# CHARACTERIZING MATHEMATICS EDUCATION RESEARCH DISCOURSE ON BELIEF

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*The discursive use of 'belief' in research articles are analyzed as a contribution to the reflexive activity in belief-research, in particular regarding theoretical aspects of the notion of belief. The purpose of this paper is to create an explicitly described procedure for such an analysis, from the selection of data to categorizations of the smallest unit of analysis. The method of analysis builds on some linguistic structures, focusing in this paper on the use of adjectives and verbs in relation to 'belief'. From the analysis of the use of 'belief' in eight articles, a set of categories is created describing different uses of the notion of belief.*

## INTRODUCTION

Belief has been described as a messy construct in educational research, for example by noting "definitional problems, poor conceptualizations, and differing understandings of beliefs and belief structure" (Pajares, 1992, p. 307). The last mentioned aspect, regarding differing understandings, highlights the problem when a research community uses the same notion in different manners, which causes problems when trying to build on previous research and when trying to summarize what the whole research community knows about belief. One reason for Pajares to see belief as a messy construct could be that he discusses a large

research community; educational research, which has many sub-communities, including mathematics education. However, the survey by Furinghetti and Pehkonen (2002) asking belief-researchers in mathematics education to characterize the notion of belief also shows "a large variety of ideas" (p. 48). Belief as a messy construct can also be found in a single research paper, for example when authors without reflection define, or describe properties of, belief that distinguish belief from knowledge both through individual/psychological aspects and through social aspects (Österholm, 2010).

The types of studies by Pajares (1992) and Furinghetti and Pehkonen (2002) are important as a base for discussing and reflecting on our field of research. The editors of the journal Nordic Studies in Mathematics Education note a lack of this type of activity in the field of mathematics education, but that "it is evident that there is a need of much more reflexivity in the field. Reflexivity refers to efforts to meta-analyse the field of research, its theories, its methodologies, and its results" (Editorial, 2009). One reflexive activity is to collect and compare results from empirical studies in order to create a more complete picture of the state of knowledge in the area of interest. This type of literature review is done by Leder (2007, p. 41), covering conference papers from PME and MERGA in order to "summarize the belief-related findings" and also to "describe the methods used to identify or measure beliefs". However, theoretical aspects are not focused on by Leder, and the view of belief as a messy construct can make it difficult to perform a broad literature review in the field of belief-research. It is therefore important to be reflexive about theoretical aspects of belief, for example to examine if (some aspect of) the notion of belief is homogenous enough to be able to compare and combine different empirical results about (this aspect of) belief.

The study by Furinghetti and Pehkonen (2002) points more to heterogeneity in mathematics education than to homogeneity

when it comes to characterizing the notion of belief. Even if their study is a type of meta-analysis of the field regarding a theoretical aspect, this is done somewhat indirectly by asking researchers to characterize the notion of belief, and thereby not directly examining aspects of completed research. This type of survey then gives a more indirect view of the field, since what a researcher says might not always directly correspond to what the researcher does when doing research and reporting on research studies. Thus, there is also a need to examine how the notion of belief is used in research studies. Pajares (1992) does focus on existing research studies in educational research more generally, where he also notices a type of heterogeneity when it comes to characterizing the notion of belief. However, he also notices that "beliefs are seldom clearly defined in studies or used explicitly as a conceptual tool" (p. 313). Thus, there is a need to examine how the notion of belief is used in research studies more broadly and not only through explicitly given definitions and characterizations.

In addition, even if there exists an elaborate explicit definition or characterization of belief, it is still of interest to study the use of this notion more broadly, for example to be able to examine if and how what is stated as part of a definition has an impact on other parts of a research study. Therefore, it is relevant to do a type of discourse analysis of research reports about beliefs. With the notion of discourse analysis, I do not refer to some specific paradigm, theory, or methodology, but refer to a type of analysis of discourse, which in this case might be seen as a type of linguistic analysis. Of interest in such a type of analysis need not only be explicit statements about properties of beliefs, which is focused on by Pajares (1992) and Furinghetti and Pehkonen (2002), but a purpose would be to study more broadly the *concept* of belief, where 'concept' is used as defined by Sfard (2008, p. 296) as "word or other signifier together with its discursive use". The word is 'belief' and 'its discursive use' needs to be related to some

community of discourse, which in this case is the field of mathematics education research. More specifically, I choose to focus on journal articles within this field, which can be seen as a further specification of the community.

The type of discourse analysis described in this paper could be seen as adding a complementary point of view to the reflexivity in the field of mathematics education regarding research on belief. Through a description and analysis of aspects of the *concept* of belief another piece can be added to the puzzle regarding issues of homogeneity and heterogeneity in research about belief.

## PURPOSE AND STRUCTURE OF PAPER

This paper is a starting point in the work of characterizing the mathematics education research discourse on belief. Therefore, focus at this moment is not on results from this type of characterization but on creating a structure for this type of analysis. The plan is then to utilize this structure in the analysis of a larger amount of mathematics education articles that focus on the study of belief.

Thus, the main purpose of this paper is to develop and problemize a method for a discourse analysis of research articles about beliefs, that is, a method for analyzing the *concept* of belief in mathematics education research.

In the next section of this paper, where methodology is discussed, focus is on the selection and description of suitable aspects of discursive use to focus on. The method of collecting and analyzing data is then operationalized through a more procedural description of the whole process from selection of articles to the categorization of data.

Although focus is not on empirical results in this paper, I use data in the form of research articles in the process of developing the

method. Therefore, some empirical results are also described in this paper, primarily for the purpose to exemplify the types of results that can come from the developed methodology.

## METHODOLOGY

The basic idea for the analysis of the discursive use of 'belief' is to search for situations where the notion is used in research articles and then analyze how the notion is used in these situations. From this basic idea, the development of methodology has proceeded using a structure of three levels:

(1) Some fundamental linguistic aspects, which includes three aspects:
   (a) The use of *adjectives* in relation to 'belief', for example if the wording "firm belief" is used there is a property of belief described through a degree of firmness.
   (b) The use of *verbs* in relation to 'belief', for example if the wording "the belief that a teacher holds" is used there is a relationship between teacher and belief through the verb 'hold'.
   (c) The use of *nouns* where 'belief' is a part of the formulation of the noun but where belief is not the main noun (i.e. 'belief' in itself is not subject or object to some verb), for example in "belief statement" or "the development of a belief", where 'statement' and 'development' are the main nouns.

   Due to space limitations, only the first two aspects are analyzed in this paper.

(2) Structural differences within each linguistic aspect:

(a) No structural differences in the role of 'belief' or how an adjective is presented in relation to a noun.

(b) Either that 'belief' acts as an object, as in the example given above where teacher is the subject, or that 'belief' acts as a subject on another object, for example in "beliefs influence teachers' lessons", where there is a relationship between the subject 'belief' and the object 'lesson' through the verb 'influence'.

(3) The content, that is, the specific words and expressions that are used, which can focus on at least two perspectives:

(i) To characterize the types of *words* that are used, including the types of adjectives, verbs, and objects/subjects.

(ii) To analyze the content of the *statements* made about beliefs, which is only relevant in relation to the use of verbs, but can include all three linguistic aspects.

Since a focus on explicit statements about beliefs is similar to what other authors have done, for example Pajares (1992) and Furinghetti and Pehkonen (2002), this perspective is not included in the discussions in this paper, but the analysis focuses on the types of words used when using adjectives and verbs together with 'belief'.

Although levels 1 and 2 are based on general linguistic aspects and structures that can be seen as fairly stable constructs, a purpose of the present paper is to test the usefulness of these constructs in the analysis of research discourse in articles and possibly adjust them accordingly for future studies. Categories

and structures in level 3 are also described in this paper, but these constructs are created through a bottom-up type of analysis. It is assumed that these categories could need to be adjusted and complemented within future studies in order to characterize the data material in the best possible way.

## METHOD FOR DATA COLLECTION AND ANALYSIS

In this section, the search for relevant articles and what parts of the articles to analyze is first described. Thereafter, the procedures for analyzing the two aspects, adjectives and verbs, are described. Categories of types of adjectives, verbs and objects/subjects that are created from the analysis of articles are also described since these are part of the method, although they can also be regarded as a result in relation to the purpose of the present paper.

### Selection of data

A selection of articles to analyze is done through a search for 'belief' in titles, in abstracts, and in full text of articles. In an article, the use of 'belief' can be part of (at least) two discourse communities; a research community and a non-scientific community. It is not of interest in this study when the word is used as a part of a more everyday discourse, which could be present in the full text and perhaps also in an abstract, but most likely not when the word is used in a title, since the title and also the abstract is used to describe the focus of the research presented in the article. Therefore, my primary interest is with articles that use 'belief' in the title. However, in order to increase the probability to capture different kinds of studies, and thereby have a breadth in how the notion of belief is used in the data analyzed when creating and testing the structure for analysis described in

this paper, I also include articles that have 'belief' in the abstract but not in the title. Articles that only have 'belief' in the full text and neither in the title or the abstract are not of primary interest, since it seems unlikely that such articles focus on research on belief, and thereby mainly use the word as part of a non-scientific discourse.

The plan for future studies is to use the methodology discussed in this paper for the analysis of articles from some major journals in mathematics education, in particular Educational Studies in Mathematics (ESM), Journal for Research in Mathematics Education (JRME), and Journal of Mathematics Teacher Education (JMTE). A preliminary plan is to include all articles with 'belief' in the title while making a random selection among articles with 'belief' in the abstract. The use of a random selection is probably necessary for the types of analyses that rely on much manual work (when searching, extracting, coding, and categorizing), in order to reduce the work load, but a more complete set of articles from one or several journals can be used for the types of analyses that can be automatized with proper computer software. For the analysis in the present paper, I choose articles from other journals than ESM, JRME, and JMTE in order to make a separate analysis of these journals later. Therefore, a random selection of totally eight articles from The Journal of Mathematical Behavior and ZDM, The International Journal on Mathematics Education was made; two articles from each journal that have 'belief' in the title and two articles from each journal that have 'belief' in the abstract but not in the title.

The selection of data to analyze from each article is made by extracting sentences from the article. A search is done in the article for 'belief' and the sentences that are found to include this notion are extracted for further analysis. It could be that nearby sentences refer to 'belief' that is used in another sentence, as is the case in the following artificial example: "Beliefs can influence

behavior. They can also influence thinking processes." Since the purpose in the present paper is not to completely cover all uses of the notion of belief, but to get relevant data for creating and testing the method of analysis, only sentences that contain 'belief' are extracted, in order to simplify the procedure of selecting data.

Note that when searching both for articles in journals and for sentences in articles, the use of different forms of 'belief' is also found, for example 'beliefs' and 'belief's'. However, the search does not include other words that could be seen as closely connected to belief, for example 'believe', since this is another word (in particular a verb and not a noun) and the analysis would then focus on another concept.

Each extracted sentence is then analyzed based on the structure described earlier, regarding methodology, for which an operationalized description is given in the next two sections. One detail in relation to the methodology is that the common expression 'belief system' would be included in the aspect of the use of nouns including 'belief', which is not discussed in this paper. Instead of excluding this expression in the analysis in this paper it is here treated as a synonym of 'belief', that is, the use of adjectives and verbs is in relation to both 'belief' and 'belief system'. This simplification is done in order to have more data to analyze, which is seen as possible in the present paper since the focus is now on developing and testing the method for analysis and not on empirical results.

## The use of adjectives in relation to 'belief'

For each sentence extracted from an article all adjectives acting on 'belief' are noted. Adjectives are written directly before a noun but can also act on several nouns, as in "content-specific cognitions and beliefs" (Kuntze, 2006, p. 457), where 'content-specific' is noted as an adjective also for 'belief'. There can also be several adjectives following directly after each other, as in

"appropriate mathematics-related beliefs" (Depaepe, De Corte, & Verschaffel, 2010, p. 206). In such instances several different adjectives are noted; 'appropriate' and 'mathematics-related' in the given example.

All adjectives from all articles are then collected and different adjectives are grouped through a process of looking for similarities and differences/opposites, in order to describe the different types of adjectives used in relation to 'belief'. This bottom-up type of analysis of the adjectives from the eight articles resulted in a collection of types of adjectives/properties that are described below.

- *Description of content*: What a belief is about, for example 'mathematical', 'instruction-related' and 'gender-neutral'.
- *Characterization of content*, divided into two subcategories:
    - *Normative characterization*: Some type of evaluation of the content, for example 'appropriate', 'supportive' and 'unhealthy'.
    - *Comparative characterization*: Some type of comparison with other beliefs, for example 'common', 'different' and 'traditional'.
- *Structural aspect*, divided into two subcategories:
    - *Accessibility*: Referring to some aspect of location or relation to what is directly observable, for example 'espoused', 'implicit' and 'underlying'.
    - *Centrality*: Referring to some aspect of importance or degree of conviction, for example 'firm'.
- *Ownership*: Whose a belief is, which can be related to some aspect of ontology, for example 'individual' and 'cultural'.
- *Temporal aspect*: Describes when (in relation to something) a belief exists/existed, for example 'initial'.

In the process of analysis it has sometimes been noted a need to take the context in the article into account in order to decide how to classify an adjective. For example, the notions of 'positive' and 'negative' could describe the content (e.g. that a belief is about a negative evaluation of oneself) or could characterize the content (e.g. that the author regards a certain type of belief as being bad to hold).

## The use of verbs in relation to 'belief'

A first step in the analysis of this aspect is to locate the verbs in a sentence, and to exclude those verbs that have belief neither as part of the subject or the object. The part of a sentence around a relevant verb is then "cleaned" from parts that are specifying some aspect or property of the verb, subject or object, for example adverbs or adjectives. In addition, all words are transformed to simplest form; nouns are written in singular form and verbs are written in infinitive form. This "cleaning process" is done in order to more easily focus on the types of verbs and subjects/objects that are used in relation to 'belief'.

Take the following sentence as an example: "The decisions made during a solution attempt are dependent upon an individual's content knowledge and personal belief system" (Lerch, 2004, p. 34). This sentence would be summarized as "decision be dependent upon belief".

Although the removal of adjectives can be said to change the specific nature of the object or subject, since a property is removed, this does not change the more general type of subject or object. For the moment, the analysis focuses on these more general types, while forthcoming analyses might take more specific aspects of the objects/subjects into account.

Sometimes there is a more complex structure in descriptions with verbs in relation to 'belief', for example in the following: "beliefs

play a role in influencing teachers' lessons" (Schoenfeld, 2000, p. 258). Here there are two verbs, where it is primarily 'play' for which 'belief' act as the subject. However, the verb 'influence' can be seen as the primary verb in this example since "play a role in" only specifies some aspect of this influence. Therefore, this example is in the analysis coded simply as "belief influence lesson".

From a linguistic perspective, there is a difference between the two statements "decision is guided by belief" and "belief guides decision", where the object in one statement acts as subject in the other, and vice versa. However, for the analysis in this paper it is not of interest to distinguish between these two statements. Instead of focusing on what is formally the subject or object, as originally planned, it is of more interest to note a type of agent or doer of the action described by the verb in question. The simplest form to code the description is used, which for both two given statements becomes "belief guide decision", where the verb is written in active form (guide) and not passive form (be guided by). From now on, when referring to subjects and objects, it is assumed that the verb is written in active form.

All verbs from all articles are collected and different verbs are grouped through a process of looking for similarities and differences/opposites, in order to describe the different types of verbs used in relation to 'belief'. This bottom-up type of analysis of the verbs from the eight articles resulted in a collection of types of verbs that are described below.

- *Belief is acting*, divided into two subcategories:
    - *Influence*: Belief (has the potential to) change something, which includes to explain something (i.e. to be seen as a cause), for example 'influence', 'impact' and 'prevent' when 'belief' is the subject, and 'be function of', 'be based on'

and 'be dependent upon' when 'belief' is the object.
    - *Examination*: Belief is being observed or elicited in some way, for example 'be attributed to' and 'be inferred from'.
- *Belief is being acted on,* divided into four subcategories:
    - *Influence*: Something is causing a change of belief, for example 'influence', 'form' and 'shift'.
    - *Examination*: Something is making belief visible for observation, for example 'profess', 'elicit', 'reflect' and 'infer'.
    - *Awareness*: Aspect of conscious focus on belief, for example 'be aware of', 'pay attention to' and 'be conscious of'.
    - *Possession*: Some sort of ownership of belief, for example 'have' and 'hold'.
- *Relation*: Symmetry between the role of subject and object, where you preserve the meaning if you switch them, for example 'relate to', 'be linked to', 'contradict' and 'be consistent with'.
- *Property*: Characterization of some part/aspect of belief, for example "belief system include emotional response", "type of knowledge involve belief system", and also the use of a form of 'to be' such as 'belief be implicit', 'belief be mental representation of reality' and 'belief be type of knowledge'.

It could be noted that the description above, in particular regarding influence, does no longer focus on the linguistic notions of subject and object, but instead describes what is causing a change of some kind since this seems to better capture the essence of the verb. Therefore, some parts of the structure described in the methodology need to change since the formal

linguistic distinction between subject and object is not that useful anymore.

The types of nouns (used as subjects or objects together with 'belief') are also characterized through another process of looking for similarities and differences/opposites, and grouping the nouns. This bottom-up type of analysis of these nouns from the eight articles resulted in a collection of types of nouns that are described below.

- *Person*: Referring to a human being in some way, for example 'teacher', 'student', 'you', 'participant', 'people' and 'researcher'.
- *Object*: Referring to an object itself or a property of it, for example 'pictogram', 'questionnaire', 'design', 'comment', 'statement' and 'task'.
- *Cognition*: Referring to a type of mental activity or state of mind, for example 'thinking', 'perception', 'expectation' and 'intention'.
- *Behavior*: Referring to a type of visible/external activity of a person, for example 'teaching', 'action', 'persistence' and 'implementation'.
- *Cognition/behavior*: Referring to activity or state of affair that could be a mixture of cognition and behavior, for example 'decision', 'knowledge', 'ability', 'experience' and 'performance'.
- *Affect*: Referring to some aspect of feeling or emotion, for example 'emotional response', 'affective approach' and 'confidence'.

Notions placed in the combined category 'cognition/behavior' could perhaps be moved to either 'cognition' or 'behavior' if the unit of analysis is increased to take into account the context in the article. However, at least some of the notions are not (well) defined in the article, making in difficult to decide where to place

it. In addition, there could be notions that are meant to have an aspect both of cognition and behavior. Thus, there is still need for the combined category.

## SOME EMPIRICAL RESULTS

In the eight articles, there are on average 24 sentences containing 'belief' per article. However, there is a large variation; the four articles with 'belief' in the title have 18, 24, 31 and 36 sentences respectively while the other four articles have 4, 8, 25 and 45 sentences respectively. Few sentences in an article points to that the notion of belief is not in focus. Based on these eight articles it seems reasonable to include in the analysis all articles that have 'belief' in the title, but when selecting articles that have 'belief' only in the abstract perhaps it is useful to add a criterion that the article should contain at least 10 or 15 sentences that include 'belief', in order to analyze articles that focus on belief. Another option could be to examine if the given purpose of an article signals a focus on belief, and use this as a criterion for inclusion in the analysis. However, this type of criterion could be more cumbersome to use and needs to be tested for how to decide when belief is in focus.

By using the created categories, one at a time or combinations of them, aspects of the discourse on belief can be analyzed. For the eight articles there are categories that are (well) represented in almost all articles (all, if excluding the two articles with lowest number of sentences including 'belief'), such as the use of verbs that describe belief as influencing some aspect of cognition and/or behavior. Other categories are present only in a few examples as a total, (and thereby) limited to a few articles, such as the use of normative adjectives.

The analysis in this paper focuses on the types of words and not the content of claims about the type of properties and

relationships that can be described using these types of words. It is therefore not possible to examine if there are some contradictions in the research discourse on beliefs regarding these topics. However, it can be noted that some types of uses of the notion of belief are more common than others, which can be of interest to analyze more in depth when making a larger selection of articles.

## CONCLUSIONS

There are two specific parts of the method of analysis here described that need to be adjusted for future studies. First, there is a need, at least for some categories, to include aspects of the context in the article that is being analyzed, that is, to somewhat expand the unit of analysis. A procedure for how to do this then needs to be developed. Second, the use of the linguistic structure including subject and object needs to be replaced since even if the use at first was limited to verbs in active form, types of verbs can be used that still create a "reverse" relationship between cause and effect, that is; what is formally a subject is de facto what is being influenced.

Besides what has been described in this paper regarding analysis of the use of nouns and the content of statements, there are also other types of expansions of the analysis that could be of interest. For example:

- For each sentence it can be noted in which part of an article it is located, such as introduction, method, results or discussion, in order to examine if and how the discursive use is different in different parts of an article, that is, if actually different concepts seem to be used in different parts.
- Articles from different journals can be compared in order to examine if, and in what way, there are different

traditions regarding the conceptualization of the notion belief.

- Articles from different time periods can also be compared, in order to examine how the concept of belief has changed historically.
- The same type of analysis can be performed with other notions, such as 'attitude', in order to examine similarities and differences between different concepts.

Benefits of the method of analysis described in this paper are that it includes an explicitly described procedure for the selection of articles to include in the literature survey, and also that it includes an explicit operationalization of the procedure of analysis that hopefully can be used for other sets of data and by other researchers. A main difference between the type of survey described here and other literature surveys is the inclusion of more implicit types of theoretical aspects of belief; the type of adjectives, verbs and nouns used, and not only the content of explicit statements. Therefore, this type of analysis can complement the analysis from other reflexive activities regarding belief-research.

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