Contrasting the 'Socio-cultural' and 'Socio-political' Perspectives in Maths Education and Exploring their Implications for Teacher Education

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Abstract
Maths teacher education as a field of enquiry and practice emerges as a hybrid between the domains of teacher education and maths education. This paper acknowledges that maths teachers' knowledge is of a complex nature and that its institutionalisation in curricula and teacher education programs should consider the multiple perspectives which influence its growth. Specifically, during the last decade, a shift towards a 'social' orientation has been witnessed in the field of mathematics education with two prevailing perspectives; the 'socio-cultural' and the socio-political'. These two perspectives are discussed here by considering their contrasting views on 'contexts' for learning mathematics and on the learners' role, as well as by exploring the implications of such views in restructuring maths teacher education programs.

A shift towards a 'social' orientation

The centrality of mathematics in the school curriculum has mainly been justified due to the efficacy of mathematics to 'discipline' and 'exercise' the mind, a view compatible with absolutism (see Ernest, 1991). But, although such a view still predominates in teaching practices and educational policies, one can notice a shift towards a 'social' orientation in maths education. Such a shift in the maths education discourse needs to be understood as part of broader societal changes. The twentieth century brought an increased need for more mathematically literate people by constituting secondary education compulsory. Presently, there is a growing appreciation amongst educationists, employers and policy makers that a mere acquisition of 'abstract mathematical thinking' is not adequate for the mainstream employment and vocational demands and that the inclusion of a 'social' orientation in the school mathematics curriculum should be enclosed. New types of jobs have shown an increased need for specialisation in specific practically oriented skills amongst which computer skills and technological literacy are in highest demand. Equal opportunities awareness has also led to greater aspirations amongst wider groups for employment and for attaining higher academic qualifications.

Such demands initiated the need to conceptualise the role of mathematics in the curriculum focusing on its utilitarian dimension. But school mathematics, although highly valued for its contributing role to society, is not being experienced in the enacted curriculum as closely relevant and significant to our cultural, technological and economic realities. Often people (including teachers and pupils who study the subject) are struggling to find answers to fundamental questions such as 'why do we have to teach and learn mathematics?' or 'where do we really need mathematics?' These questions remain largely un-answered or are addressed in a very superficial manner, which fails to convince pupils and teachers that mathematics is really relevant to our everyday lives. This then results in either opting out from studying maths and undervaluing its social role or 'mythologising' its significance and envisaging it as panacea for all problems (see Dowling, 1998 for a sociological analysis of the use of 'real life' examples in textbooks). As a result, pupils and teachers work in maths classrooms not because they are really motivated but because they are espousing the subject's hegemony in the curriculum. These issues have received different interpretations (and answers) over the years; two distinct ones being
a) the reconsideration of values in maths education and the re-conceptualisation of its epistemological roots and b) the emphasis on effectiveness by means of focusing on the acquisition of certain skills and competencies in both teaching and learning the subject.

Although, the later has been evident in the concerns of recent studies (e.g. TIMSS[1]) the present paper will focus on the first.
The community of maths educators and researchers has contributed significantly through ongoing debates and theorising for shifting attention from a view of mathematics as merely a mental exercise and disciplining. Such endeavours need to be attributed, apart from the societal demands mentioned above, to at least two more reasons; a) a counter-reaction to the formalism of the 'new maths'movement in the 60s and b) a necessity for developing maths education as a scientific discipline on its own right. By and large, a wide concern has been expressed regarding what might be the pedagogical values and underpinnings of educative contexts for mathematics teaching and learning. The 'shift' towards a 'social' orientation can be visualised in multiple forms which include the use of practical activities, real life contexts and 'socially' oriented pedagogical methods such as collaborative work, peer interaction and teachers' intervention. It has also meant the problematising of broader issues such as technology, multiculturalism, pupils' socialisation in maths classrooms. This 'shift' can also be realised as twofold; on the one hand it is a consideration of the 'human beings' and their social interactions whilst learning mathematics and on the

[1] TIMSS: Third International Mathematics and Science Study

other hand it entails a viewing on the construction of mathematical knowledge as part of a social, cultural and political process. Below, two main orientations which have been formulated within the maths education community will be explored in more depth; namely the socio-cultural and the socio-political.

The socio-cultural perspective

During the 70s and 80s several research projects developed with a particular aim to explore and conceptualise the structure of learning environments which encourage pupils' meaningful understandings. As indicative examples, one can mention projects such as; the Realistic Mathematics curriculum developed in IOWE[2], Netherlands (Treffers, 1987) where real life simulations were employed, inspired by Freudenthal's phenomenological approach; the Common Sense activities (e.g. calendars, money, thermometers, maps etc) of the Genoa group in Italy, built around the notion of the 'fields of experience' (Boero, 1992), and a number of projects in Europe and in US which have been developed around the notion of teaching mathematics through applications and modelling (De Lange, 1996). To these, one needs to add varied computer based projects, which have focused on developing in parallel curricula materials and on justifying and analysing the process of learning mathematics (Balacheff and Kaput, 1996).

A number of these projects have claimed their theoretical grounding in a socio-cultural paradigm, ranging from an explicit espousing of a constructivist orientation influenced by either a Piagetian or a radical perspective to adopting an interpretative framework for theorising within a Vygotskian or an activity theory orientation. These projects aimed to conceptualise the 'structuring' of a learning environment and have expressed an explicit agenda for making characterisations of the learning process and identifying types of suitable teaching interventions. The focus of analysis has been primarily on what the learner can potentially do in certain types of learning settings. Questions of interest have been; what are the features of pupils' problem solving, what are their ways of reasoning and how meaningful mathematical constructions are being attained.

Lately, this focus has been extended to address issues of social interaction in the classroom micro level. As a result, the focus of analysis has embraced the social interactions in the classroom culture, the studying of pupils' collaborative learning, the teacher pupil interactions and the type of teaching interventions that encourage pupils' own construction of mathematics (Bauersfeld and Cobb, 1995, Seeger, Voigt and Waschescio, 1998, Davis and Maher, 1993). The French research community has contributed significantly to some detailed conceptualisation of the nature of mathematical learning and teaching in the classroom micro-level. Contributions include the notion of 'didactical transposition' by Chevallard (1991), the theory of 'didactical situations' by Brousseau (1992) and the concept of 'didactical engineering' by Artigue (1994).

The socio-political orientation

This perspective takes a political view on mathematical education claiming that its main role should be the fostering of citizenship. From a maths educators' point of view, this is conceived as developing mathematically literate people who can be active, reflective and critical participators in our society. Mellin-Olsen (1987) has made a significant contribution by opening a new direction in viewing maths education in his book 'The Politics of Mathematics Education'. He made the claim that mathematical education is unavoidably political as any form of education is, once it serves for the reproduction of society and the formation of pupils' awareness and ideologies. People's understandings about the function of societal services (such as administration, economy, industry) is related to understanding how mathematics has been applied within those services. In this orientation two interrelated research strands have been formed; ethnomathematics and critical mathematics education.

Ethnomathematics[3] started as a movement in Africa and Brazil out of a concern for the negative effect that imported curricula have on pupils' mathematical learning. The movement made the

[2] IOWE stands for Instituut voor de Ontwikkeling van het Wiskunde Onderwijs. It was established in 1971 and had served as a centre for mathematics education in the northern part of Europe.

[3] D'Ambrosio has coined the term ethnomathematics as follows: 'The main idea focuses on the concept of *ethnomathematics* in the sense that follows. Let me clarify at this beginning that this term comes as an etymological abuse. I use *mathema(ta)* as the action of explaining and understanding in order to transcend and of managing and coping with reality in order to survive. Man has developed throughout each one's own life history and throughout history of mankind *technes* (or tics) of *mathema* in very different and diversified cultural

claim that in order to empower pupils, the school maths curriculum should be rooted in the culture and cultural artefacts and activities of the pupils' own home communities (for a review see Gerdes, 1996). Making a relational use of one's own cultural background and history in mathematics education has been viewed as a factor that cannot only facilitate learning, but also increases pupils' confidence and self-esteem as citizens in their home cultures. It constitutes a well argued reaction to the uncritical importation of Western syllabuses, usually in the form of translated textbooks. It can be seen as closely interwoven with a conscious effort to combat colonialism 'built' into an educational system by means of curricula and classroom practices.

Such practices (e.g. methods for the construction of carpets, sand drawings, basket weaving etc) can provide the context for reconstructing mathematical activity and teaching basic mathematical concepts. It has been argued that the 'hidden' mathematical wisdom in such artefacts (or better still within the methods of their production) could be explored and re-discovered by pupils. Detailed studies concerning the nature of mathematical activity in varied cultural practices (e.g. Milroy's carpenters, Lave's grocery shoppers, Saxe's candy sellers) have shown that 'mathematics' is recognised as such mainly by the researcher, but not by the practitioners. This means that the reconstruction of 'mathematical activity' through such contexts in its western sense (i.e. the way it is conventionally represented in most current curricula) demands to recontextualise such practices in didactic situations with a focus on mathematising. Such a realisation demands attention, otherwise the use of such contexts may result in superficial learning experiences.

Critical mathematics education is primarily concerned with the development of citizens who can participate actively and responsibly in decision making processes demanded in our personal and public lives. The roots of 'critical mathematics education' can be traced in the critical theory of Adorno, Habermas and Marcuse (the Frankfurt School), but also in Freire's epistemology. Its elaboration in mathematics education has been made mainly by Skovsmose (1994) and Frankestein (1983) and consists of a political voice from within a highly technologised and industrialised society. At first glance, mathematics seems neutral and irrelevant to broad social issues[4]. A deeper look can reveal that mathematics has been responsible for the establishment of inequalities and various forms of discrimination. For example, mathematics (e.g. statistics) is called upon any time that a political argument needs to be legitimised or a political decision needs to be taken. The purpose is not only to enable individuals to use mathematical tools effectively in varied applications, but to encourage them to critique the substance of mathematics itself as a 'technology for the modern world'. Skovsmose (1994) argues that mathematics has functioned historically as a 'symbolic power' and sometimes it has served to limit critique when applied. A challenging purpose for mathematics education then should be not only in fostering pupils' mathematical literacy but also to aid them in demystifying the premise that mathematics can be used to describe real life situations unproblematically. Restivo (1990) has explicitly shown how mathematics has been constructed through varied historical periods and cultures out of human co-operations and how certain 'mathematics' has been legitimised at the expense of others. Such an approach has the potential for empowering pupils to reflect and criticise mathematics itself and its significance in our social practices.

Mathematical education can then be approached as one very important avenue for ensuring the routes towards peace and equality in a certain community. A socio-political orientation advocates for a curriculum that specifically confronts implicit and explicit discriminations. Enabling pupils to be proactive, co-operative, reflective, critical and active participants in practices of their concern is another way. This orientation claims that 'power' relations of any teaching and learning situation need not to be concealed but one needs to develop awareness of its features. It tries to create a conceptual framework that will empower people to cope with and combat implicit and explicit conflict, racism and oppression. Issues of power, oppression, resistance, conflict and democracy and their significance for pupils' mathematical learning are of primary importance in this orientation and deserve close attention and scrutiny.

School mathematics: representational or authentic?

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environments. i.e. in the diverse *ethno's*. So, in order to satisfy the drives towards survival and transcendence in diverse cultural environments, man has developed and continuously develops, in every new experience, *ethno-mathema-tics'* (D'Ambrosio, 1991, p.3).

[4] This view is compatible with an absolutist philosophy of mathematics which views mathematical knowledge as an object independent of human action (Ernest, 1991).

It can be claimed that differences exist in the above perspectives not only in terms of what pedagogical suggestions offer for mathematical education but in core epistemic conceptions of what is mathematical knowledge and how it is being constructed. Such differences will be explored below by making reference to the type of curriculum contexts proposed and to their view on the learner's role.

A vision of mathematics as a mental disciplining favours the use of simple tasks in the form of exercises that can enable the practice and training of certain predefined mathematical content and skills. On the contrary, the socio-cultural and the socio-political orientations are both concerned with selecting activities that can exemplify some reference with the 'real world'. However, different meanings are assigned to the notion of 'real world' or 'reality'. The socio cultural orientation proposes materials, which can be conceived as 'representations' of reality, or real world settings where mathematical representations can be explored (e.g. the use of pizzas for the learning of division). The intention is to provide an appealing context that can facilitate the learning of some predetermined knowledge as prescribed in the curriculum. The nature of tasks is often seen as a regulative procedure carefully designed to enable pupils to organise and systematise their thinking towards mathematising (Treffers, 1987). These could be entities that pupils can easily manipulate, experience, and, in which they can either observe mathematical relations or apply their own mathematical ideas. The fundamental premise of this perspective lie with the assumption that mathematical learning develops as an active and interactive endeavour of the learner with 'cultural tools' provided through his/her learning environment. This endeavour has been seen both as experiential and dialogical. The 'tools' can be conceived as physical and conceptual entities. A manipulative (e.g. Cuisinaire rods, or a computer simulation) can be a 'physical tool' which helps pupils to experience number and to practice some specific mathematical content. A representation of a mathematical concept (e.g. a formula, an algorithm, a graph or a metaphor) can equally be seen as a 'conceptual tool' which provides avenues for mental imagery beyond physical manipulation.

In contrast, the socio political orientation argues for the use of 'authentic' contexts as the basis of the mathematical activity. Authentic contexts are situations with real dimensions, rooted in the social and cultural life, in which students live and understand. Such contexts have the potential for allowing and encouraging 'reflection' on the conditions in which the mathematical knowledge is being applied. By reflecting and discussing the features of the context itself the pupils can grasp the role that mathematics plays in it (see Christiansen, 1997). Borba (1990) in Brazil has advocated the use of activities that are closely relevant to pupils' own interests and current cultural concerns (e.g. organising the collection of money to buy second hand uniforms for a football team) as another source for sensitising pupils on how mathematics relates to social affairs. The pupils then have more chances to visualise the social role of mathematics and can reflect on its significance as part of a problem solving process and on its effect in the context of a specific situation.

As far as it concerns the role of the learner, both perspectives have expressed a genuine interest for pupils' cultural backgrounds and individuality. They constitute a shift from seeing pupils' activity merely as either training of skills or 'exercising abstract thinking' towards viewing it as a way of 'thinking analytically' (in the socio cultural orientation) and 'thinking critically' in connection to a social context (in the socio political orientation). Pupils in the socio-cultural paradigm are described as active thinkers in a process of constructing their own knowledge. Their learning develops through experience and interaction with 'cultural tools' and through dialogue with peers and more knowledgeable others. Their activity is part of the maths classroom practice and conventions (i.e. the prescribed curriculum content, particular types of talk and behaviour). Teachers' intervention is thus geared towards primarily enabling pupils to assimilate and accommodate the curriculum content and context. The importance of dialogue, collaboration and social interactions have been emphasised, but with the intention to provide didactic strategies that will enable pupils to conform to the conventional entities of mathematical curricula.

On the contrary, a socio-political vision opposes the view of the learner as an 'individual thinker' and proposes a view of an active, reflective and critical participator in activities that extend beyond the classroom and have a communal perspective (see Mellin- Olsen, 1987). The learners are thus encouraged to make their own judgements of the classroom activity, which may not

always be in accordance with what counts as school curriculum. It is not enough that pupils will understand the content and gain competency, a goal should be the inquiring mind about the nature and the ethics of mathematical applications in real and authentic problems. This orientation actually welcomes and celebrates such a perspective by encouraging pupils to be constantly and consciously reflective and critical on the role and significance of the curriculum knowledge in societal activities. Such a task is not without complexities. Skovsmose (1998) acknowledges that to be able to read and critique mathematical uses can prove impossible at most times. Given the conceptual capacities in our disposition to grasp the technological and social complexities of our world and the partial access in the knowledge production of most societal practices the role of mathematics as a 'formatting power' is easily concealed. He argues that this covert role of mathematics entails a danger for democratic processes in society that should frame the agenda of maths education.

Despite the different agendas and epistemological interests, both of these visions share a common concern for the growing number of pupils who are failing and hating mathematics in current schooling, given the fact that mathematics becomes more and more irrelevant to people's lives whilst more and more relevant for the shaping of society and the economy and yet remains absent from everyday conversations and common sense understanding. They also share a commitment for empowering pupils to recognise and utilise mathematics meaningfully in their lives. However, it needs to be noted though that they set up very different agendas for the school maths curriculum. The 'socio-cultural' orientation focuses attention on managing skills through the use of 'representational tasks' and the focus is placed on how individuals can best work at acquiring the type of knowledge that is being prescribed for them by a conventional curriculum. Whilst, the 'socio-political' orientation urges us to reconsider not only the process of meaning making within classrooms, but also the choice of learning contexts and the intentions of pupils' activity (Mellin Olsen, 1987, Skovsmose, 1994).

Implications for maths teacher education

Both, school maths curricula and teacher education programs are institutionalised forms of educational visions and they can serve as channels of communicating the purposes of maths education but also the specific objectives of classroom practice. Consistency amongst them may ensure that these 'educational visions' can eventually become communicable between different groups of people (e.g. the curriculum planners, the educational researchers, the implementers of a new curriculum, the teachers and the pupils). In the first part of this paper, the shift towards a 'social' orientation in maths education was described and the perspectives of a socio-cultural and socio-political mathematical education were explored. Although, a view of school mathematics as 'abstract' and 'decontextualised' activity is still predominant in most teaching practices, the 'socio-cultural' and the 'socio-political' visions can be seen as providing pedagogical and epistemological alternatives in teaching mathematics at schools today. But, these broad visions on maths education (the school maths curriculum; content, teaching and learning) do not touch directly the issue of maths teachers education and although one can make creative elaborations of the conceptualisations offered within them, a grounded extrapolation is yet to be done. However, one can acknowledge that these two perspectives provide working frameworks since maths educators, who happen at most times to be the university based tutors (or trainers) of perspective teachers of mathematics, are sometimes accustomed to them. Before elaborating on this, a brief overview will be taken on what constitutes teacher education and maths teacher education in current times.

Teacher education and the specifics of maths teacher education

The education of teachers, and in particular that of secondary schools has traditionally focused on the training of prospective teachers solely in their subject discipline. The development of their pedagogic skills was heavily reliant on an apprentice-like model, left to the personal and un-monitored enculturation of novice teachers in schools of their location. The formation of programs for teacher education and the consequent development of teacher education as a field of research have only emerged during the last three decades. Their birth can be regarded as a response to ongoing societal demands for providing public education to wider and more culturally diverse populations. At the same time, it needs to be attributed to a number of reported concerns for pupils' increased failure to achieve standards in main school subjects and also an

increased interest for ensuring and controlling quality in education. In addition, one should not ignore the effects of globalisation in the educational policies of individual countries which urge the adoption of models and establishing institutional structures that can ensure accountability of educational institutions to a governing body and comparability across countries and/or localities.

Elbaz (1983), Zeichner (1983) and Feiman-Nemser (1990) as teacher education researchers have, amongst others, explored the structure of teacher education programs and the experience of student teachers in the US context. They have arrived at some useful conceptualisations, which characterise clearly major perspectives in the nature of teachers' professional development curricula that can be identifiable in other countries, too. These consist of; the *academic* perspective which emphasises the teacher's expertise and competency in the subject matter; the *practical* that focuses on mastery within the classroom reality; the *technical* one which analyses the behavioural skills and knowledge that teachers need; the *personal* practical knowledge perspective based on the view of teachers' development as a process of personal development; and the critical inquiry orientation which views schooling as a process of social reform based on the promotion of democratic values and the reduction of inequalities (see Calderhead and Shorrock, 1998 for a detailed overview). Currently, most countries, have opted for (or are considering) a school-based teacher education model based on a partnership between an academic institution, in which the theoretical parts of the course are being studied, and a school where the student teachers do their practice. This is certainly the case for many North European countries such as the UK, France, Germany and the Netherlands with differences between them on issues such as the emphasis put on mathematics training and the integration between theory and practice.

Differences on how countries cope with such aspects are often attributed to culture and tradition. Nowadays, there is an awareness that there are cultural differences across countries in terms of how teaching and teachers' roles are being construed. For example, in Spain teachers elect their head-teachers amongst their colleagues through democratic processes; in Japan collegiality is encouraged between teachers in the same school through the sharing of common teaching experiences and curricula materials; in France the role of teachers has been described as highly academic; whilst the UK includes a pastoral responsibility, too. Such different views on teachers' roles create unavoidably different expectations from teacher preparation courses. However, one must consider the socio-economic conditions that determine not only the success or failure of a teacher education course, but its planning and implementation in the first place. For example, in Greece a number of social devastations up until the late 70s (e.g. a series of wars and dictatorships) have left a poor infrastructure in the education sector (see Chronaki, 1999). Nowadays, east European countries are facing enormous challenges and have to cope with very limited resources. In such cases, the implementation of a teacher education reform, such as 'school based training', means a total reorganisation of major educational provisions and human resources. As a result of taking into account the international arena, one needs to notice that the formation of teacher education courses is not merely a matter of how their principal orientation has been conceived (i.e. calling on reason or cultural capital) by a group of educationists and policy makers in a particular context.

Any institutionalised teacher education program, in which maths teacher education is no exception, could face challenges related to decisions about the orientation and the structure of the course, the combination of theory and practice, the content of individual courses and the methodologies concerning teaching and assessment. In addition, one needs to encounter subject specific micro-politics that have to do with the 'ownership' of maths education courses. For example, questions such as 'where' such courses will take place (mathematics department, school of education or an ad hoc institution) and who will inevitably have control of the content of such courses (mathematicians, maths educators, maths teachers) have framed debates and negotiation procedures amongst the interested bodies.

Broader demands for restructuring teacher education programs could not leave maths teachers preparation untouched. Research in the specific domain of maths teacher education as Borasi (1998) observes is still scarce. As a result, programs and research on maths teachers' education is a hybrid which develops between the research fields of maths education and teacher education, without directly espousing either. It has its own specifics emerging through resolving particular challenges and politics. As a result, maths teacher education courses need to be seen not only as part of a maths education community but also as part of a teacher education community. In some countries, such as the UK, the teacher education community has played a stronger role, and the academic part of maths teachers' preparation takes part in the schools of education. Whilst in others like France, the maths educators through the IREMs[5] have managed to influence instrumentally the function of the newly established IUFMs[6]. And of course, there are still countries, of which Hungary is an example, where the mathematicians exercise a greater influence.

The influence coming from the domain of teacher education can also be recognised by the 'conceptual borrowing' that maths education researchers have encountered as a form for a creative elaboration of broader teacher education concepts in their field. For example, Ernest (1989) has based his classification of what a maths teacher education program should contain on Shulman's typology. Shulman (1986) classified the features of teachers' knowledge around the categories of; knowledge of subject matter, knowledge of other subject matter, knowledge of the curriculum, knowledge of the learners, knowledge of educational aims, and general pedagogic knowledge. His definition of pedagogical content knowledge has been particular relevant for identifying what parts of the subject matter per se will be relevant to elaborate for teaching. Cooney (1994) has also argued that a main goal in a maths teachers education course should be to enable teachers to develop their understanding of mathematics that permits the teaching of the subject from a constructivist perspective. Apart from this very basic ingredient, he also emphasised the need to offer opportunities for teachers to reflect on their own experiences, to develop expertise in identifying and analysing constraints in teaching, and to gain experience in assessing students' understandings.

One needs to be aware that much of this theorising is contextualised through research in 'western' societies and reflects teaching practices that are relevant in these particular contexts. We know very little about what such conceptualisations might mean for some other countries who may not happen to possess similar socio-economic resources or who may not have the same educational infrastructure that would permit a rapid response to reformations. Often, in such disadvantaged contexts, attempts for implementing innovative programs on a larger scale are doomed to fail. Opportunities for experimentation and exploration of innovative schemes are very slim, and thus chances for the 'invention' and 'construction' of viable solutions are restricted. A 'silence' concerning the nature of practices and the particular educational concerns in such contexts is noticeable in the available literature. As Elliot (1999) has observed, we do not know yet much about why such failures exist and what really constitutes them as well as what are the real problems that one needs to cope with. Not only do we know little about such 'silences' but we are still short of working concepts that would characterise such situations in a way that would bring justice to the efforts carried out there.

Boero, Dapueto and Parenti (1996), a group of south European maths educators and researchers, may provide a more representative picture of the contemporary maths teacher education 'scene' by including the experience of south and east European countries. They make reference to three predominant viewpoints, which characterise how the maths teacher preparation programs are currently formed. These correspond to three distinctive views about the desired role of maths teachers and their professional growth. The first one envisages that maths teachers' development (especially for secondary schooling) should be based on fostering their excellence and expertise in the scientific domain of mathematics. This is the most traditional view that is still met in some countries (e.g. Italy, Greece), preferred mostly by mathematicians and strongly opposed by maths educators. The second one emphasises creativity and sees maths teachers working as artists, developing their capacities through active involvement with innovative projects (this line is still valued in Hungary). And the third one bases teacher education on the mastery and study of a number of scientific domains including psychology and sociology of education and the interplay between theory and practice in schools.

From visions of *school maths* to visions of *maths teacher education*

[5] IREM stands for Regional Institutes for Research in Mathematics
[6] IUFM stands for Institut Universitaires de Formation des Maitres

Taking the journey from envisaging main orientations on 'school mathematics' towards considering the current scene on 'maths teacher education programs' one can address a host of questions about the relative connectivity between the two, such as; What is the place of these visions on school maths curriculum in maths teacher education courses? Do they influence at all the construction of math teacher education programs or do such programs develop autonomo usly? Are some visions more predominant than others are and why? If we have a particular vision in mind, would we have to plan and structure the maths teacher education course in a different way? Would the adoption of a particular vision imply the adoption of a particular methodology for working with maths student teachers and would it also specify the construction of different learning environments? It is far from the purpose of this paper to attempt to answer all the above questions. But, from the exploration undertaken so far we can argue that each of these perspectives explored here urges us to undertake a different viewpoint in the structuring of a maths teacher education program.

A 'socio-cultural' orientation has placed a lot of emphasis on theorising the process of didactical episodes in maths classrooms. Meticulous analysis has been focused either on the role of learners or on the role of social interactions as they emerge in the classroom micro-culture. A core research agenda has been centred on how the teacher can enable pupils to construct their own mathematical meanings, and how educative and pupil-centred experiences can be structured. This vision has enabled us to envisage a role of the teacher, not as a transmitter, but as a 'facilitator', a 'scaffolder' or as one who 'engineers' the didactic interaction with his/her pupils. The realisation of such views in maths teacher education can be seen through making space in the program for studying such gentle and deep issues of the didactical process. Such a study cannot be done in a teacher education program that approaches linearly pedagogic theory, mathematics studying and school practice. For example, Keitel (1992) commenting on the German teacher education programs, has argued that the underlying expectation of student teachers to form links across single subjects by themselves leads towards producing experts either on mathematics or pedagogics but not on maths teaching. Theory and practice integration demands sophisticated endeavours which depend on a continuous interplay between reflection, practice and theorising (see Jaworski, 1998). Specific methodologies that try to develop teachers' reflective thinking and ability to theorise on his/her teaching practice can include the use of video-segments from lessons as a basis for discussions or the undertaking of action research projects. The use of professional projects in which the analysis of teaching episodes is a core element entail an integral part of the French programs of maths teacher education, and they seem to provide ample chances for exploring these issues (see Comiti and Ball, 1996).

Finally, a vision of mathematics as 'socio-political' has recently opened a new perspective and forces us to reconceptualise the role of the content, curriculum tasks, the learner, the teacher, the school and indeed the role of maths education as a whole. It calls upon an analysis not only of the quality of mathematical learning and its development through social interactions in the classroom, but also of the social role of mathematics itself. This viewpoint requires us to think over the role of mathematics education as a means for uncovering inequality and educating pupils for responsible citizenship. Thus, it would favour a preparatory program for maths teachers that exemplifies a critical inquiry process that focuses on student teachers' empowerment and the practice of democratic values (Povey, 1998). Presmeg (1999) in a recent paper describes the value of using an ethnomathematics curriculum in a maths teacher education course (i.e. materials based on the home culture of student teachers) so as to encourage their awareness about cultural diversity. She mentions that such an approach enables the students to disclose personal self-images and to make links between what is required as mathematical activity by the curriculum and what can be found as mathematical activity in the society. Moreover, the call for a critique on mathematics itself, and in particular the question 'what is mathematics' and 'how mathematics is being constructed' challenges current predominant epistemologies (such as absolutism and fallibilism, Ernest, 1991) of the subject. Skovsmose

(1998) has proposed 'aporism[7]' as a new epistemological approach in mathematics, which stresses the need to acknowledge that the uncritical use of mathematical models can lead to errors, risks and catastrophes. This very point urges a reconsideration of the study of the mathematics discipline itself. Perhaps, the offering of courses such as the studying of sociology of mathematics (see Restivo, 1990) could prove beneficial for student maths teachers. Could mathematicians or maths educators take forward this challenge?

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[7] Etymologically, aporism derives from the greek word 'áðïñÝù' which means 'being in a loss' or 'being without resources'.

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