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Links Between Beliefs and Cognitive Flexibility

Lessons Learned

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Chapter 1

Introduction

Jan Elen, Elmar Stahl, Rainer Bromme, and Geraldine Clarebout

Society is rapidly evolving. It is becoming more diverse and complex. Such a society requires its members to be sophisticated problem solvers. Problem solving in a complex and evolving context implies consideration of multiple interpretations of the problem and conceptualization of different solutions and solution strategies. A large number of social problems is discussed in relation to scientific findings. An adequate understanding of the nature of scientific knowledge is a necessity for public engagement with science, that is, for an active civic participation in modern science- and technology-based societies. As a consequence, sophisticated problem solving should be discussed in close relation to the concepts of cognitive flexibility and epistemological beliefs.

1.1 Cognitive Flexibility

Sophisticated problem solvers can be assumed to be well aware of the contextualized and relative nature of selected solutions. Changes in the context, additional information, or evolutions over time may induce them to reconsider their selection of a solution or even their interpretation of the problem at hand. From this perspective, it seems that this rapidly evolving society requires problem solvers to be cognitive flexible.

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While cognitive flexibility can be said to be important for current problem solving and while it can be argued that given the increased need to solve ill-structured problems cognitive flexibility has become an important educational goal, it is far from clear what cognitive flexibility exactly entails. As already pointed out by Diaz (1983) for the domain of bilingualism, cognitive flexibility is a rather vague notion that is often loosely used. Without any ambition to structure this notion (e.g., Chieu, 2007) or to extensively discuss related processes, a broad perspective to the notion is given in the following lines.

Cognitive flexibility can be described as the disposition to consider diverse context-specific information elements while deciding on how to solve a problem or to execute a (learning) task in a variety of domains and to adapt one's problem solving or task execution in case the context changes or new information becomes present.

Cognitive flexibility has both perceptual and representational components. In order to be able to be flexible, one has to notice changes in the context and perceive new information. The representational aspect is stressed by Spiro and Jehng. According to Spiro and Jehng, cognitive flexibility is "the ability to spontaneously restructure one's knowledge, in many ways, in adaptive response to radically changing situational demands" (Spiro & Jehng, 1990, p. 165).

Given that context-specific information elements are taken into account, being cognitive flexible implies that one considers both the context and the information at hand. Considering the context and information at hand and adequately representing the problem or task, may result in problem solving or task execution that is adaptive. Changes in the context and/or the information itself may result in the adoption of a problem solving or task execution strategy. Guilford (1959) already pointed out that such cognitive flexibility may result in creativity. Being aware and explicitly taking into account the context allow thinking "out of the box" while consciously and deliberately neglecting particular constraints. Cognitive flexibility involves a large number of cognitive operations which are executed systematically but not mechanically. It implies engagement while remaining critical about the outcomes of the operations.

Cognitive flexibility is not simply a set of skills or competencies; it is described as being a disposition. This point of view has multiple implications. First, it implies that it refers to a probability that one will act in a particular way (one is disposed to act cognitive flexible) although it does not imply one will always do so. Second, it implies that cognitive flexibility is deeply rooted in cognition and hence related in complex ways with other aspects of cognition. This second implication is at the root of this book that explores, analyzes, and theorizes about the relationships between cognitive flexibility and beliefs.

1.2 Epistemological Beliefs and Cognitive Flexibility

While a relationship between different types of beliefs and cognitive flexibility might be expected, of special interest is the relationship between epistemological beliefs and cognitive flexibility. Epistemological beliefs in its traditional description

(Hofer & Pintrich, 1997) refer to beliefs about knowledge and knowing. In a developmental view of epistemological beliefs, sophistication refers to the ability to take a stance while remaining critical about the position and aware of the constructed nature of that position. This description seems similar to a description of high-level cognitive flexibility.

Epistemological beliefs and cognitive flexibility can be interrelated in various ways. First, sophisticated epistemological beliefs and cognitive flexibility might be indicators of one another. This view would imply that particular evidence of cognitive flexibility reveals specific beliefs and that the demonstration of particular beliefs suggests that the holder of the beliefs is to some extent cognitive flexible.

Beliefs and cognitive flexibility may also be regarded to be independent cognitions that can mutually influence one another. In such a case, it is interesting to see whether and how a change in either a belief or cognitive flexibility results with respect to a change in cognitive flexibility or the belief at hand.

While epistemological beliefs are generally described as being general or domain related, of particular interest is the question about the context specificity of the beliefs. This of course also pertains to cognitive flexibility. Can we be cognitive flexible in one area and not in another, can we hold sophisticated beliefs with regard to one context but not with respect to another one? How then is cognitive flexibility related to domain-related and general beliefs?

This book aims at strengthening the field by offering a number of contributions that each discusses the notions of (epistemological) beliefs and cognitive flexibility and more importantly about their interrelationships. In each of the contributions, up to three theoretical propositions are formulated and discussed by referring to empirical research and theoretical insights.

A first series of chapters discusses conceptual issues with tremendous implications for (empirical) research. Based on an extensive review of the literature on epistemological beliefs, Jeremy Briell and his colleagues argue for the need to distinguish between a conception-oriented and a process-oriented perspective toward epistemological beliefs. It is argued that the conception-oriented form is sufficiently referred to as epistemological beliefs and defined as the abstract beliefs of lay folk that address questions relevant to professional epistemologists. The process-oriented form is suitably referred to as epistemological judgments and defined as the judgments of lay folk that mimic those of professional epistemologists. Given the complexity, it is asserted that multiple methods of measurement should be synchronized in instrumentation to support inferences and that novel research methods should be actively pursued.

The relationship between epistemological beliefs and epistemological judgments in relation to cognitive flexibility is also at the core of the chapter by Elmar Stahl. He argues that while in regular life, cognitive flexibility is normality and not an exceptional case, in educational psychology stability is regarded to be the normal and cognitive flexibility the exceptional case. It is argued that in order to strengthen the field, research on interactions is needed. A case is made for research that focuses on detailed interactions between complementary cognitive elements as the smallest unit in order to better understand the flexibility of epistemological judgments.

Marlene Schommer-Aikins highlights the diversity in different types of knowledge and specifies particular relationships between epistemological beliefs and cognitive flexibility in learning. Beliefs in multiple solutions, multiple sources of knowledge, and connected knowing can motivate learners to search for more than one option for finding solutions or view points. Beliefs in tentative knowledge, separate knowing, and complex knowledge can encourage learners to reactivate their search for solutions based on the passage of time or a trigger event. Beliefs in gradual learning, complex knowledge, and tentative knowledge can encourage learners to resist premature closure. Potential problems with regard to excessive forms of cognitive flexibility reveal the importance of metacognitive strategies (rooted in epistemological beliefs).

In his chapter, Richard F. Kitchener discusses epistemology and flexibility from a context of epistemological pragmatism. He clarifies the task of traditional epistemology as understood by philosophers. He stresses the presence of multiple conceptual pitfalls and points to the issue of domain generality and domain specificity. He ends with a discussion of the recent revolution produced by naturalistic epistemology and the implications of this challenge for understanding the relationship between personal epistemology and traditional epistemology.

A more explicit empirical stance is taken in two consecutive chapters. How people deal with inconsistencies or conflicts in scientific information is addressed by Dorothe Kienhues and Rainer Bromme. They focus on two types of explanations people could consider: the lack of one's ability to understand the information or to explain away the inconsistency, and the actually given inconsistency that is inherent to the topic, as the knowledge in itself is developing or uncertain. They assert that cognitive flexibility manifests in finding a suitable and adapted explanation for the experienced inconsistencies and that such flexibility depends on people's beliefs about abilities and on their epistemic beliefs. Several studies are summarized that underline both the role of beliefs about one's abilities and epistemic beliefs in processing scientific information. These studies show that searching for scientific information on the Internet is a suitable test bed to empirically investigate how people refer to ability and epistemic explanations in cases of (conflicting) knowledge claims.

Problems with multiple texts are the starting point for the chapter by Tobias Richter. In the case of conflicting information and opposing perspectives on the same or related issues, cognitive flexibility can be defined as the ability to develop a justified point of view by adopting some arguments and rejecting others on rational grounds. By proposing a simple process model, he addresses the cognitive processes that underscore epistemic validation as the key element in dealing with the above-mentioned problems. He argues that epistemic validation rests on two types of cognitive processes: (automatic) epistemic monitoring and (strategic) epistemic elaboration. Conceiving epistemological beliefs as declarative metacognition, it is claimed that epistemological beliefs determine whether learners achieve cognitive flexibility in learning with multiple texts.

A developmental perspective is opened by Beate Sodian and Petra Barchfeld. Around the age of 4 years, children master basic cognitive flexibility tasks, such as switching dimensions or providing alternative names for an object. In their chapter,

these authors investigate whether a developmental relation between the ability to entertain alternative representations and the ability to distinguish between true and false representations can be found with respect to more complex forms of perspective taking, such as thinking about alternative causal theories. It is observed that previous analyses of cognitive abilities involved in the coordination of theories and evidence in terms of epistemological stances conflict with recent findings on children's theory of mind. A framework for analyzing levels of theory–evidence differentiation is introduced and applied. The findings indicate that the ability to conceive of alternatives to one's own intuitive theory developmentally precedes an understanding of evidence relevant to evaluating such theories.

The last two chapters address the relationships between beliefs and flexibility from a discipline-specific angle. Ann Roex and her colleagues investigate whether the beliefs medical trainees hold about knowledge and knowing consist out of different dimensions which are stable across different medical domains. A series of studies is reported in which the relationship between sophistication in beliefs and levels of cognitive flexibility is explored. The chapter further indicates that beliefs and levels of cognitive flexibility might be affected by training and examination practices.

Mathematics and strategic flexibility are dealt with in the chapter of Lieven Verschaffel and colleagues. Strategic flexibility is defined as the selection and execution of the most appropriate solution strategy (available in one's strategy repertoire) on a given mathematical task, and for a given individual, in a given context or situation. Some empirical research is reported indicating that strategic flexibility is an important and distinctive feature of being good at mathematics or having true mathematical expertise. In the final part, it is argued that given the dispositional nature of strategic flexibility, there is a need to aim at it from the start of the teaching and learning process and for an integrative teaching approach.

The conclusion reflects on how the theoretical statements in each of the chapters are interrelated and shows new venues for further research.

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Chapter 2

Personal Epistemology: Nomenclature, Conceptualizations, and Measurement

Jeremy Briell, Jan Elen, Lieven Verschaffel, and Geraldine Clarebout

2.1 Introduction

How cognitive flexibility relates to personal epistemology depends entirely on how the constructs are interpreted. We address the latter half of this question here.

Scholars over the generations have attempted to decipher arguably the most rudimentary element of being human – “knowledge.” Kitchener (2002) defines epistemology as a theory of knowledge, reflecting its etymological origins in the Greek words “episteme” (knowledge) and “logos” (theory). An age-old branch of philosophy, epistemology is also a significant field of study for cognitive and educational psychologists. Whereas the philosophical branch concerns professional theorizing about knowledge, the psychological branch pertains to empirical observations of the epistemology of laypersons. A host of research lines, each employing preferred nomenclatures and interpretations, belong to this field, which is collectively known as “personal epistemology” – the umbrella term notably employed by Hofer and Pintrich (1997) in their extensive review.

It is well known to the reader familiar with personal epistemology that this field struggles with fundamental and persistent issues regarding nomenclature, conceptualization, and measurement. In this chapter, we visit each of these basic questions by means of a review. Our ultimate objective is to clarify the construct so that the reader may better apprehend its significance to cognitive flexibility.

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