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Chapter · February 2016

DOI: 10.1007/978-3-319-13536-6_6

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What is Knowledge? Who Creates it? Who Possesses it? The Need for Novel Answers to Old Questions

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Abstract

Abstract: *This chapter provides an overview of both traditional and more recent conceptualizations of knowledge. It also aims at identifying shortcomings of each of these conceptualizations in the context of mass collaboration. Philosophy has traditionally conceptualized knowledge as 'justified true belief', whereas psychology tends to consider it mainly in terms of semantic memory. What both traditions have in common, however, is an individualistic focus, which emphasizes that knowledge is located within people's minds. But this individual perspective reaches its limits when considering transpersonal phenomena like collaborative knowledge construction and mass collaboration. More recent approaches have taken social aspects of knowledge-related processes into account. We present some of them briefly and discuss them with regard to mass collaboration settings. Finally, we present a systemic view of knowledge as an attempt toward a synthesis of individualistic and social perspectives, which might be more suitable for mass collaboration scenarios.*

Introduction

Communication and coordination among large groups of people have become omnipresent and pervasive with the emergence of Web 2.0 environments. Such platforms are able to support collaboration in large networks of participants. This kind of *mass collaboration* allows for an enhanced connectivity among the people involved and provides them with the opportunity to come together as communities. Usually, mass collaboration comes along with the potential to establish digital knowledge bases, and accordingly, may result in openly accessible knowledge that can be shared by masses of people. In mass collaboration situations on such shared platforms, large groups of participants may interact from different places and at different points in time. But this type of knowledge exchange, knowledge acquisition, and knowledge construction clearly has a collective quality, and can hardly be adequately addressed with a traditional view of knowledge as an individual phenomenon (Kimmerle et al., in press). Hence, mass collaboration and education challenge some old insights and concepts.

One direct challenge is to that very old question of fundamental theoretical value, namely the question of what knowledge is in fact. A review of the literature of philosophy and psychology clearly shows that knowledge is predominantly conceptualized as individual property, that is, as information (of a special quality) that is located in a person's mind or memory (see below). Such conceptualizations, however, reach their limit when it comes to processes on the collective level, such as in situations of collaboration or even mass collaboration. This dilemma has received little attention in recent scientific discourse. Novel forms of knowledge construction (e.g., in Wikipedia or on other online platforms that aim at developing knowledge) thus require novel conceptualizations of knowledge itself. The goal of

the present chapter is therefore to provide insight into traditional and more recently proposed social conceptualizations of knowledge. To this end, we will first outline traditional (individual-focused) accounts of knowledge in philosophy and psychology and point out their limitations. Second, we will refer to more recent approaches that go beyond individual conceptualizations and deal with inter-individual exchange and knowledge (social views of knowledge). Finally, we will shift from small-scale social interaction to the system level in order to address the phenomenon of mass collaboration. We will present various approaches of system-oriented epistemology and outline how knowledge is embedded in social systems and in effect shaped by them.

An Individualistic View of Knowledge

Individualistic View of Knowledge in Philosophy

Looking back on a long and prolific tradition, philosophy offers a considerable variety of approaches to defining knowledge. One of the most prominent and widespread definitions is the tripartite conception of knowledge as 'justified true belief'. That is, for a person to *know* a proposition (*p*), *p* must be true, the person must believe that *p* is the case, and her belief that *p* is the case must be justified. Consider, for instance, the proposition that the earth is a sphere. For a person to *know* this proposition, the proposition must be *true* (let's assume that) and she must believe that it is true. Moreover, she must have a good reason to believe that it is true. This is to ensure that she is not only accidentally convinced of a true proposition—which would not qualify as knowledge. Take an astronaut, for instance, who has actually seen the spherical earth rotate from outer space. One might argue that she or he is *justified* in believing that the earth is a sphere (we will return to this example and issues of truth and justification throughout this chapter).

The idea of this tripartite theory of knowledge dates back to Plato (see Gettier, 1963), and since then all of its three conditions have been repeatedly challenged and are still the targets of ongoing debate (for a recent review see Ichikawa & Steup, 2014). Nevertheless, the overwhelming majority of proposed conceptualizations of knowledge have two main points in common: First, they are concerned with the pursuit of *truth*, which may be understood as the correspondence to facts (David, 2013; please note, however, that there are numerous concepts of truth in philosophy). Second, they are *individualistic* in nature (Goldman, 2010a; Kusch, 2002b). This becomes immediately evident from the very definition: To be able to speak of knowledge, it is one specific person for whom it is to be determined whether they believe that *p* is the case and are justified in doing so (see also Ayer, 1956 and Chisholm, 1957 as cited by Gettier, 1963). With regard to our example of the earth, this person was the astronaut. But of course, one could think of other individuals with or without justified true beliefs (see below). But it is precisely the fact that knowledge can only be a property of individuals that characterizes classical epistemological approaches. Knowledge in this context is by definition grounded in individuals (Goldman, 1987; 2010)[1].

With this as a starting point, most analyses of knowledge focus on the specific standards that must be met in order to be able to speak of knowledge. Particularly, there has been a lively

[1] It must be acknowledged, however, that the branch of mathematics has been granted a special role even in traditional epistemology. This is due to the fact that mathematical knowledge is generated by stringent and complete proof. Such knowledge has therefore been proposed to be "a priori" (e.g., Peressini, 2008; Womack, 1993). As such, it may be regarded to be independent of any individual's recognizing it. This particular concept is closely linked to Popper's third world (see below).

discussion about the issue of justification. Given that justification distinguishes knowledge from mere belief, its conceptualization is crucial. To date, a number of different theories have been put forward (Matthiessen & Willaschek, 2009). Their focus is on the mental processes that may or may not be able to ensure knowledge. In this regard, some of the questions dealt with are: whether sensory input (Russell, 1910) or intuition (Kant, 1778, quoted by Popper, 1968) may be a source of knowledge; whether the quality of the believer's evidence determines epistemic justification (*evidentialism*, Feldman & Conee, 1985); whether the justifying conditions need to be accessible by reflection (*internalism,* e.g., Pappas, 2009); whether a reliable mental process is needed in order to speak of knowledge (*reliabilism,* e.g. Goldman, 1979); or whether standards of justification are context dependent (e.g., Schiffer, 1996).

Consider again the spherical earth example. By suggesting that an astronaut who observed the rotating earth *knows* that the earth is a sphere, we have implicitly granted justification to this kind of sensory input. But one might ask, of course, whether visual perception indeed qualifies as justification, given that it is fallible (e.g., illusions) and constructed (e.g., guided by expectations; Bartlett, 1932), which does not apply, for instance, to mathematical proofs. Such are some of the questions dealt with in classic epistemology. Beyond this, some normative aspects are debated, such as whether the epistemic subjects themselves should be taken into account, for instance, in terms of whether they are fulfilling a duty in order to arrive at knowledge (*deontic / deontological concepts of epistemic justification,* Alston, 1988; Vahid, 1998), or in terms of which virtues guided their belief formation (such as elaborateness and objectivity, *virtue epistemology,* Greco & Turri, 2011).

This - only very broad and incomplete - list of some of the accounts of epistemic justification clearly illustrates focus on the individual they all share. It is about what a person can or must do in order to be able to *know*. What differs is only the specific mental process an individual engages in that is drawn upon or emphasized in each account. Hence, classic epistemology focuses on the question of how an *individual* arrives at justified true belief. This focus holds even if individual boundaries are exceeded, as in the case of knowledge transmission. Dealing with the question of how knowledge is transferred from one person to another, again the discussion centers around which epistemic standards need to be met in order to speak of knowledge in the receiver. Hence, in addition to the fact that a speaker must be justified in believing a true proposition, a hearer needs to be justified in believing that the speaker is justified in believing that proposition (for an overview see Adler, 2010). In the context of our example, we could imagine that the astronaut tells others about her observation. A hearer—in this regard—would only be granted *knowledge* of the earth being a sphere if she had good reason to believe that the astronaut is justified in her belief that the earth is a sphere. One might further think that such a good reason was provided if the hearer knew that the speaker was indeed an astronaut and had actually been in space, and thus was able to make this observation. But the fact that, again, the same requirements must be met for the question of whether the hearer *knows* the speaker to be an astronaut, makes it obvious that knowledge-in the classic epistemological sense-is not easily gained. Nonetheless, although other people may enter the stage as potential sources of knowledge, the essence of the discussion is still whether some specific *individual* can acquire knowledge (see Kusch, 2002a for an exception).

Some difficulties that arise from these conceptualizations with focus on the individual are of crucial importance when considering mass collaboration and education. First, advancement in knowledge is difficult to explain in terms of a conception that localizes knowledge solely within individuals (see Popper, 1968). Second, knowledge that results from collaborative work distributed among several people would be difficult to understand, as the requirement

for individual justification might not be met for each person involved. This becomes most evident in the realm of science, where collaboration is widespread. When a research project is based on the expertise of very different contributors, the knowledge resulting from the project can hardly be attributed to only one person (Hardwig, 1985). We will return to this issue below.

Individualistic View of Knowledge in Psychology

The search for a psychological definition of knowledge is a remarkably difficult task. Despite the fact that the very core of educational psychology is the *acquisition* of knowledge (i.e., learning), and despite the fact that one of the main research areas of cognitive psychology is how knowledge is represented, both educational and cognitive psychology (and the other areas in psychology alike) mostly remain silent about a definition of knowledge itself. Encyclopedias of the cognitive sciences (e.g., Wilson & Keil, 1999) as well as of research in education (e.g., Alkin, 1992) lack entries on knowledge itself, but they do offer elaborate remarks on knowledge acquisition, comprehension, and representation. These, however, do not start from a definition, either. In the same vein, Mandl and Spada (1988)—who argue for a "psychology of knowledge"—only rather casually comment on their concept of knowledge by mentioning that they not only include "static factual knowledge" but also "algorithmic capabilities, heuristic knowledge etc." (p. 2, translated by the authors). Despite the fact that a precise definition is missing, their statement makes clear that their understanding differs remarkably from the view most philosophers advance, because neither truth nor justification seem to play a role. This also applies to those cases where explicit concepts of knowledge are put forward. Bar-Tal and Kruglanski (1988), for instance, define knowledge as "the totality of a person's *beliefs* on various topics" (p. 6; italics added by the authors). This definition represents an explicit deviation from the philosophical stance: Knowledge is defined as belief. Sperling and Schmidt (2009), on the other hand, denote knowledge as "organized *information* that is saved (represented) in memory" (p. 74, translated and italics added by the authors). This definition explains the close association to learning and memory and the partly interchangeable use of the respective concepts (e.g., Gruber, 2011).

Interestingly, however vaguely the concept of knowledge itself is treated in psychology, one can easily find several distinctions regarding what kind of knowledge is stored and how accessible it is (e.g., Tulving, 1985a; 1987). Psychologists differentiate, for instance, between the representation of factual world knowledge (*semantic memory*), knowledge about experienced events (*episodic memory*), and knowledge about how something has to be done (*procedural memory*). Hence, knowledge about the earth being a sphere, about one's own graduation, or about how to ride a bike would fall into different categories. Likewise, psychologists often differentiate between knowledge that is consciously accessible (*explicit memory*) and knowledge that is not consciously retrievable (*implicit memory*, Dienes & Perner, 1999). Particularly this distinction makes the differences between psychology and philosophy obvious. From a philosophical perspective as described above, something like implicit knowledge would be a contradiction in itself. Psychology, on the other hand, rarely explicitly elaborates on what qualifies knowledge. This is not to say, however, that psychology completely ignores the concepts of truth or justification.

Take truth, for instance. Hardly any researcher would credit someone who states that the earth is flat with knowledge. Likewise, in many areas of psychological research, the distinction between correct and incorrect representations is certainly made. In the overwhelming majority of learning and memory research it is of central concern whether a person has learned and represented something correctly (e.g., from predetermined materials, Ballard, 1913; Bartlett,

1932; Ebbinghaus, 1885/1964; Erdelyi, 2010). Also, a substantial number of studies explicitly address *deviations from truth*. Much research on *biases* in information processing (e.g., Gilovich, Griffin, & Kahnemann, 2002; Pohl, 2004), *misconceptions* (e.g., Caramazza, McCloskey, & Green, 1981; Griffith, & Preston, 1992; Oeberst, 2012), *heuristics* (e.g., Gigerenzer, 2004), or *false memories* (e.g., Steffens & Mecklenbräuker, 2007) falls into this category. Common for all this research is that what is considered truth is determined by the experimenter, by the to-be-remembered material, or by logical standards (e.g., for heuristics). Specifically, researchers compare participants' responses either to what is regarded as unquestionable knowledge (e.g., the earth being a sphere) or compare it to the information that was presented to the participant within the study (e.g., learning material or whatever has been witnessed). Hence, truth is predetermined in such settings. The goal of this research, however, is often to identify certain determinants and indicators of truth (e.g., memory accuracy) which might provide guidance for assessing the validity of recollections where no objective comparison can be made (e.g., in forensic settings; Steck et al., 2010). This is particularly important, since numerous studies show that subjectively perceived truth (e.g., the conviction an individual has that something remembered was indeed presented) is highly malleable and fallible (e.g., Higgins & Rholes, 1978; Lindner, Echterhoff, Davidson, & Brand, 2010; Reber & Unckelbach, 2010; Shaw & Porter, 2015; Sporer, Penrod, Read, & Cutler, 1995).

Much less research in the realm of psychology is found for conceptualizations corresponding to justification. This is not surprising given that justification does not constitute a necessary precondition of knowledge. There are, however, studies that investigated the basis of participants' claims. Various measures have been taken, for instance, to identify the extent to which guessing contributes to correct answers (e.g., Fiedler, Russer, & Gramm, 1993; Oeberst & Blank, 2012, Schroeder, Richter, & Hoever, 2008). Taking it one step further, some researchers distinguish between whether a person can explicitly remember having had some experience or merely knows by "feel" that this experience has taken place (Dunn, 2004; Gardiner, 1988; Tulving, 1985b; 1989). Relatedly, research in the formation of opinions investigates whether people base their belief in a proposition on thorough elaboration (e.g., Petty & Cacioppo, 1986) and "epistemic validation" through other sources (e.g., Richter, 2003; Maier & Richter, 2014), or whether they are instead persuaded by superficial aspects such as attractiveness of the communicator. Hence, issues that implicitly relate to the philosophical concept of justification are sporadically found in psychology as well. But again, these side issues dealing with the basis for an individual's claims remain unrelated to a more encompassing elaboration regarding what knowledge is.

Taken together one might summarize that reference to philosophical epistemological considerations about truth and justification are rare in psychology (see Dienes & Perner, 1999, for an exception). It seems that researchers in psychology prefer to circumvent any debate about knowledge and its possibly qualifying status, and use concepts such as *information* and *cognition*, instead. And what is counted as knowledge in psychology might be termed *information* or *belief accumulation* from a philosophical stance. Whatever we may name it, however, it must be stressed again that it was traditionally viewed and investigated as a feature of individuals.

A Social View of Knowledge

A Social View of Knowledge in Psychology

In the 1990s, some approaches were put forward in social and organizational psychology that explicitly challenged the individual perspective and extended it to social processes. This includes research about socially shared cognition (Resnick, Levine, & Teasley, 1991; Thompson & Fine, 1999), groups as information processors (Hinsz, Tindale, & Vollrath, 1997), groups as problem-solving units (Larson & Christensen, 1993; Kerr, MacCoun, & Kramer, 1996), distributed cognition (Giere & Moffatt, 2003; Salomon, 1993), shared mental representations and schemata (Hinsz, et al., 1997; Moussavi & Evans, 1993), team mental models (Klimoski & Mohammed, 1994), joint complementary memory systems (e.g., transactive memory; Wegner, Erber, & Raymond, 1991), and collective memory (Hirst & Manier, 2008). These approaches apply relevant cognitive concepts to groups as a whole and their information processing. Similar to the more individual approaches, all these social psychological approaches consider neither truth nor any kind of justification. In sum, they aim to overcome the exclusively individual perspective that is typical for a traditional psychological approach, but they likewise refrain from any elaboration on a precise definition of knowledge.

A Social View of Knowledge in Philosophy

One of the first attempts to overcome the individualistic view on knowledge in epistemology was made by Popper (1968). He criticized that classic epistemology can hardly contribute to understanding scientific knowledge (see also Popper, 1978) and argued that the traditional focus on knowledge in the subjective sense needs to be extended by the notion of knowledge in the objective sense. He distinguished between thought *processes*, which are bound to specific individuals, and thought *contents*, which are independent of individuals (as the same thought may come to various people's minds). Although thought contents certainly result from thought processes (also Scardamalia & Bereiter, 2010; but see Klemke, 1979 for a more radical conceptualization), Popper broke with the idea that knowledge is dependent on someone's claim to know (see also Footnote 1). Rather, once a thought is verbalized it is the potential of being understood that matters more in Popper's proposal. Moreover, he stressed that only by making thought contents explicit can they be criticized inter-subjectively and thereby lead to growth in (objective) knowledge. Since traditional approaches are restricted to individual knowledge, they cannot contribute to this line of thought. Popper (1968), instead, proposed that growth of knowledge is the very core concept in an epistemology that takes an objectivist view. Therefore, he introduced a general schema of growth of knowledge.

This process starts from a first problem, which leads to a tentative solution or tentative theory, which is then subject to error elimination, through theoretical discussions or empirical investigations. In the course of this error-elimination process, new problems arise. Thus, knowledge growth basically results from the elimination of errors. Hence, it is not undefeatable truth that is to be expected from this process. Popper questioned the existence of such truth and thus challenged one of the core aspects of the philosophical definition of knowledge. He expected instead an increasing approximation of what corresponds best to the facts, as a result of the process of error elimination (see also Wood & Nezworski, 2005 for the notion of science as a history of corrected mistakes). Thus, within this process, some ideas may fail to withstand critical discussion and some theories may be empirically proven to be false. At the same time, however, other solutions and new ideas will emerge. What is expected to survive then are—in analogy to Darwinian selection—the best (tentative) theories.

Although this conceptualization does not exclude the possibility of single subject inquiries, Popper (1970) argued that progress and growth of knowledge requires exchange among researchers. For the vast majority of problems in science, indeed, more than one person is usually involved. This becomes immediately evident if one considers that involvement starts with the reference to others' opinions and the reliance on others' justified beliefs. Contrary to the traditional view that promotes the idea of arriving at direct knowledge by thinking for oneself, Hardwig (1985) argued that it may be much more rational to accept such *epistemic dependence*. Hence, not only individual mental processes such as perception, reasoning, and introspection, but also other people may be seen as a source of knowledge or justification. This notion introduces a social aspect, which has long been neglected in traditional epistemology (Goldman, 2010b). Accordingly, the question arises as to how knowledge is transmitted (which also refers again to the astronaut example). One possibility is through the statements from other people one hears or reads (i.e., testimony, Adler, 2010). The main challenge in terms of philosophical considerations that emerges in this case lies with the issue of justification, because the hearer's justification for the belief that *p* is true (i.e., the content of the testimony) is dependent upon the speaker's justification for believing that *p* is true (Lehrer, 1987). Moreover, the hearer must be justified in believing the person who testifies. This may be least questionable in the case of experts. If the speaker is an intellectual authority, it follows that the hearer will believe that the speaker has good reasons to believe some proposition (Hardwig, 1985). Experts' knowledge, however, relies on others' findings and thoughts as well, as concisely pointed out by Hardwig (1985). Hence, even those people we expect to be the most knowledgeable are actually epistemically highly dependent, thereby revealing that justification is frequently linked in chainlike fashion to other people and their findings, rather than being independently and individually derived.

But again, Hardwig (1985) argues that accepting such epistemic dependence may be more rational than trying to replicate all results for oneself in order to arrive at direct and independent knowledge. If such epistemic dependence is accepted, the field becomes open for other sources as well, thereby providing the opportunity to expand beyond the individual focus. In line with this reasoning, Lehrer (1987) argued for taking groups as a source of knowledge into account as well, given that groups "contain more information" (p. 93). In the same vein, Kitcher (1990) stated that cognitive diversity is beneficial for progress. Thus, for growth of knowledge, it is optimal that more than one person is involved and, at best, that these people differ substantially from one another in terms of background, skills, and ideas.

As mentioned before, classic standards of justification are inapplicable for cases like these. This does not mean, however, that the idea of justification must be abandoned completely. Instead, two implicit premises should be questioned: First, there may not be only one correct answer to the question of what justifies a belief (Boghossian, 2006). Critics contend that there is no objectively correct set of norms that is universally valid. Rather, they suggest the existence of 'local' norms that vary across cultures or communities (Goldman, 2010a). Second, the premise of a dichotomy in epistemic valuation (justified vs. not justified) may not hold. It could be beneficial to consider not only whether certain standards of knowledge are met or not, but also to distinguish among a variety of different states that are considered valuable from an epistemic standpoint (e.g., having true beliefs; having justified beliefs; having rational beliefs; having knowledge; Goldman, 2010b). This becomes obvious if one considers in how many instances science gathers *support* for one or the other hypothesis, yet lacks *unquestionable evidence* for its truth (Greenwald, 1975; Lakatos, 1970; Vicente & Brewer, 1993). Hence, even in the most professional enterprise of knowledge construction, researchers deal much more with justified beliefs than with knowledge. Nevertheless, by

aiming to determine how knowledge is constructed we might be likely to come closer to knowledge, even if our best tentative theory is only an approximation and probably not the final answer.

The social aspect of knowledge is stressed particularly in *social epistemology* (Goldman, 2010a), which not only takes social exchange into account, but also acknowledges that individuals receive the overwhelming majority of their information from other people. But how can a belief be justified under such complex circumstances? We will outline briefly two accounts that deal with this question: Lehrer (1987), on the one hand, proposed a coherence-based theory of knowledge. The basic idea is that incoming information is evaluated in terms of background information. This may be applied to personal knowledge (of individuals) as well as to social knowledge (of groups), which is more relevant for the present purpose. Lehrer (1987) introduces the idea of *consensual justification*. According to this, "a group is consensually justified in accepting that *p* if and only if *p* coheres with what is consensually accepted." (p. 90). Truth, in this respect, is not simply abandoned, but the notion of dichotomy is replaced by the concept of probability—a sufficiently high probability of the truth of a proposition must be assigned. Thus, according to this view, the evaluation of new information is determined by its relationship to previously existing information. Nevertheless, the idea of some kind of social consensus is already implied here.

Faulkner (2006) took a similar line and developed the notion of *social warrant*. Consider the case that a belief has been previously justified in science but then is discovered to be false in the progress of research. If not made public, such revision may go unnoticed. But Faulkner referred to the case that even though the novel findings are published widely, a subject *S* fails to take notice of this recent development. Although *S*'s knowledge then may be objectively and subjectively warranted, as the previous belief had been justified and *S* does not hold any contradicting justified beliefs, *S should* not continue believing, since it has been *socially recognized* that contradictory evidence is available. The crucial point is that no individual is capable of establishing whether a belief is socially warranted. Rather, it requires a community to determine the absence of such *normative defeaters*. In another line of reasoning, Faulkner (2006) made justification *essentially social*. In proposing this, he referred to Hardwig (1985), who analyzed collaboration and who based his argument on a scientific publication with 99 authors. Hardwig wondered in this extraordinary case to whom we would attribute knowledge. Given that different authors probably contributed their domain-specific knowledge, none of them would be individually justified in claiming to have knowledge according to classic epistemological standards, because each person's knowledge would in some way depend on their collaborators' knowledge. Following from this, Hardwig (1985) proposed the notion that not individuals, but groups may actually be the bearers of knowledge. Faulkner (2006) added that it might be the very premise that knowledge is in the mind of individuals which is problematic.

Taken together, the arguments outlined above clearly demonstrate the limits of the definition of knowledge proposed by classic (individualistic) epistemology. As precise and straightforward as the traditional accounts may be, they cover only a very small subset of instances (propositions and persons). Also, they fall short of taking into account the epistemic dependency and social construction of expert knowledge, not to mention their inapplicability for collaborative creation of knowledge or growth in of knowledge in general. Thus, precision comes at a price. But so does the extension of the individual perspective. All of the accounts outlined have weakened either the truth claim or the standards for accepting justification. Note, however, that the notions of truth and justifications have rarely been rejected entirely.

By allowing more latitude for truth and justification, however, it has been possible to cover a much broader range of phenomena.

At this point, another branch of philosophy needs to be recognized, one that emerged from traditional epistemology but soon acknowledged the social nature of human knowledge—the philosophy of science. Here, scientists such as Thomas Kuhn (1962) and Hilary Putnam (1975; just to mention two) stressed the importance and influence of social aspects on knowledge (construction). In his famous book about scientific revolutions, for instance, Kuhn (1962) emphasized that scientific knowledge always results from a research *community*. Moreover, he stated that every research community is characterized by a similar education and a shared scientific practice (e.g., theories referred to, methods used), which, in turn, affects what this scientific community can find out. Hence, scientific knowledge construction depends fundamentally on social practice.
In a similar vein, Fleck (1935) had pointed out that researchers are always embedded in a "thought collective", which is characterized by a particular "thought style". In Fleck's view, it is this shared thought style that determines what is accepted as a scientific problem, an appropriate method and a conclusive judgment, and—ultimately—as truth. Consequently, scientists as well as their research and their findings are fundamentally affected by a scientific community. In other words, they are essentially socially constructed. In the following, we will pursue this line of thought and present system-oriented approaches to knowledge.

A Systemic View of Knowledge

Beyond his social epistemology (Goldman, 2010a), that was described above, Goldman (2010b) proposed a systems-oriented epistemology. There, he considered groups as epistemic agents and elaborated on *collective agents* (group of individuals, whose individual judgments are aggregated) and *social systems*. For the present purpose we will focus on epistemic systems. According to Goldman (2010b), an epistemic system is "a social[2] system that houses a variety of procedures, institutions, and patterns of interpersonal influence that affect the epistemic outcomes of its members" (p. 2). And it is precisely the impact these have on epistemic outcomes which Goldman views as the subject of investigation in systems-oriented epistemology. Epistemic outcomes in his view can be: (1) having true beliefs, (2) avoiding errors, (3) having justified beliefs, (4) having rational beliefs, and (5) having knowledge. Hence, he avoids a knowledge-no knowledge dichotomy and considers different epistemic states to be valuable. Nonetheless, it becomes clear that he takes a normative stance, as epistemic outcomes are valued differently. Moreover, he stresses that epistemic systems can thus be evaluated by the set of epistemic outcomes they foster or generate: Better outcomes merit higher epistemic evaluation of the system.

Goldman (2010b) suggests that it is the central task of system epistemology to analyze and compare different systems with regard to their epistemic outcomes. For instance, he points to different legal systems (which also have the task to seek the truth in a trial), such as the common-law system where judgment is passed by juries of laypersons and civil law systems that limit judgment to professionals. From the epistemic systems perspective it would be of interest which of the two systems provides better epistemic outcomes, that would be in this case, fewer false verdicts. Likewise, one may take features of the science system (e.g., reward structure) and ask how these features affect the epistemic outcomes.

[2] An epistemic system is thus by definition a social system, not an individual system.

In a similar vein, Goldman (2010b) emphasizes that harvesting "dispersed knowledge" can lead to better epistemic consequences than reliance on a small group of experts. With reference to the Internet he acknowledges that mass collaboration may enable "democratic epistemic systems to reap significant epistemic bounty" (p. 13). Despite these considerations he mainly focuses on the epistemic states of *individuals*. That is, he mainly pursues the epistemic outcomes of epistemic systems on individuals. Although he does acknowledge that epistemic systems may sometimes also affect collective agents, he does not further elaborate on this aspect. With regard to justification, however, he suggests that not only objective justification but also "local" justification according to the epistemic system should be taken into account. In other words, he suggests that a person is justified in believing that a certain proposition is true if it conforms to the "governing set of epistemic norms, norms that permit belief in light of the agent's evidential situation" (p.18). However, he would suggest labeling it "local justification", in contrast to "objective justification", if there is universally valid reason for believing that the proposition is true. As an illustrative example, Goldman (2010b) refers to Galilei, who may have been objectively justified in stating that heavenly bodies move. Yet, within the context of the predominant epistemic system at that time, which was based on Scripture, he was locally unjustified, whereas the reversed pattern of justification applied to his opponents. Hence, Goldman brings together two perspectives that have been usually presented as irreconcilable views—an objectivist approach as well as a relativistic point of view. Moreover, his viewpoint enables a discussion of truth and justification (a) that takes epistemic systems into account, (b) that is partly independent of the individual in question, and (c) that provides a solution for the difficulties that arise with an objectivist conceptualization of truth and justification. What is still missing, however, is an elaborated account of knowledge *construction* in the context of mass collaboration within an epistemic system. After all, the focus of Goldman's system epistemology is by definition a focus on the effects that epistemic systems have on their members. It does not, however, address the very construction of the epistemic basis itself that might influence the members.

In the following, we will propose another systemic approach that focuses on that specific context. This systemic-constructivist approach is the basis for our co-evolution model of individual learning and collaborative knowledge construction as it takes place in masses of people (Cress & Kimmerle, 2008; Kimmerle, et al, 2012; Oeberst, et al, 2014; Kimmerle et al, in press). We present our co-evolution model as applied to collective knowledge construction in more detail in Chapter 5 of this book (Cress, U., Feinkohl, I., Jirschitzka, J., & Kimmerle, J., in press)..

The systemic perspective, we propose in our work, fits within the tradition of constructivist theory. It not only radically breaks with the individual focus on knowledge, but also with the concept of knowledge as *true* belief. It proposes that no system in general can ever truly capture reality. Even though systems process input from the outside, that is, from their environment, all processes in a system are self-referential and are therefore always strongly defined by the system itself (Maturana & Varela, 1987; von Foerster, 2003). Hence, in the case of knowledge, acceptance of the truth of a belief and its justification always count only within the context of the knowledge-related system from which it originates. Applying Goldman's (2010b) distinction between local and objective justification, this means that from a constructivist point of view we always and exclusively deal with local justifications of knowledge. The sociologist Niklas Luhmann adopted this constructivist perspective for his influential "social systems theory" (1984). This theory states that all systems are autopoietic: they permanently create and recreate themselves through their own operations. The mode of operation for social systems is communication: through communication, a social system constructs meaning about (i.e., makes sense of) its environment. It observes the environment,

selects relevant information, and applies a so-called “binary code” to it, which makes an either-or decision. In the ‘science system’, which is concerned with the creation of knowledge (Luhmann, 1990), this binary code regards truth and thus it distinguishes itself from its environment by deciding whether or not a finding or a statement is true. But truth in Luhmann’s terms is not meant in an objective sense. Luhmann (1990) abandons the existence of objective truth. Rather, truth is referred to in a systemic sense: The system is self-referential and thus defines what is accepted and what is rejected as being true within its boundaries (see Knorr-Cetina, 1981, for the notion of relative truth in science). Hence, again, truth judgments are based on “local” (i.e., system-bound) norms. The scientific system has developed quite elaborate methods for testing truth. These methods make sure that the system deals with all information in an adequate and reproducible manner and ‘objectively’ decides what it accepts and what it rejects. But the system can only operate upon (i.e., apply its code to) what it perceives from the environment, and these perceptions are also selections made by the system itself. So a system can never sense the environment or reality directly. From a system’s perspective the environment is always contingent, chaotic, and infinitely complex (Luhmann, 1984). A system cannot entirely capture and deal with this complexity. Therefore, its perception of the environment is always selective. It can only observe that part of the environment which is already meaningful for the system. Hence, a knowledge-related system that processes input from its environment can only respond to that information in the environment which it considers potentially relevant. This means that a system is open to information from the environment but ‘operationally closed’. It self-selects its own operations and thus behaves circularly (for a recent summary see Kimmerle, Moskaliuk, Cress, & Thiel, 2011).

As a sociologist, Luhmann was mainly interested in social systems. But in his General Systems Theory (Luhmann, 1984), he also regards individuals as cognitive (or as he calls it, ‘psychic’) systems. Such a cognitive system also strives for meaning. It operates by cognitive processes such as thinking, reasoning, and problem solving. As systems in general, a cognitive system is self-referential and operationally closed as well. It cannot experience the environment directly but is bound to its perception (which represents, again, an active process of selection). From the perspective of the individual, a social system belongs to the environment and vice versa. That is, for one system, another system is always contingent, chaotic, and infinitely complex. Moreover, due to its operational closeness, a system can never directly interact with another system. Two systems, however, can irritate each other and thus stimulate each other’s development. Luhmann assumes that systems mainly develop when confronted with new and unexpected observations (i.e., irritations) from the environment. A system then has to deal with this irritation, and it does this in its typical manner: it applies its specific code to the unexpected event and tries to make meaning of it. Hence, a knowledge-related system that is confronted with a novel and unexpected observation has to decide whether or not the new observation or its explanation can be considered to be true. If so, this new knowledge modifies the system’s expectations for future events. The integration of new knowledge then enhances the complexity of the system, but reduces the (perceived) complexity of the environment. This means that the system now has more concrete expectations about the environment, which—from the system’s perspective—makes the environment less unpredictable. Cognitive systems can be irritated by their environment and deal with a novel and unexpected stimulus by thinking about it and making sense of it. Likewise, a social system can be irritated by another system that stimulates its development and leads to higher complexity. Thus, cognitive and social systems may never directly interact. But they can build expectations about each other, and if they do so—over some time—they can mutually irritate each other in some way. As a consequence, both

systems co-evolve and develop higher complexity. This kind of mutual irritation of two systems is called *structural coupling* (Luhmann, 1984).

Combining Luhmann's theory with concepts of Vygotsky (1978) and Piaget (1977), Cress and colleagues presented the Co-Evolution Model of learning and collective knowledge construction (Cress & Kimmerle, 2008; Kimmerle, Cress, & Held, 2011; Kimmerle et al., 2011; Kimmerle, Moskaliuk, Harrer, & Cress, 2010; Moskaliuk, Kimmerle, & Cress, 2009). The model describes individual learning and collaborative knowledge creation as structural coupling between the cognitive systems of human beings and the community as a knowledge system. In order to interact with the social system, an individual has to externalize her own knowledge and subjective beliefs. This has to be done in such a way that the social system can apply its binary code and decide whether or not it will be accepted as knowledge. So it is the individual who externalizes her own individual knowledge (for example into a written text), but it is the knowledge-related social system that shapes how this is done. The social system determines if the individual's knowledge is incorporated. A scientist, for example, can publish a new theory, but it is the scientific community that decides whether it accepts this theory, refers to it, and develops it further. In this process the individual scientist (with her own individual expertise) always remains a particular environment for the knowledge-related social system. Her individual beliefs and expertise build the basis for her operations (publishing an article), but it is the scientific system that decides if this externalized individual knowledge is received and how it is processed. Hence, an individual could have her own specific opinions and beliefs, which she then expresses, but it depends upon the social system as to how these beliefs are understood, integrated, or rejected. The externalized knowledge of an individual is only a stimulation for the social system. Both the individual scientist and the scientific community are operationally closed systems that cannot simply merge, but can stimulate each other and lead to development processes in the individual as well as in the community.
Taken together, the systemic perspective emphasizes the relative nature of all kinds of standards and norms, as these are always defined by and only valid within a given system. Hence, systems define what is considered to be true, as well as how the truth of a given proposition shall be evaluated—thereby ultimately defining knowledge itself. *Growth* of knowledge, in this perspective, results from interacting systems that may co-evolve through mutual stimulation.

Discussion

Our starting point was the question as to what knowledge is, and we considered a variety of accounts originating from different disciplines. Within this process, three fundamental themes emerged that are closely related to the question of when a proposition is *known*: the requirement of truth of the proposition, the justification for believing in the proposition, and the question of who bears the knowledge. Our elaborations have shown that these three aspects are given consideration to differing degrees in the various disciplines and are to some extent conflicting issues. If one's analysis is restricted to individuals, one can draw upon a prolific philosophical tradition that may not provide an ultimately valid answer, but that provides a fairly consensual concept of knowledge (*justified true belief*). The philosophical tradition also delivers extensive detail regarding specific standards for ensuring knowledge. As precise as such an understanding may be, its applicability to real life is highly limited. This philosophical tradition does not explain fundamental phenomena such as mediated information (i.e., beyond the direct transmission from one person to another), collaboration, or growth of knowledge.

It may be questionable to use as a starting point for any analysis the implicit premise that knowledge exists only in individuals' minds. Philosophical accounts that transcend the single person perspective provide broader coverage of real-world issues at the expense of only a small degree of precision. Here, truth has been conceptualized in weaker terms (e.g., probability), and justification has been given more latitude by introducing mediated forms and by embedding justification into social context (e.g., social consensus; social warrant). In this broader analysis, justification, and thus knowledge itself, is made essentially social. Last but not least, the systemic-constructivist perspective radically breaks with the idea that any definitions or standards can be generalized. It denies that any proposition can be universally considered as true. It proposes instead that only the social or cognitive system itself defines truth and its justification. The system will also apply its own methods to incoming information for evaluating whether or not a piece of information is true. From this perspective, knowledge construction is far less a matter of individuals. Rather, it is the application of a specific code that a social system has developed and that essentially guides the behavior of its members. In this way it harnesses the individual expertise of its members for creating emergent knowledge.

Regarding our fundamental questions with respect to knowledge, we conclude from our elaborations that knowledge is not something that can be universally defined, but instead it is what a specific knowledge-related system accepts. In mass-collaboration scenarios social systems are communities that process and construct knowledge. What is accepted in those groups strongly depends on the criteria for truth and justification that exist in these groups (e.g., the social system of Wikipedia rejects information without any reference, as the system requires contents to be verifiable and from reliable sources). For example, these criteria may be completely different in a community of doctors, in patient forums, or in other platforms. In the case of Wikipedia, verifiability and neutral point of view are the most crucial variables in this regard, in patient forums it may be subjectivity and personal experiences. Concerning the question of *who creates* knowledge, the systemic perspective clearly argues that it is the system that shapes the actions of its members. By applying its code, the social system enables users to become epistemic agents and allows the collaborative construction of knowledge. If people participate in different knowledge-related communities, their activities would be expected to differ as a function of the different social system.

The question then, *who possesses* knowledge, brings us back to the debate between classic epistemology and more recent theories. Hardwig (1985) proposed that the community is the bearer of knowledge in such cases (see also Faulkner, 2006), whereas Popper (1972) grants to thought contents an objective nature that is independent of anybody's mind. From the systemic perspective we would argue that knowledge is contained in the communication that constitutes the social system. In mass-collaboration scenarios on the Internet, this communication may become manifest in shared digital artifacts, as artifacts condense the interplay between the social system and cognitive systems which took place in mutual stimulation, thus reflecting the co-evolution of both systems (Cress & Kimmerle, 2008).

Our perspective differs from traditional accounts in that we introduce a systemic-constructivist concept of knowledge and put emphasis on the code of a system. Some implications arise from this point of view that may stimulate the debate in the Learning Sciences: In a nutshell, our approach proposes that novices should be able to create information content of high quality—or knowledge—if the social system offers the proper conditions. The notion that knowledge construction may be accomplished by non-experts such as students has been put forward before (e.g., Bereiter & Scardamalia, 2010). We put emphasis on the latter part of the proposal, however, on the proper conditions, or the 'code' of

the social system. From this perspective the question as to what constitutes a system's code arises immediately. More precisely, what is a system's definition of knowledge? And what is required in order to accept a certain proposition as knowledge? Hence, for a system that strives to enable construction of knowledge, a focus on these questions would be crucial and a discussion fruitful. Also from this view, it becomes immediately obvious that traditional education's code is *not* in essence one that leads to knowledge construction. Instead, the present common code tackles primarily the issues of teaching and learning. More precisely, the question is not what knowledge is, but whether or not (or how) it can be imparted, along with the question as to whether or not and how it may be effectively encoded and retrieved. As early as 1999, Scardamalia and Bereiter argued in their knowledge-building account for a novel understanding of schools as places where knowledge construction should take place (see also Paavola & Hakkarainen, 2005). The idea was that schools should prepare students for their lives in a knowledge society in which they should take responsibility for this common good (i.e., knowledge; see also Damșa, Kirschner, Andriessen, Erkens, & Sins, 2010). Our approach further stresses that for successfully achieving this goal, reflection about the code, and in turn reflection about the conditions imposed by a system, is downright necessary.

References

Adler, J. (2010). Epistemological problems of testimony. In Edward N. Zalta (Ed.), *The Stanford Encyclopedia of Philosophy* (winter 2010 ed.). Retrieved from http://plato.stanford.edu/entries/testimony-episprob/

Alkin, M. C. (1992). *Encyclopedia of educational research* (6 ed.). New York, NY: Macmillan.

Alston, W. P. (1988). The deontological conception of epistemic justification. *Philosophical Perspectives, 2,* 257-299.

Ballard, P. B. (1913). Oblivescence and reminiscence. *British Journal of Psychology, 1*(No. 2, Monograph Supplements), Preface-82.

Bartlett, F. C. (1932). *Remembering: A study in experimental and social psychology.* Cambridge, UK: Cambridge University Press.

Bar-Tal, D. & Kruglanski, A. W. (1988). *The social psychology of knowledge.* Cambridge, UK: Cambridge University Press.

Bereiter, C. & Scardamalia, M. (2010). Can children really create knowledge? *Canadian Journal of Learning and Technology, 36*(1). Retrieved from http://www.cjlt.ca/index.php/cjlt/article/view/585/289

Boghossian, P. A. (2006). *Fear of knowledge: Against relativism and constructivism*. Oxford, UK: Clarendon Press.

Caramazza, A., McCloskey, M., & Green, B. (1981). Naïve beliefs in "sophisticated" subjects: Misconceptions about the trajectories of objects. *Cognition, 9,* 117-123.

Cress, U., Feinkohl, I., Jirschitzka, J., & Kimmerle, J. (in press). Mass collaboration as co-evolution of cognitive and social systems. In Cress, U., Moskaliuk, J., & Jeong, H. (Eds.), *Mass collaboration and education*. Cham, Switzerland: Springer International Publishing.

Cress, U. & Kimmerle, J. (2008). A systemic and cognitive view on collaborative knowledge building with wikis. *International Journal of Computer Supported Collaborative Learning, 3,* 105-122.

Damşa, C. I., Kirschner, P. A., Andriessen, J. E. B., Erkens, G., & Sins, P. H. M. (2010). Shared epistemic agency: An empirical study of an emergent construct. *The Journal of the Learning Sciences, 19,* 143-186.

David, M. (2013). The correspondence theory of truth. In Edward N. Zalta (Ed.), *The Stanford Encyclopedia of Philosophy* (fall 2013 ed.). Retrieved from http://plato.stanford.edu/entries/truth-correspondence/

Dienes, Z., & Perner, J. (1999). A theory of implicit and explicit knowledge. *Behavioral and Brain Sciences, 22,* 735-808.

Dunn, J. C. (2004). Remember—know: A matter of confidence. *Psychological Review, 2004, 111,* 524-542.

Ebbinghaus, H. (1964). *Memory* (H. A. Ruger & C. E. Bussenius, Trans.). New York, NY: Dover (Original work published 1885).

Erdelyi, M. H. (2010). The ups and downs of memory. *American Psychologist, 65,* 623-633.

Faulkner, Paul. (2006). Understanding knowledge transmission. *Ratio 19,* 156-175.

Feldman, R. & Conee, E. (1985). Evidentialism. *Philosophical Studies, 48,* 15-34.

Fiedler, K., Russer, S., & Gramm, K. (1993). Illusory correlations and memory performance. *Journal of Experimental Social Psychology, 29,* 111-136.

Fleck, L. (1935). *Entstehung und Entwicklung einer wissenschaftlichen Tatsache. Einführung in die Lehre vom Denkstil und Denkkollektiv* [The genesis and development of a scientific fact]. Basel, Switzerland: Schwabe.

Gardiner, J. M. (1988). Functional aspects of recollective experience. *Memory & Cognition, 16,* 309-313.

Gettier, E. L. (1963). Is justified true belief knowledge? *Analysis,* 121-123.

Giere, R. N. & Moffatt, B. (2003). Distributed cognition: Where the cognitive and the social merge. *Social Studies of the Science, 33,* 301-310.

Gigerenzer, G. (2004). Fast and frugal heuristics: The tools of bounded rationality. In D. J. Koehler & N. Harvey (Eds.), *Blackwell Handbook of Judgment and Decision Making* (pp. 62-88). Malden, MA: Blackwell.

Gilovich, T., Griffin, D., & Kahnemann, D. (2002). *Heuristics and biases: The psychology of intuitive judgment.* Cambridge, UK: University Press.

Goldman, A. (1979). What is justified belief? In G. Pappas (Ed.), *Justification and Knowledge.* Boston, MA: D. Reidel.

Goldman, A. (1987). Foundations of social epistemics. *Synthese, 73,* 109-144.

Goldman, A. (2010b). Systems-oriented social epistemology. In T. Gendler & J. Hawthorne (Eds.), *Oxford Studies in Epistemology (vol. 3).* Retrieved from http://fas-philosophy.rutgers.edu/goldman/Systems-Oriented%20Social%20Epistemology.pdf

Goldman, A., & Blanchard, T. (2010a). Social Epistemology. In Edward N. Zalta (Ed.), *The Stanford Encyclopedia of Philosophy* (summer 2010 ed.). Retrieved from http://plato.stanford.edu/entries/epistemology-social/

Greco, J. & Turri, J. (2011). Virtue Epistemology. In Edward N. Zalta (Ed.), *The Stanford Encyclopedia of Philosophy* (spring 2011 ed.). Retrieved from http://plato.stanford.edu/entries/epistemology-virtue/

Greenwald, A. G. (1975). Consequences of prejudice against the null hypothesis. *Psychological Bulletin, 82,* 1-20.

Griffith, A. K., & Preston, K. R. (1992). Grade-12 students' misconceptions relating to fundamental characteristics of atoms and molecules. *Journal of Research in Science Teaching, 29,* 611-628.

Gruber, T. (2011). *Gedächtnis - Lehrbuch Basiswissen Psychologie.* Wiesbaden, Germany: VS-Verlag für Sozialwissenschaften.

Hardwig, J. (1985). Epistemic dependence. *The Journal of Philosophy, 82,* 335-349.

Higgins, E. T., & Rholes, W. S. (1978). „Saying is believing": Effects of message modification on memory and liking for the person described. *Journal of Experimental Social Psychology, 14,* 363-378.

Hinsz, V. B., Tindale, R. S., & Vollrath, D. A. (1997). The emerging conceptualization of groups as information processors. *Psychological Bulletin, 121,* 43-64.

Hirst, W., & Manier, D. (2008). Towards a psychology of collective memory. *Memory, 16,* 183-200.

Ichikawa, J. J. & Steup, M. (2014). The analysis of knowledge. In Edward N. Zalta (Ed.), *The Stanford Encyclopedia of Philosophy* (spring 2014 ed.). Retrieved from http://plato.stanford.edu/entries/knowledge-analysis/

Kerr, N. L., MacCoun, R. J., & Kramer, G. P. (1996). Biases in judgment: Comparing individuals and groups. *Psychological Review, 103,* 687-719.

Kimmerle, J., Cress, U., & Held, C. (2010). The interplay between individual and collective knowledge: Technologies for organisational learning and knowledge building. *Knowledge Management Research & Practice, 8,* 33-44.

Kimmerle, J., Gerbing, K.-K., Cress, U., & Thiel, A. (2012). Exchange of complementary and alternative medical knowledge in sport-related Internet fora. *Sociology of Sport Journal, 29,* 348-364.

Kimmerle, J., Moskaliuk, J., Cress, U., & Thiel, A. (2011). A systems theoretical approach to online knowledge building. *AI & Society: Journal of Knowledge, Culture and Communication, 26,* 49-60.

Kimmerle, J., Moskaliuk, J., Harrer, A. & Cress, U. (2010). Visualizing co-evolution of individual and collective knowledge. *Information, Communication and Society, 13,* 1099-1121.

Kimmerle, J., Moskaliuk, J., Oeberst, A., & Cress, U. (in press). Learning and collective knowledge construction with social media: A process-oriented perspective. *Educational Psychologist.*

Kitcher, P. (1990). The division of cognitive labor. *The Journal of Philosophy, 87,* 5-22.

Klemke, E.D. (1979). Karl Popper, objective knowledge, and the third world. *Philosophia, 9,* 45-62.

Klimoski, R., & Mohammed, S. (1994). Team mental model: Construct or metaphor? *Journal of Management, 20,* 403-437.

Knorr-Cetina, K. (1981). *The manufacture of knowledge: An essay on the constructivist and contextual nature of science.* New York, NY: Pergamon Press.

Kuhn, T. S. (1962). *The structure of scientific revolutions.* Chicago, IL: University of Chicago Press.

Kusch, M. (2002a). Testimony in communitarian epistemology. *Studies in History and Philosophy of Science, 33,* 335-354.

Kusch, M. (2002b). *Knowledge by agreement: The programme of communitarian epistemology.* Oxford, UK: University Press.

Lakatos, I. (1970). Falsification and the methodology of scientific research programmes. In I. Lakatos & A. Musgrave (Eds.), *Criticism and the growth in knowledge.* London, UK: Cambridge University Press.

Larson, J. R., Jr., & Christensen, C. (1993). Groups as problem-solving units: Toward a new meaning of social cognition. *British Journal of Social Psychology, 32,* 5-30.

Lehrer, K. (1987). Personal and social knowledge. *Synthese, 73,* 87-107.

Lindner, I., Echterhoff, G., Davidson, P. S. R., & Brand, M. (2010). Observation inflation: Your actions become mine. *Psychological Science, 21,* 1291-1299.

Luhmann, N. (1984). *Soziale Systeme. Grundriß einer allgemeinen Theorie* [Social systems. Outline of a general theory]. Frankfurt am Main, Germany: Suhrkamp.

Luhmann, N. (1990). *Die Wissenschaft der Gesellschaft* [Science as a social system]. Frankfurt am Main, Germany: Suhrkamp.

Maier, J., & Richter, T. (2014). Verstehen multipler Texte zu kontroversen wissenschaftlichen Themen: Die Rolle der epistemischen Validierung. *Unterrichtswissenschaft, 42,* 24-38.

Mandl, H. & Spada, H. (1988). *Wissenspsychologie* [The Psychology of Knowledge]. Weinheim, Germany: Beltz.

Matthiessen, H. O., & Willaschek, M. (2009). Epistemische Rechtfertigung. In H. J. Sandkühler (Ed.), *Enzyklopädie Philosophie* (3rd ed.). Hamburg, Germany: Meiner.

Maturana, H. R, & Varela, F. J. (1987). *The tree of knowledge: The biological roots of human understanding*. Boston, MA: New Science Library / Shambhala Publications.

Moskaliuk, J., Kimmerle, J., & Cress, U. (2009). Wiki-supported learning and knowledge building: Effects of incongruity between knowledge and information. *Journal of Computer Assisted Learning, 25,* 549-561.

Moussavi, F., & Evans, D. A. (1993). Emergence of organizational attributions: The role of a shared cognitive schema. *Journal of Management, 19,* 79-95.

Oeberst, A. (2012). If anything else comes to mind… better keep it to yourself? Delayed recall is discrediting – unjustifiably. *Law and Human Behavior, 36, 2*66-274.

Oeberst, A. & Blank, H. (2012). Undoing suggestive influence on memory: The reversibility of the misinformation effect. *Cognition, 125,* 141-159.

Oeberst, A., Halatchliyski, I., Kimmerle, J., & Cress, U. (2014). Knowledge construction in Wikipedia: A systemic-constructivist analysis. *Journal of the Learning Sciences, 23,* 149-176.

Paalova, S., & Hakkarainen, K. (2005). The knowledge creation metaphor – An emergent epistemological approach to learning. *Science & Education, 14,* 535-557.

Pappas, G. (2009). Internalist vs. externalist conceptions of epistemic justification. In E. N. Zalta (Ed.), *The Stanford encyclopedia of philosophy* (spring 2009 ed.). Retrieved from http://plato.stanford.edu/entries/justep-intext/

Peressini, A. (2008). Proof, reliability, and mathematical knowledge. *Theoria, 69,* 211-232.

Petty, R. E., & Cacioppo, J. T. (1986). The elaboration likelihood model of persuasion. *Advances in Experimental Social Psychology, 19,* 123-205.

Piaget, J. (1977). *The development of thought: Equilibration of cognitive structures*. New York, NY: Viking Press.

Pohl, R. F. (2004). *Cognitive illusions: A handbook on fallacies and biases in thinking, judgement and memory*. Hove, UK: Psychology Press.

Popper, K. R. (1968). Epistemology without a knowing subject. *Studies in Logic and the Foundations of Mathematics, 52,* 333-373.

Popper, K. R. (1970). *Die offene Gesellschaft und ihre Feinde* [The open society and its enemies]. Bern, Switzerland: Francke.

Popper, K. R. (1972). *Objective knowledge: An evolutionary approach*. Oxford, UK: Clarendon Press.

Popper, K. R. (1978). *Three worlds: The Tanner lecture on human values.* Lecture delivered at the University of Michigan, April 7, 1978. Retrieved from http://tannerlectures.utah.edu/_documents/a-to-z/p/popper80.pdf

Putnam, H. (1975). The meaning of 'meaning'. *Minnesota Studies in the Philosophy of Science, 7,* 131-193.

Reber, R., & Unckelbach, C. (2010). The epistemic status of processing fluency as source for judgments of truth. *Review of Philosophical Psychology, 1,* 563-581.

Resnick, L. B., Levine, J. M., & Teasley, S. D., (Eds.). (1991). *Perspectives on Socially Shared Cognition.* Washington, DC: American Psychological Association.

Richter, T. (2003). *Epistemologische Einschätzungen beim Textverstehen* [Epistemological evaluations in text understanding]. Lengerich, Germany: Pabst.

Russell, B. (1910). Knowledge by acquaintance and knowledge by description. *Proceedings of the Aristotelian Society, 11,* 108-128.

Salomon, G. (Ed.). (1993). *Distributed cognitions.* Cambridge, UK: Cambridge University Press.

Scardamalia, M. & Bereiter, C. (1999). Schools as knowledge building organizations. In D. Keating & C. Hertzman (Eds.), *Today's children, tomorrow's society: The developmental health and wealth of nations* (pp. 274-289). New York, NY: Guilford.

Scardamalia, M. & Bereiter, C. (2010). A brief history of knowledge building. *Canadian Journal of Learning and Technology, 36*(1). Retrieved from http://www.cjlt.ca/index.php/cjlt/article/view/574/276

Schiffer, S. (1996). Contextualist solutions to skepticism. *Proceedings of the Aristotelian Society, New Series, 96,* 317-333.

Schroeder, S., Richter, T., & Hoever, I. (2008). Getting a picture that is both accurate and stable: Situation models and epistemic validation. *Journal of Memory and Language, 59,* 237-255.

Shaw, J., & Porter, S. (2015). Constructing rich false memories of committing crime. *Psychological Science.* Advance online publication. doi:10.1177/0956797614562862

Sperling, M., & Schmidt, T. (2009). *Allgemeine Psychologie kompakt - Wahrnehmung, Aufmerksamkeit, Sprache, Denken.* Weinheim, Germany: Beltz.

Sporer, S. L., Penrod, S. D., Read, J. D., & Cutler, B. L. (1995). Choosing, confidence, and accuracy: A meta-analysis of the confidence-accuracy relation in eyewitness identification studies. *Psychological Bulletin, 118,* 315-327.

Steck, P., Hermanutz, M., Lafrenz, B., Schwind, D., Hettler, S., Maier, B., & Geiger, S. (2010). Die psychometrische Qualität von Realkennzeichen *[Psychometric characteristics of the criteria based content analysis]*. Retrieved from http://serwiss.bib.hs-hannover.de/frontdoor/index/index/docId/263

Steffens, M. C., & Mecklenbräuker, S. (2007). False memories. Phenomena, theories, and implications. *Journal of Psychology, 215,* 12-24.

Thompson, L. & Fine, G. A. (1999). Socially shared cognition, affect, and behavior: A review and integration. *Personality and Social Psychology Review, 3,* 278-302.

Tulving, E. (1985a). How many memory systems are there? *American Psychologist, 40,* 385-398.

Tulving, E. (1985b). Memory and consciousness. *Canadian Psychology, 25,* 1-12.

Tulving, E. (1987). Multiple memory systems and consciousness. *Human Neurobiology, 6,* 67-80.

Tulving, E. (1989). Memory: Performance, knowledge, and experience. *Journal of Cognitive Psychology, 1,* 3-26.

Vahid, H. (1998). Deontic vs. nondeontic conceptions of epistemic justification. *Erkenntnis, 49,* 285-301.

Vicente, K. J., & Brewer, W. F. (1993). Reconstructive remembering of the scientific literature. *Cognition, 46,* 101-128.

von Foerster, H. (2003). *Understanding understanding: Essays on cybernetics and cognition*. New York, NY: Springer.

Vygotsky, L. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Wegner, D. M., Erber, R., & Raymond, P. (1991). Transactive memory in close relationships. *Journal of Personality and Social Psychology, 81*, 923-929.

Wilson, R. A., & Keil, F. C. (1999). *The MIT encyclopedia of the cognitive sciences.* Cambridge, MA: MIT Press.

Womack, C. A. (1993). The crucial role of proof: A classical defense against mathematical empiricism. *Doctoral Dissertation at the Massachusetts Institute of Technology.* Retrieved from http://dspace.mit.edu/handle/1721.1/12678

Wood, J. M., & Nezworski, M. T. (2005). Science as a history of corrected mistakes. *American Psychologist*, *60*, 657-658.