# From questions of how to questions of why in mathematics education research

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# FROM QUESTIONS OF *HOW* TO QUESTIONS OF *WHY* IN MATHEMATICS EDUCATION RESEARCH

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*The educational sciences are generally construed around concerns of providing research that informs practices of learning and teaching in educational institutions. This research emphasizes questions of* ***how to*** *and has led to a "technification" of educational research, as primarily concerned with providing solutions to practical problems. In this paper we will show how mathematics education as a research field is not an exception, by analysing how theory is understood and used in the field, to address questions of how. We suggest that, although important, this research leave some important areas unaddressed, namely the ones which can emerge from posing questions of* ***why****. We argue that making this move implies rethinking and enlarging definitions and views of mathematics education research.*

## INTRODUCTION

In recent decades the field of mathematics education research has opened its agenda towards new paradigms and discourses, and it has expanded the field also to include issues of the social, the cultural and the political. Issues of social justice (Gutstein, 2003), critical mathematics education (Skovsmose, 1994), equity (Secada, Fennema, & Adajian, 1995), ethnomathematics (D'Ambrosio, 2002) among others, have become influential players in a research field otherwise and continuously dominated by research exploring psychological and cognitive aspects of students' and teachers' engagement with mathematics. Although we consider this move towards the socio-political and socio-cultural a significant one, we also see a need to move the boundaries even further. We thus suggest a move from a research agenda primarily contained within a very specific discourse of the importance of mathematics education, addressing primarily questions of *how* to improve possibilities for teaching and learning mathematics, towards a research agenda strongly concerned with addressing the question of *why* mathematics education. In making this move we see possibilities of opening up the field to alternative discourses and ways of constructing important understandings about the teaching and learning of mathematics in complex social, political and economic settings. We will explore this move from questions of *how* to questions of *why* in relation to the role of theory in mathematics education research. We will argue that the overwhelming majority of theories constructed in the field aim to address questions of *how* and, therefore, do not have the possibility of seeing beyond a technical rationality in order to understand the *whys* of the configuration of mathematics education practices in classrooms, schools and society.

Based on an analysis of recent literature addressing the role of theory in mathematics education research, we start by pointing to the way this research is structured around questions of *how*. We then analyse some recent trends in mathematics education

research (arising out of the so-called "social-turn" (Lerman, 2000)), which has contributed to an enlargement of a field traditionally dominated by a didactical perspective. This research has opened the field to questions broader than those strictly concerned with providing immediate solutions for practical problems. Nevertheless, we will argue that even research presented within the scopes of the social, cultural and political often focuses on questions of *how*. We then proceed to bring in questions of *why*, by exploring new discourses embedded into this simple question. We conclude the paper with some brief comments about the implications of transgressing the boundaries of the existing discourses shaping the field of mathematics education research.

## THEORY CONSTRUCTING RESEARCH IN MATHEMATICS EDUCATION

Theory as a key component of mathematics education research is currently on the agenda. At ICME 11 in 2008 one of the survey teams developed a study on the notion and role of theory in mathematics education research. This survey team had the task of identifying, surveying, and analysing different notions and roles of 'theory', as well as providing an account of the origin, nature, uses, and implications of specific theoretical directions pertaining to different research developments in the field. Similarly, the *Second Handbook on Mathematics Teaching and Learning* (Lester, 2007) contains two articles addressing issues of theory (Cobb, 2007; Silver & Herbst, 2007). In CERME there has been a working group linking, contrasting and comparing the wide variety of theoretical approaches found in the field in order to tackle the teaching and learning of mathematics. In 2008 the international journal *ZDM* published an issue of some of the results of the CERME working group. Finally in 2009 the theme of PME 33 was "In search for theories in mathematics education". These examples point to a widespread desire of the community for understanding the role of theory in mathematics education research and a wide acknowledgement of the variety of perspectives brought into the field through theoretical expositions. As Silver and Herbst (2007, p. 41) state, "the moment seems propitious for a serious examination of the role that theory plays and could play in the formulation of problems, in the design and methods employed, and in the interpretation of findings in education research."

We wish to make a modest contribution to this discussion by engaging in a critical analysis raising questions of *how* and *why*. We wish to understand in more detail how research perspectives in general and theoretical perspectives in particular construct and/or ignore particular discourses and, in this, our possibilities for addressing these basic yet powerful questions.

As the "linguistic turn" in the social sciences has touched mathematics education research (Lerman, 2000), it appears increasingly important to pay attention to the discourses that mathematics education research constructs about itself and the contributions and limitations of these constructions. By discourses here we understand the ways of naming and phrasing the ideas, values and norms that emerge from the constant and complex interactions among human beings while engaged in

social practices. Academic fields construct particular discourses about themselves and their objects of study. Such discourses constitute systems of reason that regulate what is possible to think and do in a given field (Popkewitz, 2004). Discourses thus both open up possibilities and impose limitations on what we can imagine and construct as alternatives to existing orders. Mathematics education as a field of research is not an exception. As researchers engage in studying the field, they not only define what is characterized as legitimate practices of mathematics education. They also define the ways in which it is valid and legitimate to research those practices (Valero, 2009). We have engaged elsewhere in examinating the discourses generated in and by the field of mathematics education research, such as the idea of mathematics education being "powerful" (Christensen, Stentoft & Valero, 2008), the conceptions of students as mathematics learners (Valero, 2004), the concept of learners' identity in mathematics (Stentoft & Valero, in press b) and the concept and view of ethnomathematics (Domite & Pais, 2009). We have also pointed to some blind spots of some of the theoretical constructions in the field. Considering these constructions of various discourses in the field we argue for the need to broaden the research gaze of mathematics education research to embrace the "noises" that are often ignored, in a search for new imaginaries for our field of study and for the educational practices in mathematics (Stentoft & Valero, in press a).

## MATHEMATICS EDUCATION RESEARCH AS A SCIENCE OF HOW

One major assumption in mathematics education research is that its main aim is to improve students' performance in mathematics. For example, Niss (2007, p. 1293) is very clear when answering the question of why do we do research in mathematics education: "We do research on the teaching and learning of mathematics because there are far too many students of mathematics, from kindergarten to university, who get much less out of their mathematical education than would be desirable for them and for society." If this is the main concern of mathematics education research, it is not surprising that the field has grown as a space for researching in a systematic, scientific way "the problems of practice" (Silver & Herbst, p. 45), defined as problems relating to teaching and learning. According to Boero (in press) "this is a rather obvious widely shared position" (p. 1). In this framework, the work of mathematics educators is "to identify important teaching and learning problems, considerer different existing theories and try to understand the potential and limitations of the tools provided by these theories." (Boero, in press, p. 1)

The above quotes demonstrate an emphasis in the field of mathematics education research on the questions of *how*. How can we improve and enhance the teaching and learning of mathematics? How can we help students to learn? These questions are highlighted further when Cobb (2007) addresses the issue of philosophy in mathematics education as he in a concise manner addresses assumptions engulfing the field of research. Cobb suggests that mathematics education should be understood as a "design science" (2007, p. 7), and provides as an example the NCTM standards. By design science Cobb understands "the collective mission which involves

developing, testing, and revising conjectured designs for supporting envisioned learning process" (p. 7). The ultimate goal of a science designed this way is to "support the improvement of students' mathematical learning" (p. 8). As part of the pragmatic realist philosophy adopted by Cobb, attention is given to the comparison between four significant theoretical perspectives used in mathematics education research, namely experimental psychology, cognitive psychology, socio-cultural theory and distributed cognition. Cobb's discussion revolves around how these theoretical perspectives could help improving students' learning of mathematics. We can research at the level of the national educational system, school or classroom, however the goal remains the same. In Cobb's writing, theory is understood as a tool to give insight and understanding into learning processes with the aim of improving them.

An alluring analogy made by Silver and Herbst (2007) between mathematics education and medicine helps us to understand the meaning of theory as "theory for learning". The authors play with the analogy that mathematics education can be seen as a science of treatment, similar to medicine: By understanding the symptoms that characterise the difficulties of students' mathematical learning we can propose the proper treatment. They state: "The evolving understanding of the logic of errors has helped support the design of better instructional treatments, in much the same way that the evolving understanding of the logic of diseases has helped the design of better medical treatments" (Silver & Herbst, 2007, p. 63). In this perspective, students are seen as patients in need of treatment, and the role of mathematics education research is to understand students' problems and elaborate designs that direct us *how* to treat those learning diseases.

This trend that focuses on learning — enhancing or remediating it—is not exclusive to the field of mathematics education research. Philosophers of education such as Biesta (2005) argue that over the last two decades this perspective has proliferated in broader educational discourses where a technical language of learning has largely dominated and almost overruled a language of education. The "learnification of education", in Biesta's terms, has narrowed the possibilities to think and do education and educational research. The disagreements about the role of school and the goals of education that fuelled part of the educational debate during the last century[1] seem to have been overcome. We appear to have reached a consensus on the benefits of schooling: we need to make it more effective and, therefore, we live an apparent consensus about what concerns education. The problems with schooling and school subjects are no longer to be political or ideological, but have become primarily technical or didactical. In most cases, solutions to educational problems are being reduced to the devising of better teaching and learning methods and techniques, to improve the use of technology, to assess student's performance, etc. Educational

[1] For instance the discussions fueled by the work of John Dewey, Ivan lllich, Louis Althusser or Paulo Freire.

thinking has progressively been reduced to be a controllable, designable, engineerable and operational framework of action for the improvement of individual cognitive change. It is obvious that the research supporting the emergence of this type of discourse is a research essentially concerned with questions of *how*.

Although the prevalence of theory as "learning theory" has allowed us to gain deeper knowledge about the processes of teaching and learning mathematics, we suggest that it has left important discourses faced by the educational communities in their everyday practices unaddressed. We will argue that in order to bring these discourses seriously into the gaze of research, we need a broader theoretical palette which allows us to understand theory not just as "theory of learning", but also as "theory of education". This leads us to propose another type of question for the research agenda, namely the questions of *why*.

## TOWARDS QUESTIONS OF *WHY*

As mentioned above, the "social turn" (Lerman, 2000) in mathematics education brought to the field new concerns and new theories that progressively de-emphasise cognitive psychology as the only interpretative framework and instead favour socio-cultural theories. In this we have witnessed a move from an understanding of children's learning focused on the individual subject and his cognition to an understanding that perceives learning as a product of social activity, where not only the cognition of the subject is at stake but also his relations with other individuals and their shared discourses.

This trend is not merely related to a displacement of the way we perceive processes of learning. According to Lerman (2000) this trend also emerged as a result of growing political concerns about the ways mathematics education could be linked to reproduction of inequalities through the structures of school. Several studies in recent years have contributed to an understanding of mathematics education in association with issues of social exclusion according to race, gender, language, social class and culture. Those studies have opened up a space of critique about the way mathematics education could be contributing to systematic social exclusion of some groups carrying particular characteristics. The critical role of mathematics education in society is also addressed in research on ethnomathematics, particularly in studies aiming to understand how mathematics in society conveys hegemonic discourses and oppressive practices that promote exclusion and domination (e. g. Powell & Frankenstein, 1997). Skovsmose (1994), analyses the way mathematics formats reality, by creating models that end up ruling our decisions and daily lives. This "mathematics in action" is critical since it is not neutral, but ideologically loaded, conveying economic, military or national interests. Finally, another way of analysing the critical role of mathematics in society is by raising the issue of power. Valero (2004) and Skovsmose and Valero (2002) have developed a theoretical framework to engage with the issue of power in mathematics, namely, to understand how the idea that "mathematics empowers people" is conceived in mathematics education.

Popkewitz (2004), in his incursion into mathematics education research, applied a Foucauldian perspective on mathematics as a school subject. He brought out the mechanisms though which the alchemy of school mathematics constructs a set of learning standards that are more closely related to the administration of children than with an agenda of mathematical knowledge. This alchemy is carried out by pedagogy (psychology and social psychology that generate knowledge about children) that appropriates the mathematical content to transmit competences, behaviours and attitudes (e.g., being participative, critical, having self-esteem, etc.). In this perspective, school mathematics serves as an alibi for the appropriation of behaviours and modes of thinking and acting that make each child governable.

Some of the research outlined above, bearing social, cultural and political connotations, has opened up the field of mathematics education by conceiving theory as more than "theory for learning", and posing questions that do not imply a "technical" response or solution but rather an intellectual and philosophical reflection. This is research which, instead of "facilitating" the work of intervention in the mathematics education process (particularly students and teachers), points to potential and unexplored problems within the field, and raises more questions than answers. This kind of research has an intention to "complicate" and to dislocate "certainties" assumed in the field.

However, despite this invigorating openness, we argue that a significant part of research in mathematics education labelled socio-cultural-political research shows a tendency to understand mathematics education in a didactical sense and to aim primarily to address questions of *how*: How to teach in multicultural classrooms? How to teach for social justice? How to educate teachers for social justice? How to integrate immigrant students in the learning of mathematics? How the socio-cultural contexts of students influence the learning of the concepts of chance and probability? These questions were found in the proceedings of the Mathematics Education and Society, MES conference in Albufeira, Portugal in 2008 (Matos, Valero & Yasukawa, 2008), and shows how even in a research environment where the emphasis is on the political, the research persists on the question addressing the technicalities of the field.

## IMPLICATIONS OF RESEARCHING QUESTIONS OF *WHY*

We acknowledge the importance of raising questions of *how*. The research that comes from raising such a question is one that intends to give solutions to the problems faced by those involved in the teaching and learning of mathematics. It is what we can call comfortable research. And all of us need some amount of comfort in our lives. Asking questions of *how* opens up to discourses concerning the individuals navigating with and in mathematics. First and foremost it invites propositions of how students can learn, with some underlying assumption that it is important for the student to learn mathematics. Second, it invites perspectives on teaching and the teacher as a key player to assist in meeting the hypothesis of the importance of mathematics education. Third, questions of *how* invite a broader socio-political and

socio-cultural perspective when they address issues of resources, gender, political agendas etc. The question can in this respect hold a strong political agenda when it asks *how* we distribute resources best to ensure that all receive mathematics education. Questions of *how* navigate within an implicit discourse assuming and attributing some kind of importance to mathematics education. Although potentially political these questions do not touch upon fundamentals or put a question mark on the nature and content of the research field itself. In other words, questions of *how* take mathematics education and mathematics education research for granted and consequently they lack a scope for what can be termed radical alternatives.

As we argued at the beginning of this paper, the ultimate goal for mathematics education appears to be improving students' mathematical learning. The idea described previously of mathematics education as a therapy, a design science or a science of *how* constructs education as a technological endeavour, where mathematics education is understood as a technical engineering of students' mathematical thinking and learning. We acknowledge the contributions that this learnification has brought to our understanding of what happens in a mathematics classroom at a micro-scale. Nevertheless we argue that reducing the possible meaning of "mathematics education" to "mathematical learning" can narrow our perspectives. And thus it becomes impossible to think and act in ways that could open spaces of possibilities inside and outside mathematics education research. Cobb (2007) is well aware of this. When referring to the theory that informs the researcher he mentions that "the constraints on what is thinkable and possible are typically invisible" (2007, p. 7). This awareness also emerges strongly in much research and it is obvious that addressing mathematics education from the narrow perspective pointed out here, reconfirms the fact that "if we look strictly at events as they occur in the classroom, without consideration of the complex forces that helped to shape those learning conditions, our understanding is only partial [and] the solutions to the problem [are] ineffectual" (Rousseau & Tate, 2008). Very few researchers, however, have addressed these limitations.

The MES conference appeared more than ten years ago with an intention of broadening the research field by developing and applying new approaches, new methodologies and new theories to the problems faced in mathematics education research. The MES community acknowledges the need to address these problems from cultural, social and political approaches that situate the problems in a broader context than classrooms and schools. However, assuming a social and political perspective of mathematics education as a research field also involves developing research where the field itself is under critical scrutiny, and where we can formulate questions that are not directed only towards *how* to develop better ways to teach and learn mathematics (in cultural settings, for social justice, in a critical way, etc.). This kind of research raises the question of *why* the theories, methods and discourses that research constructs and is embedded into. Ultimately it raises the question of *why*

mathematics education, which implies an analysis about the discourses setting the scene for its very existence.

Core questions such as the goals of mathematics education, the *whys* and for whom, are political issues that should not be left unattended. The field of mathematics education is not simply a technical field, where the teacher should improve his/her teaching skills and where researchers should develop designs to improve teaching and learning possibilities. To say that education is political means to bring to the field a discussion on the construction of subjectivities through mathematics education. It means addressing the issue of which kind of people are being formed by the learning of mathematics, and for what and why are people to engage in the teaching and learning of mathematics? Ultimately, we can engage in a discussion of which kind of world is being constructed and sustained by the research in mathematics education? Therefore, a theory of mathematics education (and not just for mathematics learning) that places educational practices in a wider political context, where mathematics and mathematics education are neither neutral nor intrinsically "beneficial", makes it possible to raise deep educational questions about the teaching and learning of mathematics in the social, political, economic, cultural and historic contexts in which they are immersed.

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