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How to Do Educational Research in University Mathematics?

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Situated as a Ph.D. student in university mathematics education, I present some of my considerations about my identity as a researcher in this field. I discuss the larger global and local societal issues and their connections to educational research in university mathematics. My discussion goes beyond personal considerations and touches upon the structures and ideas that are both internal and external to university mathematics education. I discuss the different political projects that I can identify from my personal experiences across the fields of educational research, practice, and policy in university mathematics. I place myself firmly within the tradition of critical education, but also draw on postmodern theories. The results of the discussion are the identification of challenges for a postmodern critical mathematics education, with a focus on university mathematics.

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I live in Denmark, one of the richest countries in the world, a small democratic kingdom in the western world. I am a white male living in a welfare society with all the commodities of the western way of life. I have free access to education—even to all the universities. I have free access to medical care. I live in a peaceful neighborhood. I can walk on the streets in the middle of the night without any fear of being attacked in any part of my city. I will not have to sell my home or change my life drastically if I lose my job. I have never felt starvation. I have democratic rights to vote and to participate in political life. I do not risk discrimination or being arrested at random. I live in a country where everybody gets what he or she needs and deserves. This is a brief glimpse of the Danish society from my perspective.

Mathematics Education and the Larger Society

Is this short story from the Danish society in any way relevant for the question of how to do educational research? Does it make sense to ask what kind of educational research should be conducted in the context of this society? These questions I have asked myself as a Ph.D. student in university mathematics education.[1] I have done so because it is important for me to consider the role that my work and I will take in this society and it is important for me to contribute to my society. And my society is the one you just glimpsed. In the following analysis I try to sketch some of the answers that I have found.

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The first answer I listened to when I began my work focused on the internal problems of university mathematics education, and thereby deemed my glimpse of the Danish society irrelevant. It suggested, for example, that I could look at how to get students to learn the concept of function space better, or how to understand how students actually learn concepts.[2] Another group of issues I could look at was how to get the students motivated and how to get more students to pass the exams. This answer almost totally ignores the relation between the larger society and university mathematics education and thereby makes the context of this education irrelevant, but it certainly offers a paradigm of research in university mathematics education. This I call the conservative answer.

Another answer suggests that the institutions of university mathematics education are very important for the welfare of the Danish society, understood mainly in an economic sense. This makes my opening glimpse of the Danish society relevant in the sense that we need the institutions of university mathematics education for maintaining the things that we like which are represented by this glimpse. But this answer also suggests that these institutions are in crisis in the sense that the very important link between these institutions and the larger society (understood as the economic system) is not close enough. Furthermore, they often claim that the institutions of university mathematics education are also in crisis in the sense that they are inefficient. 'We', the taxpayers, do not get enough for the money 'we' pour into these educations. This means that the focus of educational research should be on the learning of mathematical concepts by the individual student, but also on what and how the students should learn. What and how they should learn should be

relevant for the economy, which in this context translates mainly to the industry. It also suggests that I could research into how to measure the efficiency of the institutions, in order to increase the efficiency of the institutions by benchmarking them. This I call the neoliberal answer.

Many additional answers that reflect moments of both the conservative and the neoliberal answers I've already offered can be found. For example, one answer takes the internal concerns from the conservative answer seriously, but also finds mathematics education to be a crucial institution in the Danish society, though these institutions are not seen to be in crisis because the link to the larger society is not tight enough. On the contrary, it sees mathematics education in crisis because it is being challenged by the neoliberal project.

Yet another answer tells me it is not certain that university mathematics education is one of the institutions that helps guarantee all the good things in Danish society. Also it is not certain that university mathematics education has no influence on the larger Danish society. It might be that these institutions are also the source of some of the bad things that I mention next. This I call the critical group of answers.

Another way to experience my country—an alternate glimpse—is to take a walk in the red-light district near the railroad station, or simply walk down the main shopping street. There you will notice the junkies and homeless people that nobody wants. They get pushed around between different places in the city. Some of the homeless and alcoholics used to drink their strong beers near a traffic junction in the middle of Nørrebro where many people pass by. They used to sit there peacefully, or at least as peacefully as they could while being an alcoholic and having many other problems, until the authorities took their bench. They literally removed it. Now the homeless are at another place where they do not 'disturb' the people that have a job and 'contribute' to 'our' society. These people we often do not see, are near the bottom of our small peaceful society. They are not alone down there, others are just harder to notice. They are being rejected by the peaceful, democratic, and just Danish welfare society; they are not considered good for anything (other than trouble and someone to spend 'our' money on).

As with the first gaze into the Danish society, there are different opinions about the relevance of this glimpse for research in mathematics education. The conservatives would tell me that this picture has nothing to do with mathematics education and especially university mathematics education. The neoliberals would tell me that what 'we' need is more and better mathematics education in order to address these problems (if they are seen as problems of society and not only individual problems). The critical educators try to tell something akin to what is mentioned in the Aims of the Third Mathematics Education and Society (MES) Conference:

> Mathematics qualifications remain an accepted gatekeeper to employment. Thus, managing success in mathematics becomes a way of controlling the employment market. Mathematics education also tends to contribute to the regeneration of an inequitable society through undemocratic and exclusive pedagogical practices which portray mathematics and mathematics education as absolute, authoritarian disciplines. (Skovsmose & Valero, 2002, p. 3)

This means that this second glimpse becomes relevant. But this is not all. Both the neoliberal and critical group tell me to look further than the Danish society, to the global world. They urge me to look at different parts of the global world and in different ways. Let me try to share one glimpse into the larger society.

Yet another way to experience the world (and not only Denmark) is to take a plane from inside to outside the Western World (or more correctly from inside to outside the industrialised world and its holiday resorts in the sunny or "exotic" parts of the not-so-industrialised world). Here you can meet hunger, war, serious environmental problems, cultures being destroyed, peoples and countries being plundered, torture, and disasters and crimes of any kind.[3] (Well, not personally, it is likely you would have a nice room in a hotel and a return ticket to your home country in your pocket.[4])

The original voices, conservative and neoliberal, are again answering me, whispering different suggestions in my ear: "Mathematics education is the hero of civilization," or "mathematics education is innocent." They continue whispering seductively, "these problems that you see are only small errors in the system and if only people would not resist the system these errors would be easily fixed." The critical group of answers would suggest that mathematics education might play a role in producing all the nightmares that haunt the world globally, and that mathematics education might play a role in the unequal distribution of wealth globally.

Mathematics and the Larger Society

Not only can university mathematics education be seen as playing different roles in our local and global society, mathematics can also be seen as playing

different roles. And how we see and understand university mathematics education might depend quite a lot on the role played by mathematics in our societies, both globally and locally. The conservatives claim that mathematics is objective and neutral in itself, and it is only the use of mathematics that can lead to good or bad things. This means that university mathematics education is protected from considerations about the role of mathematics in society, and the only problem with mathematics education is that students have problems learning it. Mathematics is of major importance *because* it is an important part of our culture. The neoliberals are saying that mathematics is of major importance in the pursuit of economic growth and thereby the success of our societies, and in this way mathematics education is made important as well, namely as a producer of competencies in mathematics in the shape of a mathematically skilled work force.

But I can also hear other people, for example in the field of ethnomathematics[5], that try to tell me a more critical story:

> The critical strand [of ethnomathematics] is not just interested in the mathematics of Angolan sand drawings and their use in story telling, but also in the politics of imperialism that arrested the development of this cultural tradition and in the politics of cultural imperialism that discounts the mathematical activity involved in creating Angolan sand drawings. (Powell, Knijnik, Gilmer, & Frankenstein, 1998, p. 45)

These voices say that mathematics and mathematics education might not be innocent and might not be our hero and problems might not just be errors, but mathematics and mathematics education might have something more substantial to do with all these problems.

Who is right? Which story should be believed and on what grounds should the different kinds of answers be judged?

The Larger Society and Hegemonic Projects

I think it should be clear by now that what I have called the larger society or 'our' society are terms that are highly disputed and that these terms play a crucial role in the stories that I am offered when I ask about how to do educational research in university mathematics. Personally, I felt that I had no firm foundation that I could stand on when I was to judge the different ideas about 'our' society. I found that the discourse theory of Laclau and Mouffe (1987; see also Torfing, 1999) expressed theoretically just that feeling. In discourse theory, society is not seen as something that is without conflicts or something that can be described from a neutral and objective standpoint. Theoretically put, what I have sketched above is my experience of the struggle of different political projects that all try to dominate society and to that end give different interpretations of what is important in society. They all try to make their descriptions look neutral and objective—to look like the truth about our society. In this sense, such theories are in the same vein as the theory of Foucault. In the words of discourse theory, these efforts are called *hegemonic projects* and they are said to try to gain hegemony. Hegemony translates roughly into leadership, including cultural and political dimensions. My point is that these struggles also extend to the arena of university mathematics education, and that this arena is both used as a resource and as a stake in the struggles. It is not the case that a hegemonic project is always struggling in all arenas and it might be that the project takes different forms in different arenas. The hegemonic projects are not some overarching ideology that structures everything. The answers I sketched in the previous section are very different in scope, but they are all more or less entering the arena of university mathematics education.

It should also be clear that I could have chosen to give you, the reader, quite different glimpses of society. But as I am also situated in these struggles (on the side of the critical group, which you might have guessed) I want to obtain something, and to this end I have chosen these particular glimpses. I do not have hopes that I can show you that things necessarily must be like I see them; I only hope to show you something you might not have seen before. This might be seen as an answer of how to judge the different answers; yet there is no way to stand on a firm ground and be able to judge. You are always a part of these hegemonic projects; you always see the world from somewhere.

In my work I wanted to get a little closer to the hegemonic projects in order to know the terrain that I was entering. This implied that I took a closer look at how the different hegemonic projects are connected to university mathematics education. In the following, I concentrate on the Danish context, but I am sure that the discussion also extends to most Western countries, though maybe with different emphasis caused by the different contexts. The works of Michael Apple have inspired the following discussion of hegemonic projects.

The Field of Educational Research

Different projects are present in the field of educational research, such as the conservative and

neoliberal. When it comes to general education, critical education can be said to constitute a project, but as far as I can see, critical education has mainly been interested in the primary and secondary educational system. I want to mention critical education anyway, because it is a project that I have sympathy for and because I think it is possible to extend it to university mathematics. In the field of educational research the conservative project is dominant when it comes to university mathematics. However, the field itself is quite young.

Critical Mathematics Education

In the Aims of the MES Conference, I see concern for identifying structural problems that affect the people who are learning mathematics: "Mathematics qualifications remain an accepted gatekeeper to employment", and "mathematics education also tends to contribute to the regeneration of an inequitable society through undemocratic and exclusive pedagogical practices" (Skovsmose & Valero, 2002, p. 3). Here we see a focus on democracy, and elsewhere on the idea of citizenship. Mathematics is not seen as unproblematic, but seen as a potential social actor that supports the production of risks in society. Ethnomathematics is also interesting, since it for me has a completely different focus on mathematics than what is usual in the field of research in mathematics education.

Only in the very broadest sense can these concerns and focuses be said to be a part of a hegemonic project. Critical mathematics education is a movement that is connected to practitioners of the teaching of mathematics but might have weak links to fields outside mathematics education. This should be seen as a challenge to critical mathematics education. It is a movement that has not entered the field of university mathematics education in a substantial way. This is something that I would like to change.

University Mathematics Education

The conservative project dominates the field of educational research in university mathematics (Hart, 1999). Hart identified the dominating research tendencies in post-secondary mathematics education, "Except for a handful of studies, most research at this level has focused on the student or on various pedagogical methods…" (p. 3). She proposed a research agenda that can be characterized as a post-conservative agenda. It retains conservative characteristics since it still sees mathematics and mathematics education as disconnected to the larger society. It is post-conservative since it clearly goes beyond the conservative agenda by proposing constructionism (Hart refers to Gergen, 1992; and Phillips, 1995) as the epistemological foundation of research within what she calls post-secondary mathematics education.

The Field of Educational Practice

At many departments of mathematics in the 'old' universities in Denmark, the teaching is centred on courses based on lectures and classes (where the student are supposed to solve problems) with typically large numbers of students attending. The pedagogy is often authoritative, picturing mathematics as an absolute discipline and teachers as holding the absolute truth about mathematics. Mathematics is seen as packages of knowledge that should be put into the heads of the students. The students are seen as individuals and their context is unimportant (unless to the degree that their motivation is of interest). The teaching of mathematics and mathematics itself are seen as unproblematic.

At some departments of mathematics, the teaching is centred on group-based project work, but also lectures. Some of the project work focuses on links to the larger society and the role played by mathematics in society. These universities have become the best suppliers of workers because they focus on project work in groups while the old universities more or less try to copy their ways of organising the educations.[6] My impression of groups that are in these environments is that they both more or less represent different degrees of what I call the conservative project.

In the context of one of the old universities, some of the problems that I have heard talked about are economic problems and pedagogical problems. The first kind is caused by the decrease in the number of students studying mathematics[7] and the second by the fact that the student population is becoming more heterogeneous[8] and that the students lack motivation. The first problem is understandable so, since economic problems will mean less funding for the researchers and teachers in the department. The second problem consists partly of increasing difficulties teaching at a level where as many as possible benefit, and partly of increasing exam failure.

What I think is characteristic of these problems is that they focus on economics and on the individual students—they are both more or less external problems being imposed on the departments. This naturally puts other problems on the sideline. For example, there is

not much attention on mathematics itself: No one asks why there is such a thing as university mathematics education, what kind of mathematics should be taught, or the relation between mathematics and the larger society. Or this view perceives such problems and issues in a particular way. The focus is on how mathematics should be taught so that more students want to study mathematics, so that they complete their study faster, and so that they become better mathematicians. It seems like the conservative ideas of mathematics education that prevail in the departments of mathematics are under attack from the neoliberal ideas, and that this attack comes mainly from the area of national university policy.

This identification of certain problems is not innocent. It has caused different actions to be taken. That tells me a certain story of what research in university mathematics education should be and what I ought to do to be a 'normal' researcher. For example, there is a suggestion of making elite courses alongside a normal course to accommodate the problem of a heterogeneous student population. A Centre for Science Education[9] has been built to undertake research and development of mathematics education to make it more 'sexy'[10] and thereby attract and motivate more students.

The Field of University Education Policy

National

I have tried to understand the kinds of arguments and understandings of the universities and society. One thing that is striking in these debates on university and society is the use of a particular idea that is always connected to the role of the universities—the idea of a *knowledge society.* This idea is used to refer to the kind of society that we live in (at least in the Western World) and by connecting to the universities via the idea of knowledge, a certain perspective on universities is constructed that dominates the debates. The idea comes in different versions—for example, the concept of a "learning society" in Michael Young's *The Curriculum of the Future* (1998, p. 137-155). I think of the knowledge society as a contested concept.[11] This means that different groups in society (not necessarily political parties) with different interests try to gain the power to define the idea of a knowledge society and to connect it with other different ideas. This would help the groups gain the power to define facts, problems, and solutions concerning, among other things, the university and the role of the university in the knowledge society.[12] In other words, they try to make their ideology hegemonic. Some groups try to connect the idea of a knowledge society with the ideologies of business and management using ideas as production, competition, management, and markets. Other groups try to connect the knowledge society with the idea of democracy with emancipation, the risk society, and ethics.[13]

The typical dominant argument goes like this: We are in, or partly in, a knowledge society, therefore the role of the universities have changed in a certain way and we, as a society, have to react responsibly to these new conditions. This is the general form of the argument, and when it is presented like this it is obvious that defining the knowledge society to some extent determines the new conditions of the universities and thereby the kinds of reactions there are. What is also obvious is that in this form of argument there are reactions—not actions. This supposes that the universities have the role of reacting to the conditions in the society, and not the other way around. This makes the university a 'service' institution of society, making sure that the right amount and kind of knowledge is produced, and not an institution that can critically examine parts of the larger society, including itself! This idea of a 'service' institution nicely fits with the idea that research in university mathematics education is 'efficiency' research, that it never gets critical in any profound sense, but only makes sure that the 'service' institution is as efficient as possible.

As examples of different contested ideas of the knowledge society, I will examine articles from *Universities for the Future*[14] (Maskell & Jensen, 2001) and from *Education*[15]. Sometimes there is a small description of what is meant by a knowledge society, normally focusing on economic. There are no discussions of the processes that have lead to this development or the adequacy of the concept itself. It is taken as fact that we live in a knowledge society and that this is a fact that we have to adjust to and, in particular, the universities have to adjust to. These kinds of description and this kind of construction of necessity are also found in the political policies on education of most of the political parties in Denmark.

After establishing the fact that we have to react to the emerging knowledge society, the writers draw conclusions about the role of the university. These writers agree that it is a very important institution and much more important than it used to be. They see it is an institution where knowledge is 'produced' mainly in two forms: as research results and as academic workers. Both are conceived as inputs to the private corporations that are so important for our welfare

system. This means that universities, as a knowledge society, are conceived only from an economic perspective and not from a cultural or political perspective.[16] This means that changing the structure of the universities will have effects on the economy, and more importantly, it means that this is the only relation that is conceived in the relation between university and society.

International

In this context, economy connects to competition, markets, and freedom. The economic description of the knowledge society is typically followed by some kind of description of a globalisation process, constructing a link between the success of 'our' welfare system and how competitive our country is. If knowledge is the most important factor for competition between countries, then the success of our welfare system is dependant on the success of our society as a knowledge society. The General Agreement on Trade and Services (GATS) that is a part of the World Trade Organization (WTO)[17] contains a clear neoliberal approach to higher education, including university mathematics education. It sees mathematics and mathematics education as a commodity that should be given the opportunity to be traded on a free market. The Bologna Declaration can be seen as an attempt to clear the way for a free market in university education in Europe.[18] This declaration has also some "regionalistic" agendas, such as the building of a common European culture. The agreements and declarations are beginning to have effects on both the thinking and the everyday life of higher education, including university mathematics education, in most European countries.

How to do Educational Research in Mathematics Education?

I hope that I have sketched with some clarity the different answers that have been given to me in my search for an identity as a researcher in university mathematics education. These answers make different suggestions for a research paradigm. I have tried to sketch how these possible research paradigms are contained in different hegemonic projects with very different scopes and identities. I leave it to the reader to think about the names that I have given to the different answers: conservatives, neoliberals and critical.

The conservative suggestions are mainly focused on mathematics and try to ignore external relations, though the conservatives have been under pressure from the neoliberals. The neoliberals focus on the economic link between university mathematics education and the larger society, which they understand in mainly economic terms.

One of my main points would be that whether you like it or not, deciding how to do educational research in university mathematics education makes you a part of these struggles in one way or the other. It is not a neutral realm that can refer to the pursuit of truth for the legitimisation of work being done. In this way, the three glimpses of society that I have given are relevant to consider. I have found it is not an easy thing to choose how to do research in this field (or any other field for that sake); there is no firm ground to stand on from where to make a neutral and necessary judgement.

Challenges for Postmodern Critical Educational Research in University Mathematics

As mentioned before, I can identify with the concerns of critical education, though I also find some of the ideas problematic. Therefore, I have chosen the word "postmodern" from critical education; this signals my flirtation with discourse theory. As mentioned, both the ideas of discourse theory and those of critical mathematics education have not been especially interested in university mathematics, therefore there are a manifold of challenges and uncertainties for a research paradigm that is inspired by these two approaches. The challenges I focus on here are those that I find important. This does not mean that I see them as the most important or the only ones, but it means that they are those that I have found interesting and within my reach as a researcher.

Theoretical Challenges

There is need of a theoretical framework that can help:

1. Conceptualise the multiplicity of educational research paradigms, practices, and policies; and the way that they internally compete and struggle.
2. Conceptualise the relations between the different fields. I have focused on educational practice, educational research, and educational politics in this paper, but many others exist.
3. Conceptualise key-concepts such as society, politics, and mathematics.
4. Conceptualise political implications as to what democracy, citizenship, and mathematics education should be like.

These are the challenges that I feel to be urgent. I have appropriated the theoretical framework of the Laclau and Mouffe's discourse theory (1987) as an approach to the concepts of society and politics and as

an approach to understand the struggle for power within the discipline of education research. I have also drawn on the work of critical mathematics education, especially the work of Ole Skovsmose (1994), to conceptualise mathematics in society.

The theoretical framework I call for should not only be descriptive; it should also provide directions and strategies for research in university mathematics education, but also in society and education at large. Also, the framework should give us directions that we can explore as to theorize how we would like the educational institutions of university mathematics to be. I have myself focused on concepts such as democracy, citizenship, and the apparatus of reason.

Empirical Challenges

Parallel to such a theoretical framework, there are also challenges that relate to the understanding of the actual state of the fields and their connections. How is educational research in university mathematics actually being done? What are the conceptualisations of students, of mathematics, of connections to the larger society, and so forth, that are implicit or explicit in the kinds of research that takes place? How are the educational practices in the universities and what are the connections to the larger society and other fields? In other words, what kind of world is it that the critical strand is a part of and in which it finds itself?

But this is not all. There are also empirical challenges connected to the normative part of the theoretical framework. We need to explore empirically how the ideas such as democracy and citizenship can be realized in a university mathematics education.

I have personally concentrated on the first part of these empirical challenges, and I have done so by focusing on the three fields that I also mention above. I have looked at the educational practices at a certain department of mathematics at a university. I have looked at international policy on higher education. And I have looked at educational research in university mathematics.

Building a Hegemonic Project

One of the most important features that a postmodern critical mathematics education should have is that it should be able to form an alliance of different groups in order to get enough momentum. It should be able to connect to other fields as the neoliberal project has done. In my opinion, some of the most important groups to connect to are the teachers at all levels of the educational system, the students, and others. It is not clear to me how these connections could be made, but the idea of a radical plural democracy[19] and a democratic citizenship seem to be a concern that can be traced throughout many fields.

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[1] My focus is on educational research within the departments of pure or applied mathematics at the universities, not on the teacher training colleges. Although in Denmark, the departments of mathematics at the universities are educating the upper secondary school teachers (the high school/gymnasium level). These teachers are educated in just the same way as the students that choose to be a researcher in mathematics or choose to work in industry or elsewhere. In fact, at the university of Copenhagen no course in mathematics education is available for those who later want to be teachers in high school.

[2] I.e., a focus on learning theory, and a certain kind of learning theory.

[3] I would like to mention only two numbers, namely the number of 1,200,000,000 and 7,000,000. The first in the number of persons in the world today that daily have under 1 dollar to live on. The second is the number of children that die every year of hunger. Compare this number to the 5,000 people that died when the World Trade Center was destroyed.

[4] This comment could be applied to what I am doing here; in some sense this paper is also exploiting the people in hopeless situations.

[5] See for example Powell & Frankenstein (1997), and for a discussion of ethnomathematics see for example Vithal & Skovsmose (1997).

[6] In Kjersdam & Enemark (1994) there is a presentation of Aalborg University as a success in the sense that they supply the employment market with some of the best workers.

[7] In Denmark some of the funding of the universities are partly dependent on the number of students.

[8] This means that there is a group of about 20% that finds learning mathematics easy and a group of about 80% that has difficulties, at least according to some of the lecturers in the department.

[9] Science includes mathematics in this context. The centre's homepage is http://www.naturdidak.ku.dk.

[10] As I heard one of the speakers say at the opening of the centre the 27th of March 2001.

[11] More correctly I think the concept is *partly contested* because the dominant part of the debates actually agrees to a large extent, but there are also many disagreements.

[12] I must admit I am a little uncertain about this formulation. I do not want to think of the idea of a knowledge society as something that one can apply or use like a tool to gain power. It is more like something that is a part of the construction of the way one perceives the society and one's identity. I am not sure if I really end up doing what I do not want in this paper.

[13] These thoughts on how ideas, concepts and power interact are to a large extend inspired by Michael Apple (e.g., 2001).

[14] This is my translation of the title 'Universiteter for fremtiden'. This book consists of articles written by politicians and others.

[15] This is my translation of the title of the Danish magazine 'Uddannelse' published by the Danish Ministry of Education (n.d.),

[16] Young (1998, p. 156) has identified a similar trend in public education.

[17] This agreement is being negotiated continuously, and has been the target of many protests especially for making education a commodity that can be traded as bananas are traded.

[18] See http://www.unige.ch/cre/activities/Bologna%20Forum/Bologne1999/bologna%20declaration.htm for the text of the declaration. There is resistance to this declaration from for example the Attac movement.

[19] This is a hegemonic project proposed by Laclau and Mouffe. See (Torfing, 1999, p. 247-261) for an introduction.