

# To translate between different perspectives in belief research: a comparison between two studies

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A common problem in belief research seems to be a missing link between aspects of theory and empirical analyses and results. This issue highlights a question of how dependent empirical studies about beliefs actually are on the theoretical perspective described in the study. In this paper, I examine relationships between two different perspectives. One perspective focuses on belief change, and seems to rely on a type of cognitive perspective, where beliefs can be characterized as mental objects. The other perspective argues for moving away from such cognitive perspective and instead to adopt a participatory perspective in the analysis of mathematics teaching. The results show that the study about belief change is not dependent on seeing beliefs as mental objects, but that this study could as well have been located within a participatory perspective.

In belief research, a clear connection between theoretical aspects and empirical investigations seems to be missing in many studies. For example, Leder's (2007, p. 48) review of conference proceedings from PME and MERGA shows that "small sample, qualitative method studies, of questionable generalizability, were particularly favored", and she questions how these types of studies can develop theoretical aspects in the research area. In addition, there are many descriptive studies in belief research, for example by focusing on different persons' or groups' beliefs using different types of categorizations. Speer (2005, p. 366) describes this situation by noting that "there are nearly as many sets of categories as there are researchers", highlighting a lack of building on previous research. A final example can be taken from Pajares' (1992, p. 313) review of belief research in educational science, where he notes that "beliefs are seldom clearly defined in studies or used explicitly as a conceptual tool",

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highlighting that theoretical aspects seem not to be used as analytical tools in empirical research.

Besides the problem of relating aspects of theory to empirical research, there are also problems with the definitions and theories that exist in belief research. For example, when researchers are asked to characterize the notion of beliefs, the answers include "a large variety of ideas" (Fur-inghetti & Pehkonen, 2002, p.48). In line with this result, in Philipp's (2007, p.265) review of research on teachers' beliefs it is also noted that regarding the concept of beliefs, "no clear agreement about the definition has been reached". However, definitional problems do not only appear when comparing different researchers, but for singular studies there is also a "frequent failure to distinguish carefully and consistently between beliefs and other affective factors" (Leder, 2007, p.48). Similar problems are noted for educational research in general when Pajares (1992, p.307) describes beliefs as a messy construct since there are "definitional problems, poor conceptualizations, and differing understandings of beliefs and belief structure" – highlighting problems both regarding relations between studies (*differing understandings*) and also within studies (*poor conceptualizations*).

On the one hand we have conceptual/theoretical problems in belief research, but on the other hand we also have missing connections between aspects of theory and empirical research. Thus, it is unclear to what extent and how the specific theoretical problems affect empirical research, if the empirical research is not based on these aspects of theory that are problematic. For example, Philipp (2007, p.268) does not see the need to resolve the issue of defining the key notion of beliefs, since constructs "are operationalized as much by the research methodologies used as by a particular definition". Since aspects of methodology are usually seen as part of theory (Niss, 2007; Radford, 2008), this can still be seen as an issue of relationships between theory and empirical research. However, it also shows that we need to refine our discussions about relationships between aspects of theory and empirical research. This topic is the focus of the present paper, in particular regarding if and how different theoretical perspectives in belief research affect, or could affect, empirical research. Through this focus, the present paper is a continuation of some of my previous studies about the role of theory in belief research, regarding a previous attempt to combine different theories when studying relationships between beliefs and communication (Österholm, 2009) and regarding an examination of the role of theory depending on when and how it is entered and used in the research process (Österholm, submitted). In the latter study I argue for the need to examine the use of theory in specific empirical studies and not only compare different theories in themselves.

This is needed since all parts of an empirical study do not necessarily depend on all parts of a theory that is claimed to be used. A comparison between theories, and not how they are used, could therefore make you miss a potential to relate, or even combine, different empirical studies that are based on different theories.

In this paper, I do not elaborate on specific definitions of the notion of theory or other closely related notions, such as framework, perspective and approach. Instead, as a starting point, I see more generally that there are different aspects of how you approach a certain research area, including aspects of definitions and methodology, which affect research studies. In particular, in this paper I will use a set of eight different theoretical aspects as a basis for my analysis of different studies. These aspects are described in the method section.

## Purpose

Based on the problems in belief research discussed above, in particular regarding the missing relationship between aspects of theory and empirical research, a relevant question is whether much empirical belief research could be (re-)interpreted using a type of approach/perspective not originally used. This topic is examined in the present paper, in particular if and how one specific study that does not focus on the definition of "beliefs" but focuses on another theoretical aspect (change of beliefs) can be (re-)interpreted using a perspective described in another study, which suggests to move away from a cognitive perspective (which seems to dominate belief research) and instead take on a participatory perspective. I compare these studies in order to examine if and how they can be related to each other and perhaps even be combined in a fruitful manner. In particular, I examine if the empirical study about change of beliefs is not necessarily that dependent on a cognitive perspective as perhaps first assumed, based on some type of notions used in the study (regarding conceptual change). The purpose of this comparison between studies is to examine if, and to what extent, differences caused by the use of different perspectives/approaches could mostly be about a choice of wording; if it seems possible to "translate" descriptions and analyses made within one study in order for the descriptions and analyses to make sense (also) within another perspective, not originally used in the study.

## Method

For the analysis in this paper I have gotten access to preliminary versions of two other papers in the present issue of *NOMAD*; one paper about

belief change from Peter Liljedahl and one paper about a participatory perspective on belief research from Jeppe Skott, Dorte Moeskær Larsen, and Camilla Hellsten Østergaard. I also include as a basis for my analysis another paper by Skott (2010) in which he discusses the same perspective as in the paper by Skott and his colleagues in the present issue of *NOMAD*. From here on I refer to these two different perspectives as the change perspective and the participatory perspective. Both these perspectives focus on teachers and mathematics teaching, which is therefore also the focus of the present paper, although the main unit of analysis in the present paper is the different perspectives.

These perspectives are described in more detail later in the present paper, but at this point the reader is also encouraged to directly familiarize him-/herself with the content of the two other papers in the present issue of *NOMAD* that form the basis for the analysis in the present paper.

When comparing different research studies or perspectives adopted in different studies, this can be done regarding many different aspects, and a selection is needed. Some researchers use a definition of "theory" or other related notions such as "framework" or "approach" as a tool for comparison (e.g. Bergsten, 2008; Österholm, submitted), some researchers focus on more general aspects of research, such as validity and relevance (Gellert, 2008), while some researchers do not use any explicit structure of aspects to focus on when comparing different studies (e.g. Even & Schwarz, 2003). In contrast to these examples, I choose to use more specific theoretical aspects in relation to the content of the studies that are analyzed, regarding aspects of belief research. The purpose of this choice is to be able to make more in-depth comparisons, which perhaps is not always possible when using only general aspects of theory or research as a starting point for comparisons. However, the intention is also that the analysis in the present paper can be seen as part of a general discussion about the use of theory in research, and not only relevant for discussing belief research. I return to this issue after the description of the specific aspects used in this paper, regarding how these aspects relate to more general aspects of theory.

Primarily I choose aspects to analyze based on literature that in a structured manner discusses belief research: a comparison between different perspectives in research about epistemological beliefs by Pintrich (2002) and also a handbook chapter focusing on teachers' beliefs by Philipp (2007). Even if the interest of Pintrich is focused on a certain type of beliefs (epistemological) and also primarily on students, his discussions include more general aspects of beliefs and belief research. Since Pintrich has the more structured and comprehensive approach to discussing different aspects of belief research, I use his list of eight different aspects as a basis for my analysis. The contents of these eight aspects are also, if

necessary, complemented and adjusted based on discussions by Philipp and based on the specific purpose and focus of the present paper. By using these two papers, that both focus on summarizing and discussing belief research as a basis, the analysis in the present paper will cover central aspects of belief research.

### *The eight aspects*

The book chapter by Pintrich (2002) is a last chapter, where he discusses the different perspectives presented in the other chapters of the same book, regarding what there is consensus about and what conflicts exist. In his analysis he focuses on eight general issues regarding the nature and role of (epistemological) beliefs. The description of these eight aspects done here is my adaptation of the aspects described by Pintrich. Regarding some aspects I focus mainly on the overarching issues since Pintrich sometimes focuses more specifically on *epistemological* beliefs and the specific perspectives presented in the other chapters of the book. The aim of my interpretation and adaptation of these eight aspects is to make them more directly applicable to belief research in general and also to teachers' beliefs in particular.

#### **Aspect 1: Nature of the construct**

Can include a definition, stating what to include and to leave out of the construct, and also what to consider as related but distinct constructs. Can also include what mode of representation is used, in particular regarding if the construct is seen as a state or a trait, e.g. as a way of thinking or as schemas.

#### **Aspect 2: Components**

Whether it is possible to describe the structure or functioning of beliefs using (possibly a priori specified, possibly independent) different dimensions or components, or if beliefs are seen as more holistic constructs.

#### **Aspect 3: Domain generality versus domain specificity**

Not only yes/no or general/specific, but can include statements about domain boundaries and the level of consistency within/across boundaries, by for example considering larger areas of our lives (work, personal, academic), subject areas or disciplines, or situational classroom contexts.

#### **Aspect 4: Nature of developmental change**

Not directly relevant for this paper, since focus in this aspect is on development from younger students to adolescents, regarding relationship between age-linked development and context-linked (the classic

question of differences between development and learning). One part that could be relevant more generally is if there is a potential degree of sophistication in the relationships between different beliefs and some endpoint of such a scale.

**Aspect 5: Mechanisms of change**

Includes if change is seen as internal psychological mechanisms and/or contextual facilitators and constraints. Also includes how necessary or sufficient different mechanisms are for change.

**Aspect 6: Relations to cognition, motivation, learning, and teaching**

I have here added "teaching" compared to Pintrich's (2002) original description. This aspect includes the issue if beliefs are seen to facilitate and/or constrain, which is also a question of how and why. Also includes if beliefs are seen as precursors to various academic outcomes, if these relations are seen as reciprocal or seen as integrated as a whole (i.e. if it is impossible to separate them and to discuss "relationships").

**Aspect 7: Group differences**

Can include different types of groups; gender, ethnicity, class, culture etc. and different ways to characterize groups, e.g. gender as sex or gender orientation in terms of a masculinity-femininity dimension. Can also include whether differences are seen as effects of groups per se or underlying aspects connected to groups.

**Aspect 8: Methods and measurements**

Includes the uses of different types of methods, e.g. qualitative interviews, self-report questionnaires, and observations of behavior, language use or discourse patterns, together with arguments for or against different types. In particular, arguments can include whether monomethod or diversity of methods is seen as most beneficial, including how to view relationships between methods.

In his handbook chapter, Philipp (2007, p.258) focuses on "what beliefs are, how they are measured, what stances are taken on the role of inconsistent beliefs, and how they are changed". In relation to the eight aspects described above, Philipp's focal points can be located in aspect 1 regarding what beliefs are, in aspect 8 regarding how they are measured, and in aspect 5 (and potentially aspect 4) regarding how they are changed. The issue of inconsistent beliefs is not specifically mentioned in any of the eight aspects, but it is possible to include it in aspects 2 and 3 where the structure of different beliefs and relationships between different

domains/contexts are discussed. Inconsistent beliefs can also be located in aspect 6, if the inconsistency involves also other constructs (e.g. teaching). Thus, all main aspects of belief research discussed by Philipp can be included in the eight aspects described above.

All these eight aspects can be seen as a specification in relation to a general definition of theory, for example as parts of an organized network of concepts and claims (according to the definition by Niss, 2007) or as parts of basic principles and methodology (according to the definition by Radford, 2008). One component of theory, as included by Radford, is not directly included in the eight aspects; paradigmatic research questions. This component is not added as an aspect for the analysis in the present paper since it is difficult to compare this aspect when analyzing only singular papers, which do not directly focus on the same, or similar, kind of overarching problem/issue/situation.

Based on his definition of theory, Radford (2008, p. 320) describes that the system of basic principles "includes implicit views and explicit statements". Therefore, even if researchers do not explicitly describe a theory as the basis for planning and conducting a study, there are aspects of a theory (as defined by Radford) used in a study, at least through some more implicit views that become visible through how the study is structured and described. This is also in line with Philipp's (2007, p. 268) remark that constructs "are operationalized as much by the research methodologies used as by a particular definition". The eight specific aspects can therefore function as a useful tool in order to also find and describe aspects that are not necessarily expressed explicitly but nonetheless seen as parts of a used theory.

In summary, regarding the use of the eight aspects, these are seen as relevant for the specific purpose of analyzing belief research and seen as useful for highlighting aspects of belief research not as easily noted from a more general structure of the use of theory.

Thus, the eight aspects from Pintrich (2002) are used in this paper as an analytical tool to compare and relate the two different perspectives; the change perspective and the participatory perspective. In the following sections, for each perspective a short summary is given followed by a description regarding if and how each aspect is dealt with in this perspective. Thereafter, the descriptions of the perspectives are used as a basis for a comparative analysis, regarding if and how the perspectives differ with respect to each aspect. In particular, a focus of this comparative analysis is to examine if the participatory perspective can be "applied" to the study described in the change perspective. This type of analysis results in a description of to what degree and how, regarding the different aspects, the different perspectives can be unified. Since I oppose to the

black-and-white view of having *either* opposing *or* congruent perspectives, the unification discussed here is limited to the specific studies and the specific aspects that are analyzed.

### The change perspective

In this perspective, the starting point is that there are connections between how teachers teach and their beliefs, and that beliefs not in line with contemporary views of the teaching and learning of mathematics need to change. The purpose of the study in this perspective is to examine if the theory of conceptual change can be used as a basis for creating an intervention that should create this type of change of beliefs. The implementation consisted of a master course for in-service mathematics teachers, and included different activities where the nature of mathematics and research about students' learning were discussed. The results show that the intervention was successful since teachers rejected their a priori beliefs, and that the theory of conceptual change therefore can be seen as a suitable tool for creating this type of interventions.

Two of the eight aspects are not directly discussed in this perspective and seen as not directly relevant for the perspective; aspect 3 (about domain generality/specificity) and aspect 7 (about group differences). These aspects are therefore not included in my analysis of this perspective.

#### *Aspect 1. Nature of the construct*

No explicit definitions are given for the notion of belief or other closely related notions. Some metaphors are used to describe properties of the construct, in particular that beliefs can be seen as possessions you can get comfortable with and where letting go can be painful.

Properties of related constructs are mainly discussed through arguments that the theory of conceptual change is applicable also to beliefs. Thus, there is some similarity between (mis-)conceptions and beliefs, but the focus of this perspective is on the similarities of how they have been created and not on other properties of these constructs.

The issue of trait or state is not explicitly discussed but certain descriptions can be seen as more congruent with belief as a trait, by describing belief as an entity of some kind. In particular, descriptions include that some things can *affect* a belief and that a belief can be *created* and *replaced*.



### *Aspect 2. Components*

Some types of components of beliefs are described through beliefs about mathematics, about teaching and about learning, where a division is made regarding six core aspects of mathematics education. For different interventions in the master course it is noted that each intervention focuses on one of these aspects at a time, which can be interpreted as signaling independence between these aspects/components.

### *Aspect 4. Nature of developmental change*

The creation of beliefs is described as occurring through lived experiences, which puts focus on situational aspects and not on age-connected development.

In this perspective, it is possible to see the existence of different types of beliefs regarding the level of sophistication, through the central issue of replacing unwanted beliefs with other types of beliefs, which is related to the notions of misconceptions and naïve views. However, discussions in this perspective do not presuppose that there is some general, universal hierarchy regarding the sophistication of beliefs, but the perspective can as well be applied to different beliefs in general, without putting them on any scale of sophistication.

### *Aspect 5. Mechanisms of change*

This aspect is the central aspect of this perspective. However, the perspective does not discuss change in general since focus is on those types of beliefs that have been created through lived experiences and in absence of formal instruction, for which the theory of conceptual change is seen as applicable.

The basis for the mechanisms of change is taken from cognitive theories, through the notion of conceptual change and relations to assimilation and accommodation. However, the perspective does not primarily focus on aspects of internal/cognitive issues but focus more on how contextual aspects of a specific situation can be seen as affecting the teachers' beliefs. This focus is in line with the use of the theory of conceptual change as a description of a method to create suitable situations that can change the participants' beliefs (i.e. the study in this perspective is using conceptual change as a "theory for" change and not only a "theory of" change).

Exposure to provocative literature is seen as the central part of the interventions used in this perspective. However, it is not argued that the described type of interventions are necessary for belief change, but

that it can be seen as sufficient, when used as described in this perspective. Awareness of one's beliefs is described as essential in the process of change, which in this perspective occurs through teachers' reflections of their own teaching in relation to the provocative literature. After becoming aware of their beliefs, it is possible for the teachers to go through the processes of conflict, rejection and replacement, regarding their beliefs.

*Aspect 6. Relations to cognition, motivation, learning, and teaching*

That beliefs affect teaching is used more or less as an axiom in this perspective, and focus is not on discussing this relationship more in-depth. However, it is evident that the effect is regarding both facility and constraints, in particular since the beliefs that are seen as needing to change are constraining while the beliefs that are meant to replace the old beliefs are seen as relatively more facilitating.

While beliefs are seen as influencing teaching (i.e. beliefs is something that can be separated from teaching), it is also described how experiences of teaching situations create or change beliefs. Thus, the relationship is reciprocal. In addition, it is mentioned that not only the teachers' prior experiences as students can create beliefs about mathematics education, but also that their own routinely teaching practices can be seen as a source of their beliefs. These relationships can make it difficult to separate beliefs from teaching practice, stressing even more the reciprocal relationship, since beliefs can be described as a cause of teaching practices and also that routinely teaching practices can be described as a cause of beliefs.

*Aspect 8. Methods and measurements*

In this perspective, a semi-natural situation is used for data collection; the teachers are taking a master course but certain extra activities have been added for the purpose of research.

Several different methods are used in this perspective; field notes from observations, journals from the teachers, interviews, and a course assignment to write an essay. All types of data are analyzed regarding evidence for cognitive conflict, belief rejection and assimilatory behavior. Thus, the different types of data are used to examine the same types of events, regarding aspects of conceptual change. Focus is therefore not on measuring beliefs per se but to observe the process of change. However, since the awareness of their own beliefs is central in this process, the teachers' beliefs can also be observed.

There is no explicit argumentation for or against certain methods, but the teachers' reflective journals are labeled as the major source of data. In these journals, the teachers wrote their reflections when working on different tasks in the course, where a main activity was to reflect on their own teaching in different ways. Thus, this reflective activity seems central as a basis for data, both for observing beliefs per se (through teachers' becoming aware of their beliefs) and also for observing (and creating) a change of beliefs.

### The participatory perspective

In this perspective, the overarching focus is on the role of the teacher for the practices of the mathematics classroom. The starting point is some problems noted in traditional belief research in relation to the overarching focus. These problems are seen as both conceptual and methodological, and primarily caused by viewing beliefs as object-like, mental entities. The authors argue for adopting a different perspective; to focus on patterns of participation in different practices. Focus is then put on the use of this perspective in an empirical study, when presenting data on the case of one teacher that is followed prior to and after graduation from teacher education. The analysis focuses on relationships between different practices, in particular the teacher education programme on the one hand and the teacher's instructional approaches on the other hand. Based on the analysis of interviews and observations, the authors argue for benefits with the suggested perspective, without needing to assume the existence of beliefs as mental objects.

Three of the eight aspects are not directly discussed in this perspective and seen as not directly relevant for the perspective; aspect 3 (about domain generality/specificity), aspect 4 (about developmental change) and aspect 7 (about group differences). These aspects are therefore not included in my analysis of this perspective.

#### *Aspect 1. Nature of the construct*

A basis for this perspective is participationism and not acquisitionism, which seems to be a basis for much of existing belief research. Essential in this perspective is to maintain the process character of individual meaning making, in particular to reject the view of beliefs as reified mental objects. Instead, focus is on relationships to those practices that an individual is or has been part of, regarding if and how different practices are used as resources in a certain situation. Thus, in this perspective, beliefs are not seen as mental objects but focus is put on those

processes that are assumed to be the basis for the objectification of beliefs. This focus on processes and rejection of beliefs as mental objects clearly characterize aspects of a state and not a trait.

### *Aspect 2. Components*

The study of how different practices relate to a current situation can be seen as a holistic perspective, where all prior experiences of an individual are necessary for studying a certain situation. However, an essential part of this perspective is to localize and characterize different specific practices that teachers can be seen as shifting engagement between, more or less continuously. This focus seems to demand a type of separation between different kinds of components, consisting of different practices or modes of participation.

Teachers' activities in the classroom are in this perspective interpreted in relation to specific types of practices, thus using these practices as different components. However, these components are not seen as universal or general (i.e. given a priori) but consist of practices relevant for a specific teacher. At the same time, the practices used in the analyses can be based on natural and physical borders, which are relevant for all teachers, for example the practices of being at home, being in the mathematics classroom, being in the teachers' lounge etc. However, practices are not necessarily based on such physical borders, there can also be other types of borders, for example practices that are theoretical or discursive, as also described in this perspective.

### *Aspect 5. Mechanisms of change*

The process-focus in this perspective, in particular regarding relationships between teachers' activities and participation in past and present practices, can make it difficult to talk about change of something since there is no specific object that can be changed. At the same time, every new situation can be seen as causing a continuous change, since the activity in a present situation always adds something to the pattern of participation in those practices that are relevant in the present situation.

### *Aspect 6. Relations to cognition, motivation, learning, and teaching*

The central point of this perspective is not to view beliefs as objects with "a life of their own", which themselves can affect something else. However, a central point is also that teachers enact and re-enact patterns from past experiences/participations, so there is an effect of past

experiences on a present situation. This relationship is not described as causal, but it is used in the analyses as a way to interpret and explain a present situation, where the different modes of participation are seen as resources for the activity in the present situation.

Thus, the relationships can be seen as reciprocal in this perspective, since both an influence of past practices is described and also that a present situation is a part of, and adds something to, the pattern of participation in different practices.

### *Aspect 8. Methods and measurements*

Different methods are preferred in this perspective, not to triangulate regarding a measurement of "the same thing", which seems common in studies when focusing on specific mental objects, but in order to examine different relevant practices. Different types of data can be needed since not only the activities in the classroom are of interest, but also other practices such as being part of a community of mathematics teachers or participating in teacher education. The focus for data analysis in this perspective is described as examining how the teacher's contributions to the practices in the mathematics classroom relate to the verbal (if using interviews) accounts of her engagement in different sets of social practices. In addition, an interview can also be used as a method for examining how the teacher acts in a discursive practice related to school mathematics, where it is the interview situation in itself that is of interest and not primarily that it can tell something about another type of practice.

### Comparing and combining the two perspectives

The two perspectives are here compared regarding the five aspects for which both perspectives have been analyzed. For some of these aspects a more specific issue is also discussed, regarding if/how the change perspective is dependent on reified mental objects or if/how this perspective can (also) be described using the basis of the participatory perspective. Figure 1 is similar to a figure given in the participatory perspective. The arrow directly from prior experiences to the present activity is a characterization of the focus of the participatory perspective, while the change perspective can be characterized by the arrows to and from beliefs. The focus of my analysis is whether the use of the notion of beliefs (perhaps often explicitly or implicitly referring to mental objects) is not always dependent on actually seeing beliefs as (reified) mental objects in an ontological sense, but perhaps could reflect a choice of wording when needing to (briefly) describe empirical analysis and results.

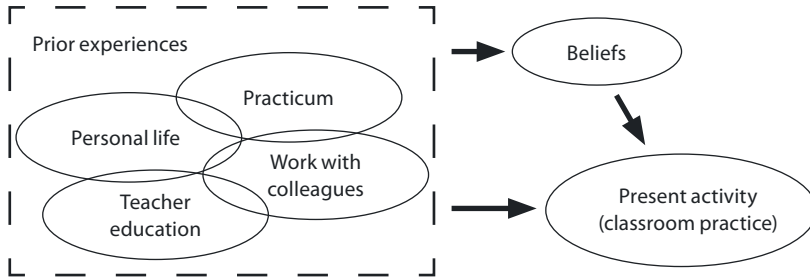


Figure 1. *Schematic characterizations of the two perspectives*

### *Aspect 1. Nature of the construct*

No explicit definition is given in the change perspective, in particular that no explicit statement is made regarding the ontology of beliefs. However, there are some connections to cognitive theories in the change perspective, in particular regarding assimilation and accommodation, which can be seen as presupposing mental objects. At the same time, the theory of conceptual change, which is the central part of the change perspective, is described as not only applicable to cognitive constructs but for example also to affective aspects and socio-cultural factors.

The metaphorical characterizations of beliefs given in the change perspective are not dependent on seeing beliefs as mental objects, for example since the participation in practices can potentially be characterized as routines and becoming a basis for feeling safe and comfortable, and thus difficult to change.

### *Aspect 2. Components*

The two perspectives use components in different ways, where the change perspective focuses on differences regarding what a belief is about while the participatory perspective focuses on different types of practices. In this way, the change perspective focuses on aspects that are (or could be) relevant in or common between different practices, such as beliefs about mathematics teaching, while the participatory perspective focuses on the different practices as the most important unit of analysis. In line with this, in the participatory perspective, beliefs are labeled as mental meta-constructs, since they are assumed to capture something general and common based on several different practices. This difference could reflect different views regarding ontology; if these more general *meta-constructs* (as reified mental objects) exist or not. However, this

difference could also reflect a shift in focus of analysis, regarding whether to focus on aspects common in different practices (not assuming that these aspects correspond to mental objects) or to focus on the different practices.

### *Aspect 5. Mechanisms of change*

In the change perspective, beliefs are seen as changing through teachers' reflections, where their awareness of their own beliefs is important, and where the process of change goes through the three steps of conflict, rejection and replacement. A question is whether this central part of the change perspective demands to view beliefs as reified mental objects; does it need to be a mental object going through the process of change as described in the change perspective or could this process equally well be located in, and thus "translated" to, the participatory perspective?

The data presented in the change perspective consists of teachers' reflections, when focusing on their own teaching practice and triggered by provocative texts. The conclusions teachers draw based on these reflections seem primarily to be about realizing that what they do in their own teaching is not good, regarding some aspect, and that they need to change their teaching somehow. The observed conflict can therefore be described as an experienced conflict between wanted properties of, or results from, examples of teaching from the provocative texts and properties of their own teaching. This conflict can then result in rejecting some aspect of their own teaching, and realizing the need for replacing this aspect with something new.

Thus, it seems possible to describe the type of change process depicted in the change perspective by focusing on changes of the teachers' own teaching practice instead of their beliefs. By this shift in the description I do not mean that the teachers (necessarily) have changed, or will change, their classroom practice, since we do not have any data about that. The need of describing something that really has changed that perhaps can affect the future teaching practice seems to be a starting point for introducing the notion of beliefs, potentially referring to mental objects. However, we could as well describe this process of change as being a development or change regarding a certain practice; the practice of reflecting on their own teaching, where this reflective activity can be said to create (or be part of an already existing) type of practice regarding, for example, the practical situation of taking a course in mathematics education and/or a discursive practice around analyses and reflections about (their own) teaching.

*Aspect 6. Relations to cognition, motivation, learning, and teaching*

In both perspectives there is a reciprocal relationship between (prior) practices or beliefs and a present situation. It is not only prior experiences, described through practices or beliefs, that affect a present situation but this situation can also be part of the construction of these practices/beliefs.

*Aspect 8. Methods and measurements*

In the change perspective, different types of data are used in order to measure the "same thing", which is criticized in the participatory perspective, where different types of data are seen as giving information about "different things" (different practices). The "same thing" examined in the change perspective is either beliefs or the change of beliefs. At the same time, the different types of data are collected in the same type of situation/practice within the course and also with a similar focus regarding the triggering of self-reflections. Therefore, these data can also from a participatory perspective be said to examine the "same thing", where this thing is the observed practice.

The methods used in the participatory perspective could be seen as having much in common with more traditional perspectives; that interviews with teachers are used as a basis for interpreting or explaining a certain situation. A central difference between the perspectives is regarding the type of analysis and interpretation that is done: In the change perspective, some aspects of the interviews are taken as evidence for beliefs, regarding beliefs about something specific (e.g. about the nature of mathematics), while in the participatory perspective, focus is on what the interview says about some type of practice. This difference can be related to the difference described regarding aspect 2, about components; if focus is on some aspect that is (or is assumed to be) common between different practices or if focus is on the different practices.

## Conclusions and discussion

In many other studies, clear differences are noted in the analysis of data when based on different theories (e.g. Bergsten, 2008; Even & Schwarz, 2003; Gellert, 2008). However, for such comparisons of uses of different theories it is important to note what aspects of theories and what parts of empirical studies are focused on, and not be satisfied with a general conclusion that (the uses of) certain theories are different.

In the analysis in the present paper, certain aspects have been noted where there is a potential to create clear differences between studies that rely on the two different perspectives, in particular regarding the issues



of components and methods (aspects 2 and 8). However, these aspects are not essential in the specific studies here analyzed. Instead, focus has been on the aspect of change, where the change perspective is not directly dependent on seeing belief as a mental object, but the study in this perspective could very well have been placed also within the participatory perspective.

Is the study in the change perspective then independent of theoretical perspectives? This question is badly formulated since it seems to presuppose the existence of some general type of answer regarding the relationship between this study and theory. It is important to note that the observed independence only refers to specific aspects of theory and the study; primarily regarding aspects of change of beliefs in relation to aspects of ontology of beliefs (whether to see beliefs as mental objects or not). Furthermore, in accordance with Radford (2008), I have argued that empirical studies are always dependent on some theoretical aspects, where it is primarily a question of whether these are explicitly described or not. For the study in the change perspective, focus is on theoretical aspects of belief change, and in particular a type of application of such a theory. However, focus is not on theoretical aspects of ontology of beliefs. In general, this relationship to theoretical aspects seems always be the case; that all possible theoretical aspects are not always discussed since all are not directly relevant for a specific study. For the study in the change perspective, I have argued that this study is not directly dependent on a specific theoretical perspective regarding ontology of beliefs, and therefore that this theoretical aspect does not need to be discussed in the study. However, even when a somewhat irrelevant theoretical aspect is not explicitly specified, this aspect could be seen as being specified more implicitly, for example through the kind of wording used.

It is not explicitly stated in the change perspective, but based on the choice of wording in this perspective the analysis in the present paper has started from the assumption that a cognitive type of theory (seeing belief as a mental object) is the basis in this perspective. However, the analysis shows that the study in the change perspective could as well have been based on the participatory perspective, where the main difference would have been a change of wording, but where the main content, structure and conclusions could have been kept. The results from this analysis highlight the importance of not only concluding that different, and potentially conflicting, perspectives have been used, since there can still be many similarities in the uses of different perspectives regarding some aspects of empirical analyses and results.

Thus, for the specific studies here analyzed, the main differences between the two perspectives can be characterized by a choice of wording

and not that these differences are dependent on a difference regarding the issue of ontology, in particular regarding whether belief is seen as a mental object or not. Even if differences in the choice of wording, as in this case, do not necessarily reflect a dependent on different ontological assumptions, such differences in wording can still affect research in many ways. For example, when using the notion of *belief*, which is a noun, this could be seen as signaling that beliefs are specific objects, perhaps of a mental type. This objectification is a central part of the criticism of traditional belief research in the participatory perspective. However, the analysis in the present paper shows that even if this kind of wording is used in a study, as in the change perspective, it is not necessarily dependent on seeing belief as a mental object, but that this type of research can still be relevant for, and "translated" to, another type of wording (i.e. another type of perspective).

The results from the analysis in the present paper are of course highly dependent on the specific perspectives and specific studies that have been analyzed. At the same time, this is exactly my argument; that it is necessary to analyze the use of certain theories or perspectives in specific studies as a basis for comparing different aspects of theories. Therefore, I encourage, and to some degree challenge, others to examine if it is possible to do a "translation" of other studies in belief research from seeing beliefs as mental objects to, for example, seeing beliefs as a way to structure what types of previous experiences (through different practices) that are utilized in certain situations. This research task would include examining what in belief research is directly dependent on seeing beliefs as mental objects, which seems essential for belief research since, as discussed in the background, many empirical studies do not explicitly use the notion of belief as an analytical/conceptual tool. Therefore, it is of interest to examine if and how a change of perspective would affect empirical studies about beliefs, as a way to develop belief research in general, regarding both theoretical aspects and empirical results.

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