Multiple Realities and the Making of Worlds

A Multi-perspective Approach to Mathematical Belief Systems

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Abstract

After a period of rich empirical outcomes, in the field of mathematical belief research a certain 'lack of theory' becomes visible. It more and more emerges that the complexity of individual as well as cultural belief systems cannot be understood solely from the perspectives of a single discipline such as (social) psychology. This paper is aimed at giving a short outline of a theoretical model for the scientific construct 'belief system' which extends the classical psychological perspective by aspects of current sociology, ethnography, and cognitive science, especially of neuro science and cognitive linguistics.

Background

Over the past two decades, numerous empirical studies have shown up the decisive impact of mathematical beliefs on math teaching and learning processes. In their bibliography, Törner & Pehkonen (1996) list more than 800 relevant items. As a first approach, an individual's mathematical belief system can be understood as "the compound of his subjective (experience based) implicit knowledge (and feelings) concerning mathematics and its teaching/learning" (Pehkonen & Törner 1996). Most authors agree in conceptualizing mathematical beliefs as mental structures located in the borderland between cognition and affect, gaining considerable relevance as they function as individual director systems guiding personal perception, assessment, and behavior in the context of mathematics.

Not least in view of the rich and manifold empirical results that belief researchers have been coming up with by now, the research interest at present increasingly focuses on the question of how to theoretically substantiate the central scientific concept of *belief system*. The traditional reference to the concept of *attitude* – and thereby the settlement of belief research within the domain of social psychology which may be mainly due to pragmatic reasons (attaining the benefits of an established theory) – more and more emerges to be a limitation of both research perspectives and methodological approaches. For a considerable time, even social psychologists are skeptical about the scientific advantage of the attitude concept. Today many of them prefer a more complex model including social forms of knowledge such as group beliefs, subjective theories, social representations etc.

The transformative circle of knowledge

There is much indication, that an adequate understanding of the emergence, representation, and mechanisms of mathematical and other science-related belief systems will not be possible without considering the different forms of knowledge as social phenomena. In a 'transformative circle' (Flick 1995), those forms of knowledge interact on two levels –

analogues to the two realms of the *sacred* and the *profane* in ancient religion-based cultures: the first being the collective, acknowledged, and official level of the mythical-religious, ideological, or scientific knowledge, and secondly the private level of (pre- and post-scientific) everyday life with its forms of common sense, social representations, and everyday knowledge, mirroring the 'higher' forms of knowledge (cf. Fig. 1).
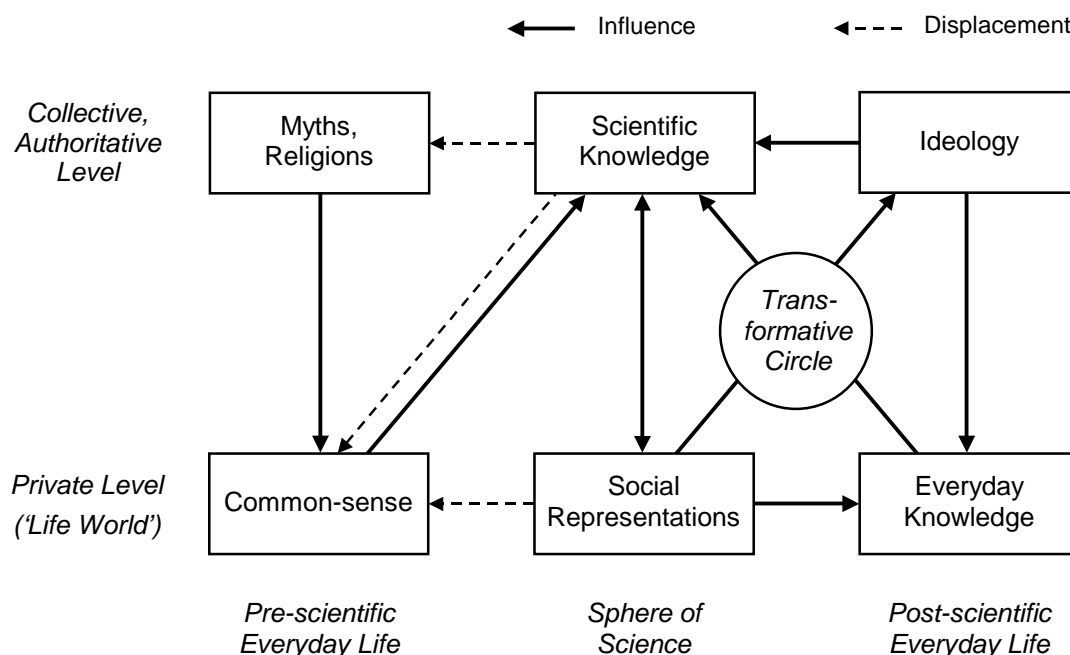

Figure 1: Transformative circle of knowledge forms (after Flick 1995)

A constructive process: sense making as reducing complexity

Mathematical belief research must not lag behind the current findings of scientific disciplines involved, such as sociology, ethnography, cognitive linguistics, and neuro science. Without continuous efforts of keeping a high level and extensive range of theoretical perspectives, our research would risk a considerable loss of scientific relevance. One of those perspectives is that of neuro science which has substantially changed our understanding of the brain.

To the *traditional view*, the brain is more or less a *mirror of reality*. Among the guiding assumptions of this traditional concept is that reality is sending a stream of sensory information to the brain and that the brain is answering by producing a sort of 'photograph of reality'. Consequently, there are objective (extra-personal) quality criteria for brainwork, namely adequacy, congruence, identity. This traditional view, however, in recent years turned out to be a too naïve one. Wolf Singer, Director at the Max Planck Institute for Brain Research, Frankfurt, summarizes some findings of modern neuro science which are in remarkable contrast to the traditional concept.

> Actually, there is much evidence that our cognitive system is behaving very selectively. … It is interested only in very small partial aspects of reality. … Its processing of sensory signals is based on prejudices in plenty. … Our perceptions highly depend on the brain's guesswork about the world. … The brain continuously produces concepts, adjusting them to the sensory information available. (Singer 2000)

Thus, sensory information does not play the fundamental role of being the source and aim of all knowledge, it is just used as a means of adjustment. Contrary to the widely held opinion,

only roughly 10% of the synaptic connections within the cerebrum (resp. the cerebral cortex) is processing sensory information, while the remaining part of around 90% is "devoting itself to an interior monologue" (Singer) creating concepts and 'making sense' (cf. Fig. 2). Actually, perception is not to be thought of in terms of 'getting information', but rather in terms of 'verifying hypotheses'. Man is mainly not a reality perceiving but a reality constructing species, not an observing, but rather a sense making animal.
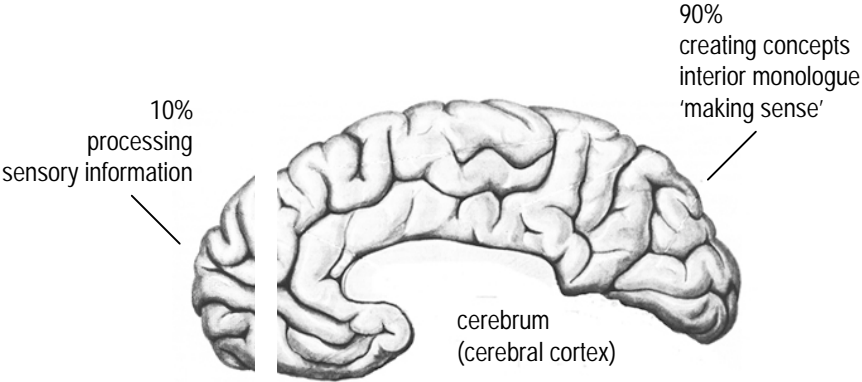

Figure 2: Man is a 'sense making animal'

To the modern view, the brain is constructing 'its own reality'. In the form of a continuous interior monologue, it is producing a stream of concepts, conjectures, and hypotheses about reality. Those hypotheses are continuously but selectively adjusted by means of sensory information. Consequently, there are only subjective (intra-personal) quality criteria for brainwork, such as viability and practicability. Fig. 3 depicts the two contrary models.
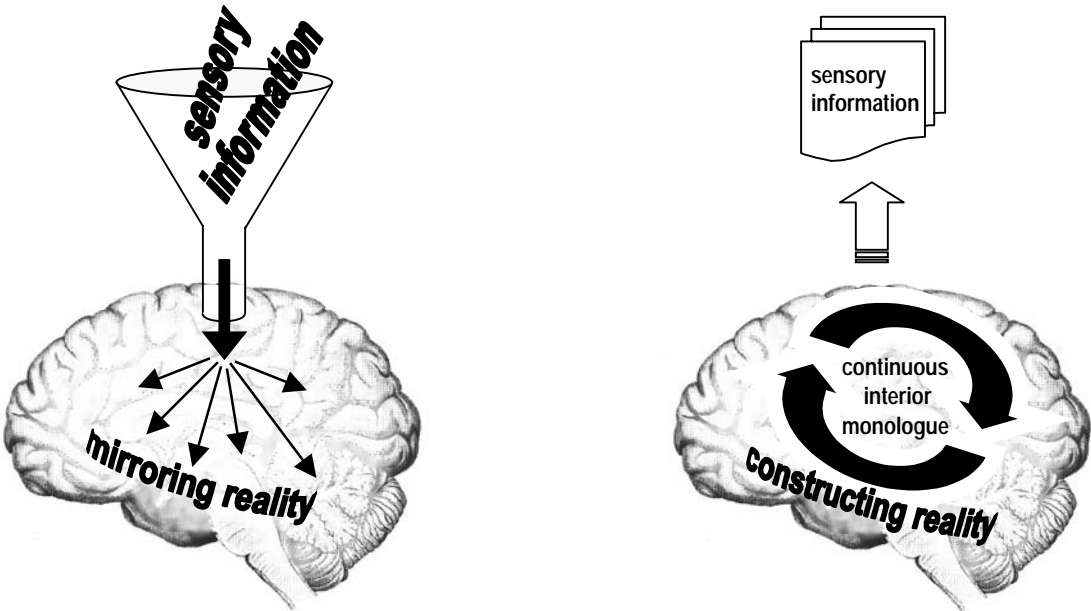

Figure 3: Traditional (naïve) versus modern view of the brain

The neuro scientific understanding of man as a sense making animal has a general biological interpretation, as we may recognize 'sense making' as the fundamental process of reducing the complexity of the world, due to evolution theory being a general adaptive behavior of most

species. In a socio-cultural context that also applies to individuals, groups, and cultures. Societies are built up by processes of commonly making sense, where sense is represented in the 'durable form' of culture. Culture is preserved by language (narratives, myths), actions (rituals), and symbols (totems).

Multiple realities: worldmaking as making of worlds

In early advanced cultures, sense making by reducing complexity had been relatively simple and led to the religion-based societies with simple, homogeneous, and uniform structures. The shift from ancient to modern societies, however, came along with what we may call a *cultural catastrophe*, attended by a loss of certainty, of simplicity, homogeneity, and unity. In modern advanced cultures 'the world' is disintegrated into several 'partial worlds', while 'the person' is disintegrated into different 'social roles'. In modern societies, thus, reducing complexity means reducing the complexity of partial worlds. Social reality in modern cultures actually takes the form of a conglomerate of multiple realities, a conceptual landscape of socio-cultural frames (worlds).

As it was the case with ancient cultures, even in modern cultures social worlds are not set up by physical objects, but rather by narrative elements, by themes and stories. It is not the machines that constitute the 'world of computers', but the stories about them. The 'world of politics' does not consist of politicians or events, but of stories about politicians and events. Those worlds are not made in factories, they are made in the media. They are relatively autonomous, occasionally linked by common themes – as the world of sports, of politics, and of medicine are linked by the common (but separately conceptualized) theme of doping. What often may appear as a contradiction within a person's thinking, is mostly nothing more than coming from different worlds. The only form of (social, cultural) consistency achievable in modern cultures is the reduced form of a 'partial consistency' within a specific partial world.

We may summarize some central *research assumptions*:
– An individual perceives reality in a complex, dynamic, active, subjective, and constructive process of deconstructing 'the world' and reconstructing it into 'multiple realities (worlds)'.
– Those multiple realities are preserved by the individual in the form of 'personal constructs' about the world(s).
– Personal constructs are not 'photographs of reality', but 'adaptive maps'.
– Personal constructs (and even the construction system itself) are subject to continuous adaptive processes which make them more stabile; they develop an inertia force against change.
– Personal constructs gain stronger stability largely not as a result of verification processes (truth), but as a result of their viability (practical benefit in a certain context) and by socio-cultural reinforcement processes.
– The ordinary conceptual system of human beings, in terms of which we think and act, is fundamentally metaphorical. There are personal as well as interpersonal, socio-cultural metaphors. There are metaphorized actions (rituals) and metaphorized objects (totems).

A multi-perspective framework for belief research

Based on a series of empirical studies on teacher conceptions in the context of computer science, mathematics, and computer culture (cf. Berger 1998, 1999), the author worked out a theoretical model for the scientific construct of *belief system.*
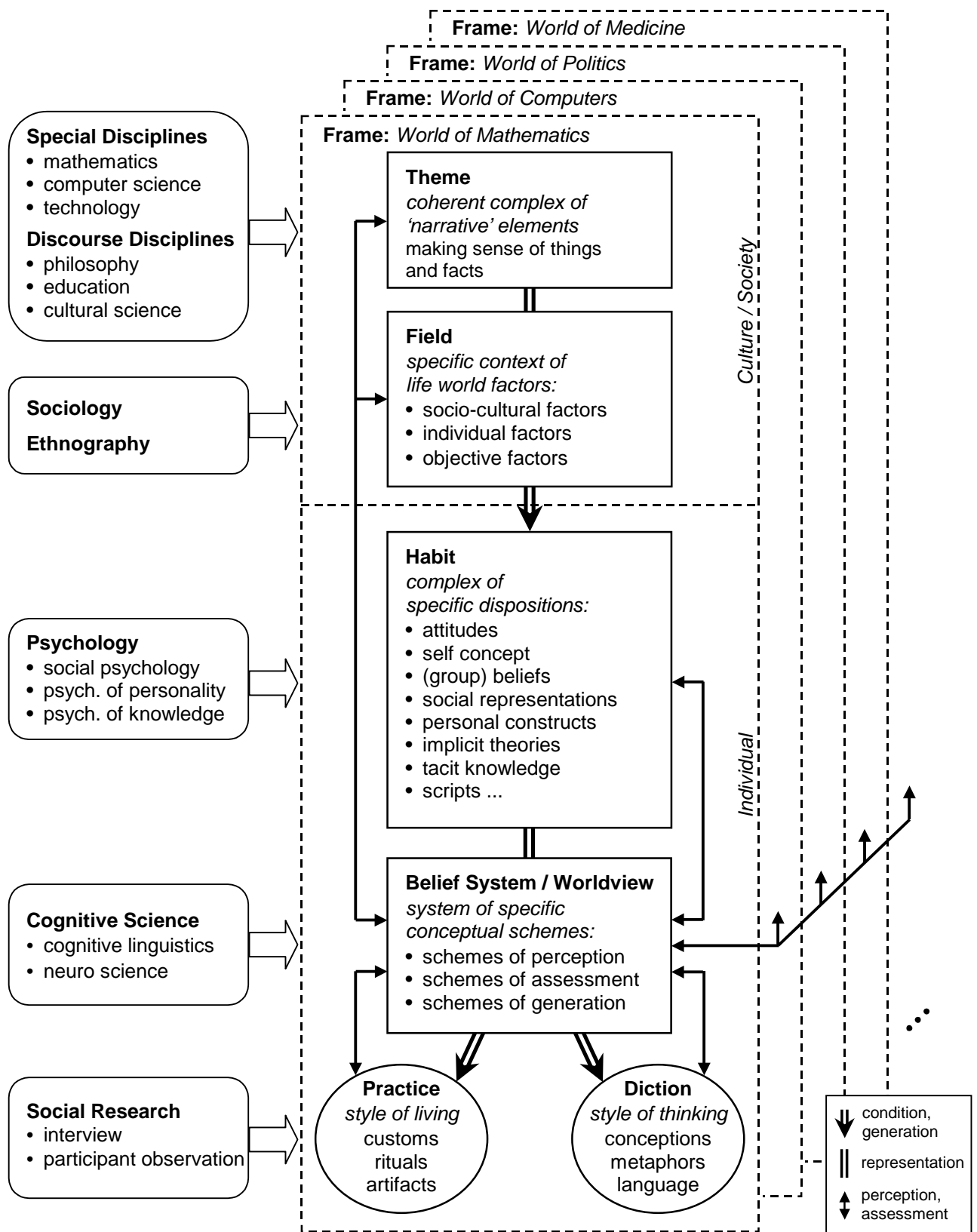
Frame: *World of Medicine*

Frame: *World of Politics*

Frame: *World of Computers*

Frame: *World of Mathematics*

Special Disciplines
• mathematics
• computer science
• technology

Discourse Disciplines
• philosophy
• education
• cultural science

Sociology

Ethnography

Psychology
• social psychology
• psych. of personality
• psych. of knowledge

Cognitive Science
• cognitive linguistics
• neuro science

Social Research
• interview
• participant observation

Theme
coherent complex of
'narrative' elements
making sense of things
and facts

Field
specific context of
life world factors:
• socio-cultural factors
• individual factors
• objective factors

Habit
complex of
specific dispositions:
• attitudes
• self concept
• (group) beliefs
• social representations
• personal constructs
• implicit theories
• tacit knowledge
• scripts ...

Belief System / Worldview
system of specific
conceptual schemes:
• schemes of perception
• schemes of assessment
• schemes of generation

Practice
style of living
customs
rituals
artifacts

Diction
style of thinking
conceptions
metaphors
language

Culture / Society

Individual

...

condition,
generation

representation

perception,
assessment

Figure 4: Multiple realities: social reality as a complex of socio-cultural frames (worlds)

The model (cf. Fig. 4) extends the classical psychological perspective by aspects of current sociology, ethnography, and cognitive science, especially of neuro science and cognitive linguistics (Berger 2000). In short terms, the model performs a 'focusing climb-down' with the stages *society/culture* (sociology/ethnography), *individual* (psychology), and *brain/mind* (neuro science/cognitive linguistics). It conceptualizes the multiple realities of individuals as specific socio-cultural frames ('worlds': world of mathematics, world of computers, world of medicine, world of politics etc.).

Belief systems, then, can be understood as habitualized conceptualizations of those worlds ('world views/belief systems') which are cognitive representations of frame-specific personal dispositions ('habit': attitudes, self concept, implicit theories, tacit knowledge etc.) forming specific schemes of perception, assessment, and generation (cf. Bourdieu 1998, 1999). Those world views emerge from a specific interpersonal context, i.e. a coherent complex of narrative elements ('theme'), which induces a specific context of life world factors ('field': socio-cultural, individual, and objective factors). World views result in specific styles of behavior ('practice': customs, rituals, artifacts) and thinking ('diction': conceptions, metaphors, language). World views, in a fundamental way, are metaphorically organized. Thus, linguistic interview analysis – within a qualitative methodological framework – provides an appropriate approach to the study of belief systems.

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