and manipulative	**17.0**	14.3	19.4	**14.4**	12.7	15.8	**6.6**	3.7	8.8	

Note:

1. For this analysis, only the empirical papers and the theoretical move to empirical papers are considered.
2. The figures in the table above are percentages based on the total number of 'empirical' and 'theoretical move to empirical' papers.

Table 10. Addressees

	PME	%	ESM	%	JRME	%
Researchers	12	8.1	35	19.8	15	10.9
Researchers & Teachers	112	75.7	128	72.3	91	65.9
Researchers and teacher Educators	18	12.2	10	5.7	20	14.5
Reseachers and Policy makers	6	4.1	4	2.3	12	8.7
Total	148		177		138	

Table 11. Pedagogical model

	PME		ESM		JRME		Overall	
	No.	%	No.	%	No.	%	No.	%
No. of papers that have a pedagogical model	124	83.8	151	85.3	123	89.1	398	86.0
No. of papers without evidence of a pedagogical model	24	16.2	26	14.7	15	10.9	65	14.0
Total	148		177		138		463	

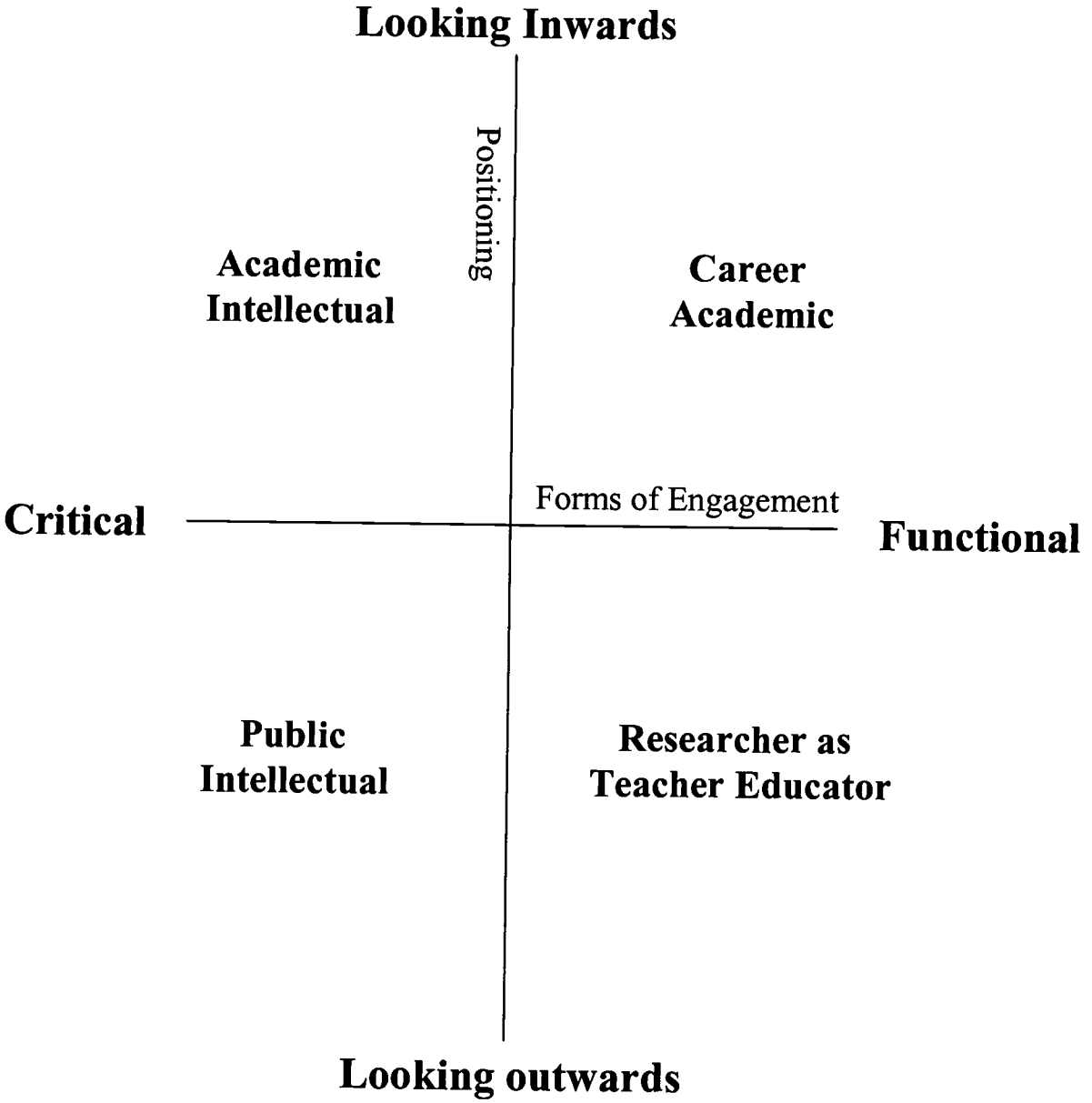
Table 12. Pedagogical model (Orientation)

		PME		ESM		JRME		Overall	
		No.	%	No.	%	No.	%	No.	%
Knowledge (performance)	Singulars	6	4.1	3	1.7	5	3.6	14	3.0
	Regions	0	0.0	0	0.0	0	0.0	0	0.0
	Generic/skill	0	0.0	2	1.1	1	0.7	3	0.6
Pupils (Competence)	Individual cognitive understanding	108	73.0	128	72.3	97	70.3	333	71.9
	Individual Affective	2	1.4	11	6.2	9	6.5	22	4.8
	Individual Social	4	2.7	7	4.0	11	8.0	22	4.8
	Group Cultural Empowerment	4	2.7	0	0.0	0	0.0	4	0.9
	Group Political Empowerment	0	0.0	0	0.0	0	0.0	0	0.0
No Evidence		24	16.2	26	14.7	15	10.9	65	14.0
Total		148		177		138		463	

Table 13. Pedagogical model (Strategy and Boundary)

		PME (148)		ESM (177)		JRME (138)		Overall (463)	
		No.	%	No.	%	No.	%	No.	%
Strategy (Criteria)	Explicit (Absent)	12	8.1	5	2.8	4	2.9	21	4.5
	Implicit (Present)	93	62.8	127	71.8	102	73.9	322	69.5
	No evidence	43	29.1	45	25.4	32	23.2	120	25.9
Strategy (Discourse)	Localised	20	13.5	19	10.7	5	3.6	44	9.5
	Specialised	84	56.8	113	63.8	99	71.7	296	63.9
	No evidence	44	29.7	45	25.4	34	24.6	123	26.6
Boundary between Maths and Everyday	Strong	78	52.7	112	63.3	95	68.8	285	61.6
	Weak	21	14.2	20	11.3	9	6.5	50	10.8
	No evidence	49	33.6	45	25.4	34	24.6	128	27.6

Appendix 3.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