

Running heading: EPISTEMIC BELIEFS REVIEW NORWAY

Epistemic Beliefs and Their Relation to Multiple Text Comprehension: A Norwegian
Program of Research

Leila E. Ferguson

University of Oslo

Correspondence should be addressed to Leila E. Ferguson, Department of Educational
Research, University of Oslo, P.O. Box 1092 Blindern, N-0317 Oslo, Norway. Telephone:
228 57 637. E-mail: l.e.ferguson@iped.uio.no

Abstract

Nowadays, students are required to use multiple information sources to complete tasks, both in and out of school. The beliefs that students hold about knowledge and knowing, their epistemic beliefs, have been linked to successful integration of information across multiple texts. Framed by literature on epistemic belief research from an educational psychology perspective, this article reviews a recent Norwegian program of research on students' epistemic beliefs. The research has implications for educational research and practice that are discussed.

Keywords: Epistemic Beliefs; Multiple Text Comprehension; Program of Research; Review

Introduction

Nowadays, students have instant access to information about virtually any topic, literally, in their pocket (Torgersen, 2004). This, of course, has implications for educational research. Particularly in the field of educational psychology, the digital and information explosions that characterise the modern era (Abelson, Ledeen, & Lewis, 2008) have led to a flourish of research on two related areas, those being epistemic beliefs and multiple text comprehension research, respectively. While *epistemology* refers to the study of theoretical and definitional matters of knowledge in a philosophical sense (i.e., the study of knowledge and, specifically, how claims of knowledge can be justified); educational researchers' use of the terms *personal epistemology* and *epistemic beliefs* describes individuals' (i.e., laypersons') personal views or theories about knowledge and knowing in a more general sense (i.e., beliefs relating to knowledge and knowing that may influence task definition, metacognition and strategy use; Greene, Azevedo, & Torney-Purta, 2008), or personal theories about the nature of knowledge (what knowledge is) and the nature of knowing (how one comes to know) (Hofer & Pintrich, 1997; Stahl & Bromme, 2007). Multiple text comprehension research focuses on individuals' attempts to integrate information from materials expressing diverse, even opposing, perspectives on an issue (Bråten, Britt, Strømsø, & Rouet, 2011). In 2011, Bråten and colleagues presented a review of burgeoning empirical evidence addressing the role of readers' epistemic beliefs in the successful comprehension of multiple texts that they surmised in an integrated model. Since that time, a systematic program of research has been carried out at the University of Oslo that has addressed some of the testable hypotheses stemming from Bråten et al.'s model, as well as presenting a need to refine this heuristic. The purpose of this article is to review this program of research and to suggest implications for educational research, in particular the integrated model of epistemic beliefs and multiple text comprehension (Bråten et al., 2011), and educational practice.

That researchers have become interested in students' beliefs about knowledge and knowing and their ability to make sense of multiple information sources at the same time as technological and societal advances have made computers and the Internet integral parts of students' lives is no coincidence. Today's students are the first generation to grow up surrounded by digital technology in the form of the Internet, instant messaging, mobile phones and gaming, and their views of technology differ from their predecessors (Prensky, 2001). But while *accessing* information is no longer a laborious task for today's students; deciding what information to rely on, *validation of knowledge claims*, is a much more cognitively taxing endeavour that is influenced by students' epistemic beliefs.

Imagine, for example, two undergraduate students (Ada and Bob) that are searching the Internet for information about possible health risks from using mobile phones in order to help a friend that has been experiencing headaches after talking on her mobile. Ada, a 19-year old newly enrolled bachelor student, with limited knowledge about radiation and how mobile phones send and receive messages, realises that knowledge about mobile phones and health risks is uncertain and that experts hold conflicting views, attributing this to the relatively short time that mobiles phones have been in use. Ada displays little reading engagement or attempts to resolve the issue for her friend, rather resigning to the temporary and indeterminable state of the question. Contrarily, Bob, 21, also a new bachelor student with limited subject-matter knowledge, also experiences that the information he reads is uncertain and contradictory, but rather than accepting this he tries to resolve the complex issue by cross-checking and integrating information from the different texts to build an informed account of the matter. In this way, Bob's adaptive epistemic beliefs (his belief that knowledge is tentative and evolving and knowledge claims have to be checked against competing claims and corroborated in ill-structured domains) contribute to him developing a well-grounded understanding of the complex matter so that he is able to advise his friend.

The foregone examples are adapted from case studies on Norwegian students' epistemic beliefs while they worked with multiple digital information sources (Ferguson, Bråten, & Strømsø, 2012). Today's students may be deemed digital natives since they have grown up with technology as an integral part of their lives, but the apparent intuition in dealing with technology that students seem to possess does not mean that integral skills for dealing with complex information develop organically (cf. Seljö, 2012). Rather, adaptive beliefs and skills like critically evaluating and integrating different perspectives must be fostered through education or interventions (Bennett, Maton, & Kervin, 2008; Greene & Yu, 2014; Kuhn & Pease, 2008).

To date, research has demonstrated that epistemic beliefs are related to students' learning and performance, in particular, online learning (Bråten, 2008; Mason, Boldrin, & Ariasi, 2010a), goal-orientation (Brandmo, 2011), self-regulated learning (Muis, 2007), scientific- (Yang & Tsai, 2010) and critical thinking (Kuhn & Pease, 2008), attention to and use of source information in argumentation (Strømsø, Bråten, Britt, & Ferguson, 2013) and comprehension of single- and multiple-texts (Afflerbach, Cho, Kim, Crassas, & Doyle, 2013; Bråten et al., 2011; Bråten, Strømsø, & Ferguson, in press; Rukavina & Daneman, 1996; Schommer, 1990), all of which are integral skills in successfully orientating oneself in today's jungle of information. Based on the important role of epistemic beliefs for students' performance in general, and their multiple text comprehension in particular, increased attention to these areas is merited. The main aim of this article is to give an overview of a recent Norwegian program of research on students' epistemic beliefs and multiple text comprehension. This systematic program of research has theoretical, research and educational implications, therefore meriting review. In the next sections, research on epistemic beliefs and multiple text comprehension are presented as a backdrop to the review that will form the main body of the argument for further discussion.

Research on students' epistemic beliefs

Dimensionality and assessment

In recent years, the study of personal epistemology has evolved into an active research area that is mainly concerned with the study of individuals' beliefs about knowledge and knowing (Greene et al., 2008). Traditionally, research has been divided in two main paradigms: Developmental psychologists have been most interested in describing individuals' progression through proposed stages of epistemic belief development, and educational psychologists have rather focussed on identifying dimensions of beliefs and investigating how these relate to aspects of cognition and learning. Worth noting, is that developmental and systems of beliefs research should not be considered opposing approaches, since the features that typify each stage in developmental theories are often described in terms of the constructs or dimensions that are studied in systems of beliefs research (Chinn, Buckland, & Samarapungavan, 2011; Hofer, 2004). In this section, key investigations of students' epistemic beliefs are presented as a back-drop for recent Norwegian research:

The foundation for much work on the development of epistemic beliefs in student populations was provided by Perry (1970). The original focus of Perry's study was not epistemic beliefs per se, but the resulting framework portrays successively more adaptive ways of viewing knowledge and knowing, generally coinciding with participants' higher-education experience. Based on a series of interviews with male undergraduates from Harvard over a four year period, Perry identified a pattern of development in students' thinking and interpretation of their academic lives and knowledge. Although Perry's developmental scheme has been challenged due to its all-male sample from an elite university (Belenky, Clinchy, Goldberger, & Tarule, 1986), studies based on all female (Belenky et al., 1986) and mixed populations (Kuhn, Cheney, & Weinstock, 2000) have uncovered similar developmental patterns in students' ways of understanding knowledge. Perry's nine original

positions are generally represented in three or four developmental stages, for example, realist (or preabsolutist), absolutist, multiplist and evaluativist (Kuhn et al., 2000).

According to Kuhn et al. (2000), while realists believe there is correspondence between external reality and truth, the dawning awareness of others' perspectives that occurs in the early years rapidly leads to development of absolutist views. At the absolutist stage, knowledge is still viewed as certain and unconditional, requiring no justification other than on the basis of authority and knowledge (and those who make claims to holding knowledge) is (are) either correct or incorrect. At the next developmental stage, multiplists' increasing recognition of the uncertain nature of knowledge and the beginnings of doubt that true knowledge exists lead to views of own opinion as equally valid to those of others; since knowledge is something that is generated in the human mind and is therefore uncertain and relative. While uncertainty and tentativeness are still acknowledged by evaluativists, the few students that reach this stage will have gained a greater understanding of the constructed nature of knowledge, and the way in which it has to be justified in light of competing theories and supporting evidence. Therefore, evaluativists appreciate well-grounded, justified knowledge claims, for example, when forming their own argument. Further, emerging epistemic beliefs, as described by this developmental model, are closely linked to students' intellectual performance and critical thinking (Kuhn & Pease, 2008; Kuhn et al., 2000).

Developmental models are generally wide in scope, also tending to encompass students' beliefs about learning and teaching. While Schommer (1990) continued this tradition in the domain of educational psychology, by focussing on beliefs about learning and ability as well as beliefs about knowledge; her approach deviated substantially from that of developmental psychologists' by strength of her proposal that, rather than developing in universal stages, beliefs might be more nuanced and made up of distinct dimensions that develop in a non-synchronised manner. Schommer's research not only marked the beginning

of systems of beliefs views of students' epistemic beliefs, her approach also allowed for quantitative investigation using paper-and-pencil (or indeed, electronic) questionnaires. In this way, Schommer further instigated investigation into more or less independently developing epistemic dimensions. Schommer labelled these dimensions structure, stability and source of knowledge and ability and speed of learning, which are each considered to reflect a continuum of beliefs. Subsequent factor analyses have typically yielded four factors relating to fixed ability, ranging from the idea that intelligence is given and fixed, to views of intelligence as an entity that can be improved; quick learning, entails views that learning may occur quickly or not at all, to the idea that learning occurs at a gradual pace; simple knowledge, varying from regarding knowledge as consisting of isolated facts to interrelated webs of knowledge; and certain knowledge, from views of knowledge as absolute and fixed to tentative and evolving (Hofer & Pintrich, 1997). Schommer also investigated relations between dimensions of beliefs and students' learning and text comprehension, for example, showing that students with beliefs in certain knowledge drew inappropriate conclusions when reading (socio-) scientific texts that lacked a concluding paragraph. However, Schommer's conceptualisation has been described as sample-dependent (DeBacker, Crowson, Beesley, Thoma, & Hestevold, 2008) and other researchers have failed to replicate this factor structure.

Thus, in a seminal paper that synthesised existing research by developmental and educational psychologists, Hofer and Pintrich (1997) acknowledged that while there may be a close relation between students' epistemic beliefs and their beliefs about learning and teaching, these are conceptually distinct constructs. Further, Hofer and Pintrich's review of the field of research led to the view of epistemic beliefs as consisting of two core sets of concerns relating to 1) the nature of knowledge, the relative certainty and simplicity of knowledge, and 2) the nature of knowing, concerning beliefs about the source and justification for knowing. Similar to Schommer's conceptualisation, each dimension is

believed to exist on a continuous scale, with the certainty of knowledge dimension corresponding to Schommer's "stability", ranging from viewing knowledge as absolute and unchanging to tentative and evolving in nature. Simplicity beliefs, in likeness with Schommer's "structure", ranges from viewing knowledge as consisting of an accumulation of more or less isolated facts to viewing knowledge as consisting of interrelated concepts. Further, the source of knowledge dimension ranges from conceiving knowledge as originating outside the self in an external authority, from where it may be transmitted, to conceiving knowledge as actively constructed by the person in interaction with others, while justification for knowing ranges from verification of knowledge claims through observation and authority, or on the basis of what feels right, to the use of rules of inquiry and the evaluation and integration of different sources. Thus, Hofer and Pintrich (1997) theoretically disentangled the constructs of beliefs about learning and teaching from epistemic beliefs, while continuing to support the notion that there are close relations between beliefs about knowledge, learning and teaching.

The four dimensions of certainty, simplicity, source and justification have been the starting point for several empirical investigations. However, they have not consistently been identified in factor analytical studies (Bråten, Gil, Strømsø, & Vidal-Abarca, 2009; Hofer, 2000; Kienhues, Bromme, & Stahl, 2008) and there is disagreement as to whether these dimensions lie at the heart of students' considerations of knowledge and knowing, or that they are in accordance with the concept's philosophical roots. For example, Stahl and Bromme (2007) and Trautwein and Lüdtke (2007) argue that the core of students' epistemic beliefs lies in establishing *what is certain or truthful*. In support of this argument, using a semantic differential questionnaire consisting of word pairs that might describe knowledge claims in specific domains (e.g., definite – ambiguous, connected – divided, temporary – everlasting), Stahl and Bromme uncovered a two-factor structure adhering to the *texture* (relative structure

and accuracy) and *variability* (relative stability and dynamics) of knowledge. Stahl and Bromme's argumentation also seems to align with a study of dimensionality and disciplinary differences in students' epistemic beliefs that was carried out by Hofer (2000), in which certainty and attainability of truth emerged as separate factors.

Despite its potential shortcomings, Hofer and Pintrich's four dimension model continues to be the basis of much research on epistemic beliefs, including Bråten et al.'s integrated model of epistemic beliefs and multiple text comprehension, as presented below (see section on *epistemic beliefs and multiple text comprehension*). However, the study of epistemic beliefs continues to be characterised by divergent approaches, conceptualisation and findings. This recently led Greene and his colleagues (2008; Greene, Torney-Purta, & Azevedo, 2010b) to their suggestion that educational psychologists should rather pay more attention to the original philosophical study of epistemology, which entails a strong focus on epistemic justification and finding out how one knows, that is, what external and internal sources of knowledge can be relied on. Therefore, as part of a program of research to integrate developmental, systems of belief and philosophical considerations of epistemology, Greene and his colleagues rejected the inclusion of certainty and simplicity in the realm of epistemology and rather centred on the justification dimension of epistemic beliefs, which, they argued is the only dimension that deserves to be labelled epistemic. Further, Greene et al. argue that different forms of justification should be split into separate dimensions, since an individual may endorse some methods of justification more than others in different contexts. Thus, Greene and colleagues differentiate between *justification by authority*, which entails reliance on external sources of knowledge, and *personal justification*, that is, internal sources such as gut-feeling or prior knowledge as a way of validating knowledge claims. Also, while Greene et al. acknowledge that students' justification beliefs may vary as a function of their beliefs about the nature of knowledge (i.e., *certainty/simplicity*), they refer to these beliefs as

ontological in nature (i.e., views about the categorisation of reality) and combine them in a single dimension.

Greene et al.'s (2008) epistemic and ontological cognitive development model sets out positions that describe individuals' beliefs about knowledge claims at different stages, but rather than applying universally, the researchers propose that development occurs at the domain level (i.e., beliefs are specifically related to distinct knowledge domains, such as history or biology). Noteworthy is the model's separation of epistemic and ontological cognition at a theoretical level while continuing to denote the importance of studying both constructs at a psychological level. Greene and colleagues' movement towards a more philosophically-informed understanding of epistemology has also been supported by Chinn and colleagues (2011), who call for a wider-scoped approach to the psychological study of epistemic beliefs, which, they claim, has largely ignored its philosophical roots. In addition to studying the structure, source and justification of knowledge, Chinn et al. propose educational psychologists should pay attention to students' epistemic aims (such as acquiring knowledge, understanding and true beliefs) and epistemic values (or the worth of epistemic aims), as well as epistemic virtues (that aid the acquisition of knowledge, e.g., intellectual carefulness) and vices (that hinder knowledge acquisition, e.g., need for closure), and more or less reliable ways of achieving epistemic aims (e.g., argumentation or various cognitive strategies). Chinn and colleagues recently proposed a way of assessing their conceptualisation of epistemic beliefs (Chinn, Rinehart, & Buckland, 2014), and preliminary findings by Greene and Yu (2014) suggest that the framework may be useful for informing coding schemes in think aloud studies.

Nowadays educational psychologists tend to agree that individuals hold general underlying beliefs (about knowledge in general), as well as domain-specific, for example, beliefs about history or mathematics, (Muis, Bendixen, & Haerle, 2006) and even topic-

specific beliefs, such as beliefs about climate change (Strømsø, Bråten, & Samuelstuen, 2008). The level of specificity at which epistemic beliefs exist and occur also has important implications for how they may be captured by tools of assessment. Regarding empirical measurement of epistemic beliefs, researchers approaching the matter from a developmental perspective have mainly relied on use of interviews, vignettes and scenarios that require students to reflect over problems that are designed to elicit views about the nature of knowledge and knowing, leaving the task of identifying prevalent epistemic stances or approaches in the students' thinking to the researcher (Perry, 1970; Warren, Kuhn, & Weinstock, 2010). Educational psychologists have also made use of interviews (Bendixen, 2002; Greene, Torney-Purta, Azevedo, & Robertson, 2010c), but a more commonly employed method is use of questionnaires that require students to rate statements on Likert-type scales (Schommer, 1990). Questionnaires tend to capture specific dimensions of beliefs on the basis of the researchers' theoretical orientation, and while they are easily administered to large populations, allowing for investigation into psychometric properties including reliability and generalization, unstable factor structures and low internal consistency have posed problems for research (DeBacker et al., 2008). Another data-collection method that has been increasingly used in recent research among educational psychologists is the *think aloud* (Ericsson & Simon, 1980; 1993). Think-alouds require students to articulate their cognition (or think aloud) as they carry out a task, while the researcher has the job of identifying statements that relate to beliefs about knowledge and knowing (Hofer, 2004; Mason, Boldrin, & Ariasi, 2010b). Other online methods such as eye-tracking, trace or navigational data have also been used to assess how students direct their attention during particularly complex tasks, allowing for inferences about underlying beliefs on the basis of overt behaviour (Greene, Muis, & Pieschl, 2010a; Gerjets, Kammerer, & Werner, 2011).

While a more detailed account of methods used to identify students' epistemic beliefs' is out with the scope of the present article, useful discussions may be found in Greene et al., (2010b, 2010c) and Wood and Kardash (2002). It is worth mentioning, however, that different methods of investigation may be more suitable for capturing specific dimensions of students' epistemic beliefs. For example, self-assessment methods such as questionnaires may say more about students' underlying beliefs about the nature of knowledge and how they think they handle competing knowledge claims (a type of *best-practice* report), whereas online tasks where students actually have to handle conflicting information may be more informative about students' beliefs in practice (i.e., beliefs in action or *actual practice*; cf. Kammerer, Bråten, Gerjets, & Strømsø, 2013), which may be worth considering when investigating relations between students' epistemic beliefs and related outcomes, such as multiple text comprehension.

Epistemic beliefs and multiple text comprehension

While numerous models of single and multiple text comprehension have been forwarded, a commonality for the majority are roots in Kintsch's Construction-Integration model (C-I model, Kintsch, 1988, 1998; and see McNamara & Magliano, 2009 for comprehensive overview). The C-I model presupposes that deep comprehension of written material involves integration of the text-internal meaning (the textbase) with the reader's prior knowledge, to construct an interpretation of the situation described in the text (the situation model). Extending that model to account for successful comprehension of situations described in multiple texts, Britt and colleagues (Britt, Perfetti, Sandak, & Rouet, 1999; Perfetti, Rouet, & Britt, 1999) proposed that, in addition to a textbase and situation model for each text, two additional levels of representation, the intertext model and the mental model, are constructed at a global level (i.e., for all texts).

Essentially, the intertext model consists of source information for each text, including form (type of document, date of publication), author (qualifications, affiliation) and goals or motivations of text (intended audience), with source information for each text being linked to text content, helping the reader to remember which claims were set forward by which author (or source). In this way the intertext model facilitates maintenance of a global meaning even for conflicting or seemingly incoherent sets of texts (Britt et al., 1999; Britt, Rouet, & Braasch, 2013; Perfetti et al., 1999). The mental model describes the integrated mental representation of the situation(s) being described across texts, essentially the situation model component of Kintsch's theory of comprehension applied to a multiple text reading context. Worth noting, is Britt and colleagues' presumption that mental models will be structured around argument schema (rather than a narrative structure) when students read about controversial scientific issues. Although Britt and colleagues' documents model is not alone in its attempts to describe multiple text comprehension, it is currently that which is best able to account for research findings and therefore enjoys supremacy in the field of educational psychology.

There is burgeoning evidence that the beliefs readers hold about knowledge and knowing are related to their ability to gain an integrated understanding of complex issues represented in multiple texts, which has prompted Afflerbach and colleagues (2013) to call for an extension of models of text comprehension to include readers' epistemic beliefs. This call is mirrored by at least two theoretical contributions to the literature: Alexander and the Discipline Reading and Learning Research Laboratory's (2012) conceptualization of competent reading for the 21st century and Bråten and colleagues' (2011) integrated model of epistemic beliefs and multiple text comprehension. While Alexander and colleagues' (2012) multidimensional conceptualization includes expertise (knowledge, strategies and personal interest) and epistemic beliefs, in the form of "acknowledgement of the authored nature of

texts and the need to justify one's interpretation of the meaning of text" (p.265). Bråten and colleagues (2011) have forwarded a heuristic for considering of the role of epistemic beliefs in multiple text comprehension, by situating existing empirical evidence in the frameworks of Hofer and Pintrich's model of personal epistemology (1997) and Britt and colleagues' documents model (Britt et al., 1999; Perfetti et al., 1999; Rouet, 2006), respectively.

Based on a review of empirical research, Bråten and colleagues (2011) proposed that there may be links between all four of the epistemic dimensions featuring in Hofer and Pintrich's (1997) model and Britt and colleagues' (1999) documents model. In particular, Bråten and colleagues supposed that simplicity and justification beliefs are most relevant for development of readers' intertext model. For example, a reader that believes that knowledge is theoretical and complex (rather than factual and simple) is likely to display more cross-text elaboration and overview generation, and a belief in the need to justify knowledge claims through cross-checking of knowledge claims, reason, and rules of inquiry would likely be related to more use of metacognitive strategies, more criteria to justify knowledge claims, and higher trust in scientific text. Moreover, certainty and source beliefs are deemed to influence mental model construction, for example, the belief that knowledge is evolving and tentative should be associated with more inclusion of uncertain information, and better cross-text comprehension and integration, and the belief that knowledge is attained from experts should lead to higher trust in information in the texts, and less reliance on own opinion.

Not only did the Bråten et al. (2011) article provide a theoretical basis for explaining existing empirical findings that epistemic beliefs and multiple text comprehension were related (e.g., Bråten et al., 2009; Gil, Bråten, Strømsø, & Vidal-Abarca, 2010; Hagen, Strømsø, & Bråten, 2009; Jacobson & Spiro, 1995), it also gave grounds to testable hypotheses concerning these relations and direction for the program of research that is reviewed in this article (see *Review* section). Importantly, Bråten et al. (2011) also raised the

question of a possible bidirectional relation between epistemic beliefs and multiple text comprehension. That is, in addition to students' epistemic beliefs predicting their ability to integrate information across texts, having students grapple with complex issues represented in multiple texts might also be a way of promoting more advanced epistemic beliefs. This empirical question has been the subject of only a few studies using single and multiple text-based approaches, with varying but promising results. Furthermore, the idea of short-term intervention as a way of influencing epistemic beliefs has not only been applauded by prominent educational researchers (Schraw & Sinatra, 2004); it also aligns with the Vygotskian notion that experimentation may expedite developmental processes that normally occur over longer timeframes (Vygotsky, 1978). Thus, the dominant text-based approach to changing epistemic beliefs has included investigation into how the presentation of thought-provoking and conflicting written information in combination with tasks that encourage reflection on the epistemic implications of the materials might lead to changes in students' views about knowledge and knowing (Gill, Ashton, & Algina, 2004; Kienhues et al., 2008; Kienhues, Stadtler, & Bromme, 2011; Porsch & Bromme, 2011; Sandoval & Morrison, 2003; Tsai, 2008; Valinides & Angeli, 2005). For example, Kienhues et al. (2011) presented two groups of students with websites focusing on the medical issue of cholesterol treatment. The groups read 15 websites with consistent or conflicting information, respectively. After reading, the group of students that studied the conflicting information believed less in the possibility that a single, straightforward answer to the issue existed. Moreover, both groups were more likely than a third group that did not read any information at all, to believe that medical knowledge is dynamic and complex, suggesting that the reading of new and complex information was enough to change the students' beliefs about medical knowledge. Similar results have been recorded by researchers using single texts with so-called *epistemic sensitization passages* that highlight the tentative and complex nature of knowledge about the

subject in the text (Porsch & Bromme, 2011), and *refutational texts* that highlight misconceptions or oversimplifications of presentations of knowledge (Gill, et al., 2004; Kienhues et al., 2008), as well as Internet-based inquiry tasks about controversial scientific knowledge (Tsai, 2008).

While there are, at present, too few intervention studies to draw conclusions about the particular elements that invoke change in students' epistemic beliefs, presenting information that leads to dissonance in readers' assumptions while also providing plausible and comprehensible alternative views that are easily adoptable (Kienhues et al., 2008), as well as incorporating engaging, personally-relevant tasks as part of the intervention (Porsch & Bromme, 2011) have been shown to be effective. Thus, having students engage with varied and conflicting sources of information by different authors in a concentrated space and time, either using multiple texts on paper or Internet-based environments may be effective ways of changing beliefs (Greene et al., 2010a; Mason, Boldrin, & Ariasi, 2010a; 2010b; Tsai, 2008). However, others have argued that more explicit discourse and guided reflection about the state of knowledge or scaffolded discourse might be necessary (Bell & Linn, 2002; Linn, Shear, Bell, & Slotta, 1999; Sandoval & Morrison, 2003). For example, Kuhn and Pease (2008) carried out a three year study that focused on development of epistemic and strategic aspects of inquiry skills in students that were followed from fourth to seventh grade. Within computer and researcher-supported learning environments, the students developed an understanding of inquiry as an enterprise that requires coordination of evidence and evolving theories constructed by human minds as well as the importance of supporting claims with evidence, which the researchers attributed to "dense engagement with problems requiring these skills" (Kuhn & Pease, 2008, p 553). What seems important, then, is that information is presented in a way that requires students to engage by grappling or even struggling with

multiple, conflicting views and the evidence that supports them, and to reflect over what this means for their own beliefs.

There have been few attempts to explain how such changes in epistemic beliefs might occur. One notable exception is Bendixen and Rule's (2004) process model of epistemic change, which describes a *mechanism of change* that may be brought to play when individuals become aware of challenges to their current beliefs in personally relevant knowledge domains. That is, in situations where students' encounter new information, knowledge or experiences that make them aware of the inadequacy of existing beliefs, they may also experience feelings of inadequacy, confusion or dissonance, and ultimately doubt existing epistemic beliefs. For students that are willing and motivated (termed *volition*) to change their beliefs, ways of overcoming doubt (termed *resolution strategies*) include contemplation of the possible consequences of accepting new views of knowledge and the eventual adoption of new stances, careful reflection on past experience, or choosing to ignore these uncomfortable feelings and rather adopting a leap of faith attitude in placing faith in a higher authority or reasserting previous beliefs, despite their inadequacies. In light of Bendixen and Rule's model, multiple text settings might be seen as a way of encouraging epistemic doubt and helping students develop more advanced epistemic beliefs.

Review of Norwegian program of research

On the basis of this theoretical and empirical backdrop, a systematic program of research has recently been undertaken at the University of Oslo. The research will be the subject of review in this section and implications of the research will be discussed. The program of research falls into two main strands reflecting the testable hypotheses presented by Bråten et al. (2011) in their review of research on epistemic beliefs and multiple text comprehension; those being, dimensionality of epistemic beliefs, with a specific focus on

justification beliefs, and the bi-directional relation of epistemic beliefs and multiple text comprehension, respectively.

Dimensionality

While the majority of research on epistemic beliefs and multiple text comprehension has been based on Hofer and Pintrich's (1997) multidimensional model, there are empirical and theoretical grounds to suggest that this particular model may not be a valid assessment of students' epistemic beliefs (see *dimensionality and assessment* section). In particular, the justification dimension of Hofer and Pintrich's model has traditionally been difficult to capture in factor analytical studies, and there is little empirical evidence relating this dimension to learning outcomes (Buehl, 2008). Yet, Greene and colleagues (2008) stressed the need to pay more attention to students' beliefs about different means of justification and further proposed that justification beliefs may be viewed as a multidimensional construct. Bråten and colleagues (2011) also noted that a belief in justification through rules of inquiry and the evaluation and integration of multiple sources was linked to multiple text comprehension, but that this notion rests on a broader conceptualization of the justification for knowing dimension than has been common in the research literature stemming from the Hofer and Pintrich model.

Noting this discussion, Ferguson and colleagues (2012), developed and tested a multi-dimensional approach to epistemic belief research with a focus on justification for knowing that built on Greene and colleagues' (2008, 2010) model of epistemic and ontological cognition as the first stage of the Norwegian program of research. Specifically, in addition to the dimensions of personal justification and justification by authority that Greene et al. proposed, the possibility that students draw on multiple sources of information when considering knowledge claims (termed justification by multiple sources) was also considered. Greene and colleagues' notion that dimensions concerning the certainty and simplicity of

knowledge combine to define the nature of knowledge was also incorporated, based on the empirically supported argument that an essential aspect of students' systems of epistemic beliefs addresses the definition of knowledge as certain and factual (cf. Greene et al., 2010b, 2010c; Hofer, 2000; Stahl & Bromme, 2007; Trautwein & Lüdtke, 2007). Specifically, a think aloud study was conducted to investigate whether students' utterances could be categorized using Ferguson and colleagues' multidimensional conceptualization of justification beliefs. Fifty-one first year students read six texts for the purpose of completing the task of advising "*a close friend*" on the matter of her discomfort when using her mobile phone. By segmenting utterances that related to knowledge and the process of validating knowledge claims, Ferguson et al. (2012) identified student verbalizations relating to justification by authority, where students made a reference to reputable information source or scientific proof (e.g., "He also mentioned that it's not been published, which, of course makes the whole study or explanation a little dubious"); personal justification, where students appealed to personal, internal factors (e.g., "I know, at least, that I haven't reacted to any such thing yet"); justification by multiple sources, which included students' attempts to compare or corroborate information across sources (e.g., "And this one builds upon another study, a Finnish one that I think sounds...yes, right away, it seemed more reliable because it builds on others"); and certainty/ simplicity, when students made references that implied that knowledge is something static, factual and simple or dynamic, theoretical and complex (e.g., "...this is not something one is completely sure about, it is just that, they find out new things all the time, and then it is a bit difficult to attach any risk to it"). In this way, Ferguson and colleagues provided evidence that justification is a multidimensional construct that is identifiable in online, think aloud data.

Building on these findings, Ferguson, Bråten, Strømsø, and Anmarkrud (2013) developed an 18-item domain-specific questionnaire (the Justification for Knowing

Questionnaire, JFK-Q) to examine the possibility that the trichotomous justification framework might also be captured using a paper and pencil questionnaire, as is customary in the educational psychology tradition. In addition to the results from the think aloud study, the JFK-Q builds on the epistemic and ontological questionnaire (Greene et al., 2010a) and the topic-specific epistemic belief questionnaire (TSEBQ, Bråten et al., 2009). The JFK-Q was specifically tailored to assess beliefs pertaining to the domain of natural science, and items that were written to assess justification by authority focused on the degree to which students considered persons of authority and scientific evidence to be valid sources of knowledge, for example, *when a scientist says that something is fact, then I believe it*. The personal justification items were considered to address the degree to which students considered personal views and opinions as valid ways of evaluating knowledge claims, for example, *knowledge about natural science is only personal opinion, there are no facts*. Finally, items written to assess students' belief in justification by multiple sources focused on the extent to which students considered it necessary to ensure the veracity of knowledge claims by checking and comparing multiple sources of information, for example, *to detect incorrect claims in texts about natural science, it is important to check several information sources*. Importantly, Ferguson et al. (2013) found the data to have satisfactory psychometric properties, and factor analysis has also confirmed these three justification dimensions in students other in countries (e.g., Kendeou, Braasch, & Bråten, 2014). In sum, the results from these studies suggest that justification for knowing beliefs may be multidimensional, which has implications for models of epistemic beliefs, as well as the integrated model of epistemic beliefs and text comprehension that are presented in the *Discussion* section. The trichotomous justification for knowing framework is further incorporated in each of the studies that follow.

Epistemic beliefs and multiple text comprehension

While there is evidence that epistemic beliefs are related to multiple text comprehension (Bråten et al., 2011) most of the research literature uses Hofer and Pintrich's (1997) model as a point of departure (i.e., the four dimensions of certainty, simplicity, source and justification). Stage two of the Norwegian program of research, represented by the studies that are reviewed in this section, investigated whether there might be links between the multi-dimensional justification beliefs that were identified in the Ferguson et al. studies (2012, 2013) and multiple text comprehension, as assessed by short essay questions and use of sourcing and argumentation in essays. Also, a limited, but growing body of evidence suggests that epistemic beliefs can be fostered through text-based interventions using multiple information sources, that is, the relation between epistemic beliefs and multiple text comprehension might be bidirectional. This question was addressed in two studies (Ferguson et al., 2012, 2013) that are presented at the end of this section.

Bråten, Ferguson, Strømsø and Anmarkrud (2014b) examined verbal protocols from undergraduates thinking aloud about a controversial socio-scientific issue to investigate whether it was possible to relate topic-specific justification beliefs, namely beliefs about personal justification, justification by authority and justification by multiple sources to aspects of multiple text comprehension (namely, sourcing and argumentation), as revealed by essays that students wrote about the topic after reading. Bråten et al. (2014b) showed that the justification by multiple sources dimension, in particular, was a unique positive predictor of students' use of source information, which is important for intertext model construction, and their written argumentation, which might bear witness of construction of integrated mental models. Specifically, a strong belief that knowledge claims have to be evaluated through corroboration and integration across sources seemed to facilitate attention to source information, which is clearly important for intertext model construction, but also for readers' mental models, in the form of argument schema that represent the situation described in the

texts. In this way, the Bråten et al. (2014b) study showed how justification beliefs might be propitious for students' construction of documents models, noting however, that relations between specific justification dimensions and multiple text comprehension were likely context dependent.

Thus in another multiple text study, this time focusing on 10th graders reading about the controversial issue of sun exposure and health, Bråten, Ferguson, Strømsø, and Anmarkrud (2013) aimed to examine the relative importance that young readers attached to each of the justification dimensions, as indicated by their responses on the JFK-Q, as well as the contribution of particular justification beliefs in predicting adolescents' multiple text comprehension. In this particular reading context, Bråten et al. (2013) noted that young students reported placing most trust in authoritative sources of knowledge, such as science teachers and textbooks, and least trust in personal justification, including personal views and opinions, with corroboration of multiple information sources, justification by multiple sources, falling in the middle. The authors noted that this particular "ranking" of authoritative sources as the most warranted source of justification aligned with modern scientific views, while a low belief in personal opinion might well be reasonable within such a domain, where young learners presumably have limited knowledge, whereas corroboration across multiple sources might not be typical for 10th grade science learners. Interestingly, further analysis revealed that justification by multiple sources was also a unique positive predictor of students' multiple text comprehension in this study, with personal justification rather figuring as a unique negative predictor. The researchers concluded that those students who reported a strong belief in justification by multiple sources also performed well on the measure of multiple text comprehension suggested that they also displayed an ability to make inferences across texts, and gain a more structured view of the situation being described in the texts, based on their beliefs, whereas personal justification beliefs' negative contribution to multiple

text comprehension might reflect the students' tendency to rely on own opinion rather than paying attention to the information in the texts. This seems to corroborate the findings of the Bråten et al. (2014b) study, despite a focus on different age groups and reading topic, with the present study also providing extra insight regarding the apparent negative influence of strong personal justification beliefs for multiple text comprehension.

The findings from the Bråten et al. (2013) study are further supported in Ferguson & Bråten (2013). In that study, a person-centred approach (cluster analysis) was adopted to profile students on the basis of the individual difference variables of prior knowledge, and the three justification dimensions that were related to multiple text comprehension. By categorizing young students in this way, both prior to and after their reading of five conflicting texts about a socio-scientific issue, Ferguson and Bråten found that students fell into groups of low knowledge and high personal justification, and high knowledge combined with low personal justification beliefs, respectively. After reading, the majority of students changed their beliefs to display increased knowledge and lower beliefs in personal justification, combined either with higher beliefs in justification by authority or justification by multiple sources. In addition to supporting the existing evidence that specific dimension of justification may be related to multiple text comprehension, the study demonstrated how the specific dimensions of justification and students' knowledge might interact in a complex and context sensitive manner. In particular, low knowledge students seemed to rely more on personal justification, with this being related to incomplete documents models, perhaps due to students' inability or unwillingness to pay attention to textual information. Whereas students with more knowledge that trusted authority scored better than the students with less knowledge and a belief in personal justification, a strong belief in justification by multiple sources appeared to be most beneficial for students' multiple text comprehension. Also

noteworthy is the finding that students were willing to change their beliefs when encountering new and conflicting information.

While the three studies reviewed in this section have shown that specific justification beliefs influence multiple text comprehension, the next two studies were performed as specific responses to Bråten et al.'s (2011) article, specifically regarding possible mediational mechanisms and generalizability of findings. First, Bråten, Anmarkrud, Brandmo, and Strømsø (2014a) developed and tested a model of individual difference variables, process variables and multiple text comprehension in order to further investigate the direct and indirect influence of epistemic beliefs using path analysis when a group of upper secondary students were asked to read five texts about the socio-scientific issue of sun exposure and health. Results showed that the belief in justification by multiple sources displayed a broad influence on the processing variables of effort, deeper level intertextual strategy use, and text-based interest. Thus, Bråten and colleagues provided preliminary evidence of the mediational mechanisms that may be operating between justification by multiple sources and multiple text comprehension, specifically, effort, strategic processing and situated interest.

Second, an interesting and hitherto little researched question regards the generalizability of results about relations between specific dimensions of justification for knowing and multiple text comprehension across different ethnic and cultural backgrounds. Strømsø, Bråten, Anmarkrud, and Ferguson (2014) examined the role of justification beliefs in two groups of upper-secondary students that were matched on the basis of gender and academic achievement in science, yet differed on background (Norwegian or ethnic minority, respectively). Examinations showed significant positive relations between justification by authority and multiple text comprehension, and negative relations between personal justification and multiple text comprehension for the ethnic minority group, whereas no such relation existed in the majority group. Strømsø et al. (2014) thus provided preliminary

evidence that the role of epistemic beliefs in multiple text comprehension may vary between different cultural groups. Thus while the study makes a substantial contribution to our understanding of cultural differences in epistemic beliefs, it also provides insight to the need for more research on the topic in epistemic belief research.

In sum, the results from the foregone studies may contribute to refinement of the integrated model of epistemic beliefs and multiple text comprehension by demonstrating ways that different justification beliefs may be related to multiple text comprehension. Also, the findings may contribute to strengthening Bråten et al.'s (2011) proposal regarding justification beliefs' relation to multiple text comprehension, in showing that such beliefs may influence construction of the intertext- and the mental model, and by further shedding light on possible mediational mechanisms that might be in play (cf. Bråten et al., 2014a).

In the final stage of the current program of research, the possible bidirectional nature of epistemic beliefs and multiple text reading, as suggested by Bråten et al. (2011) and other preliminary findings (Kienhues et al., 2011) was investigated. Ferguson et al. (2012) initially considered the influence of multiple text reading by identifying components of a mechanism of change in think aloud data, finding signs of epistemic doubt, volition and resolution strategies, the three components of a mechanism of change as identified by Bendixen and Rule (2004), and effectively showing that undergraduate students displayed signs of change while reading multiple texts, but ultimately lacking empirical proof, in the form of experimental data. However, this issue was addressed by Ferguson et al. (2013), who conducted a randomised controlled trial in which 10th graders were assigned to the reading of conflicting or consistent documents on sun exposure and health for the purpose of giving a presentation and answering questions. By examining within and between group differences based on students' answers to the JFK-Q before and after reading (at a two week interval), Ferguson and colleagues (2013) were able to show that the reading of conflicting rather than

consistent information resulted in stronger justification by multiple sources beliefs and a stronger belief in the tentative and complex nature about the topic in the texts. As a final step in this study, Ferguson et al. (2013) also showed that the students that read conflicting information and changed their beliefs also outperformed the other group in terms of their ability to comprehend the complex issue as discussed in the texts. Although changes were relatively modest, these studies show that engaging with text sets representing divergent views about complex issues may indeed lead to changes in epistemic beliefs.

Discussion and implications

This article focuses on recent Norwegian research on students' epistemic beliefs and relations to multiple text comprehension. While it is important to see this research in a wider, international context, some implications for educational research can also be drawn.

First, while previous research on epistemic beliefs and multiple text comprehension has mainly focused on the multidimensional construct of epistemic beliefs as proposed by Hofer and Pintrich (1997), the present research expanded on the philosophically inspired model of epistemic and ontological cognition proposed by Greene and colleagues (2008) that focuses on the question of how knowledge claims can be justified. Ferguson and colleagues (2012) identified three dimensions of justification beliefs, including beliefs about personal sources, such as opinion and gut-feeling as a way of justifying knowledge claims (personal justification), placing trust in authoritative, scientific sources (justification by authority) and the belief that knowledge claims must be corroborated by several sources of information (justification by multiple sources), and one dimension of epistemic beliefs that relates to the nature of knowledge, that is beliefs about the relative certainty and simplicity of knowledge in students' verbal protocols generated as they read controversial scientific information expressing divergent perspectives. Ferguson and colleagues (2013) further developed a justification for knowing questionnaire (JFK-Q) that captured the three justification

dimensions. Recently, prominent educational researchers (Chinn et al., 2011; Greene et al., 2008) have suggested that Hofer and Pintrich's (1997) much cited multidimensional model of epistemic beliefs should be expanded. Moreover, Bråten et al. (2011) noted that the conceptualization of justification beliefs that they operated with in the hypothesized model of epistemic beliefs and multiple text comprehension was substantially broader than the conceptualization of justification beliefs than that featuring in Hofer and Pintrich's model. The Norwegian program of research suggests that there are indeed empirical grounds to expand the justification dimension. Specifically, the source and justification dimensions have been merged, but rather than reflecting a single nature of knowing dimension, they are represented in a trichotomous system of beliefs about justification by using different sources of knowledge. Of course, this three dimension system may be dependent on the materials that were used in these studies, and future research might aim to explore the possibility that several other dimensions might be identifiable. One possibility is that philosophical literature might provide further insight to this question (cf. Chinn et al., 2011). Also, there is preliminary evidence to warrant further investigation into how reasonable it might be to maintain the certainty/ simplicity divide, or whether these beliefs rather feature in a singular dimension (Ferguson et al., 2012, 2013; Greene et al., 2008, 2010; Hofer 2000; Kienhues et al., 2011). In sum, this may imply that an integrated model that aims to explain the relation between epistemic beliefs and multiple text comprehension might benefit from using a multidimensional system of justification beliefs as a point of departure, rather than the Hofer and Pintrich (1997) conceptualization.

Second, regarding the specific dimensions of justification that were identified and their relation to multiple text comprehension; while Bråten et al.'s (2011) model suggests that adaptive justification beliefs might include corroboration and attention to source information, and that readers holding such beliefs would be more likely to engage in more metacognitive

thinking, the present program of research has provided insight into the specific nature of this relation. This is done in two main ways: Primarily, the results suggest that a belief in the need to corroborate and integrate information across sources is beneficial for documents model construction, by merit of influence on both the intertext model and the mental model, in terms of a willingness to integrate textual information and organization of information by use of argument schema. At the same time, trust in authoritative sources also seems to be a reliable strategy (Bråten, Strømsø, & Samuelstuen, 2008; Ferguson & Bråten, 2013), whilst a strong belief in personal views and opinions as a valid way of warranting knowledge claims seems to hinder students in paying attention to textual information (Ferguson & Bråten, 2013; Ferguson et al., 2013). Although reliance on authority has traditionally been associated with a less advanced view of knowledge than personal views in educational psychology, this is neither the case in philosophical considerations of epistemology or in modern science, where researchers commonly rely on the findings of their colleagues (Chinn et al., 2011). This finding implies that the integrated model of epistemic beliefs and multiple text comprehension might focus on specific dimensions of justification and offer ways they relate to comprehension with given knowledge domains. It may be the case, however, that such relations depend on other contextual variables, which is of course an empirical question that is still open to research. Secondly, this program of research also uncovered some mediational mechanisms that may be in play between epistemic beliefs and multiple text comprehension. Thus while Bråten and colleagues (2011) hypothesized that a belief in the need to justify knowledge claims through evaluation and integration across sources might be associated with use of deeper level strategies, Bråten et al. (2014a) were able to demonstrate that justification beliefs uniquely contributed to explaining variance in effort, use of deeper strategies, and situational interest, providing a more detailed account of how justification beliefs are actually enacted in multiple text processing that might also be incorporated to the integrated model.

Third, in accordance with Bråten and colleagues' (2011) hypothesis and preliminary research findings (Kienhues et al., 2011), the reviewed program of research gives further grounds to support a possible bidirectional relation between epistemic beliefs and multiple text comprehension. Specifically, the findings presented in this article suggest that having students grapple with multiple conflicting texts might support development of advanced epistemic beliefs, including a stronger belief in the need to corroborate across sources, and a weaker belief in personal means of justification, as well as a stronger belief in the uncertain nature of knowledge, which may be beneficial when reading in the domain of science. Moreover, this development might lead to further dividends for students' ability to make sense of an ill-structured issue that is presented across multiple information sources. While the influence on the reading of multiple conflicting texts is not included in Bråten et al.'s (2011) model, according to Spiro and colleagues (Spiro, Coulson, Feltovich, & Anderson, 1994; Spiro & Jehng, 1990; see also Iordanou, Kendou, & Muis, 2014), "the potential for maximally adaptive knowledge assembly depends on having as full a representation of complexity to draw upon as possible" (Spiro, Coulson, Feltovich, & Anderson, 1988, p.5). Therefore, students that are confronted with diverging perspectives about complex issues and that are able to grasp this complexity, and activate more advanced epistemic beliefs may, in turn, manage to construct well-integrated documents models of the topics that they are reading about. Further, according to Greene and Yu (2014), advanced epistemic beliefs exist when students "recogniz[e] the need to evaluate information for its quality, and [hold] the discipline-appropriate tools to do so (p.4). Appropriate tools in this case might, for example, include knowledge about the different sources of information and their relevance and reliability, deep processing strategies and interest in the matter.

It is vital to underline that the relations that are highlighted by the present review may be sensitive to cultural variation (Strømsø et al., 2014), and other individual differences, such

as the knowledge students hold, might further influence the interplay between justification beliefs and multiple text comprehension (cf. Ferguson & Bråten, 2013). Moreover, the studies in this review all featured reading tasks focusing on socio-scientific issues. Future research should also address multiple text reading in other domains. Two further limitations of the present research should also be noted: First, as is often the case in epistemic belief research using factor analysis, the results regarding dimensionality in this research may be limited by the models that were employed. More online studies and cognitive interviewing will therefore be useful in investigating whether alternative systems of beliefs may be uncovered. Moreover, the present program of research has focused on justification beliefs, and this has come at the cost of forsaking a focus on certainty and simplicity beliefs. While this approach is supported by Greene and colleague's (2008), who propose that certainty/ simplicity beliefs are concerned with establishing the nature of knowledge, and are therefore strictly ontological, this viewpoint is not supported by other researchers (Chinn et al., 2011; Stahl & Bromme, 2007; Trautwein & Lüdtke, 2007). Second, regarding the studies' reliance on correlational data, while the present research exerts efforts in teasing apart the direction of the relation between epistemic beliefs and multiple text comprehension, based on theoretical arguments as well as inclusion of dependent measures, use of correlational data is still insufficient to make firm statements of causality, leaving the question of the relation between epistemic beliefs and multiple text comprehension open to future research. This may take the form of more guided work with scaffolded support and explicit dialogues about epistemic implications of multiple perspectives (Kuhn & Pease, 2008; Sandoval & Morrison, 2003), as well as a pre-intervention evaluation of students' multiple text comprehension.

Despite these limitations, the program of research that is reviewed in this article is systematic and broad, and has implications for educational research (as presented above). On the basis of this review, some speculative educational implications are also offered: The first

is that modern comprehensions skills or “new literacy skills” (Leu, Kinzer, Coiro, & Cammack, 2004) should include a focus on epistemic understanding as well as strategies for dealing with uncertainty (Greene & Yu, 2014). Increased access to information necessitates teaching students to handle diverging opinions and multiple perspectives. This entails complex problem solving skills, critical thinking and an understanding of the evolving and tentative state of knowledge. Second, while the modest outcome of text-based interventions witnessed by this review give grounds for encouragement, the skills and understanding that are described in this article might rather need to develop “gradually in the context of rich practice in activities that entail them” (Kuhn & Pease, 2006, p.514), and educators and researchers should not develop a sense of false security by student performance in relation to singular tasks. Based on the findings in the present research, future research might take the form of targeted interventions in structured classroom environments, or in the form of dialogues about multiple texts that allow space for modelling how to critically evaluate and integrate information from opposing information sources, as well as room for repeated practice. Finally, interventions should also ideally be followed up by assessment of their longevity.

References

- Abelson, H., Ledeen, K., & Lewis, H. (2008). *Blown to bits: Your life after the digital explosion*. Upper Saddle River, NJ: Addison-Wesley.
- Afflerbach, P., Cho, B.-Y., Kim, J.-Y., Crassas, M.E., & Doyle, B. (2013). Reading: What else matters besides strategies and skills? *The Reading Teacher*, 66, 440-448.
- Alexander, P.A., & The Discipline Reading and Learning Research Laboratory. (2012). Reading into the future: Competence for the 21st century. *Educational Psychologist*, 47, 259-280.
- Belenky, M., Clinchy, B., Goldberger, N. R., & Tarule, J. (1986). *Women's ways of knowing: The development of self, mind, and voice*. New York: Basic Books.
- Bell, P., & Linn, M. C. (2002). Beliefs about science: How does science instruction contribute? In B.K. Hofer & P.R. Pintrich (Eds.), *Personal epistemology: The psychology of beliefs about knowledge and knowing* (pp. 321-346). Mahwah, NJ: Erlbaum.
- Bendixen, L.D. (2002). A process model of epistemic belief change. In B.K. Hofer & P.R. Pintrich (Eds.), *Personal epistemology: The psychology of beliefs about knowledge and knowing* (pp. 191-208). Mahwah, NJ: Erlbaum.
- Bendixen, L.D., & Rule, D.C. (2004). An integrative approach to personal epistemology: A guiding model. *Educational Psychologist*, 39, 69-80.
- Bennett, S., Maton, K., & Kervin, L., (2008). The “digital natives” debate: A critical review of the evidence. *British Journal of Educational Technology*, 39, 775-786.
- Brandmo, C. (2011). *Fra ambisjon til prestasjon: En studie av relasjonene mellom epistemiske oppfatninger, motivasjon, bruk av læringsstrategier og akademiske prestasjoner hos økonomistudentene*. [From ambition to performance: A study of the relations between

- epistemic beliefs, motivation, use of learning strategies and academic performance in economics students; in Norwegian]. Published doctoral thesis. Oslo: Unipub.
- Britt, M.A., Perfetti, C.A., Sandak, R., & Rouet, J.-F. (1999). Content integration and source separation in learning from multiple texts. In S.R. Goldman, A.C. Graesser, & P. van den Broek (Eds.), *Narrative, comprehension, causality, and coherence: Essays in honor of Tom Trabasso* (pp. 209-233). Mahwah, NJ: Erlbaum.
- Britt, M.A., Rouet, J.F., & Braasch, J.L.G. (2013). Documents experienced as entities: Extending the situation model theory of comprehension. In M.A. Britt, S.R. Goldman, & J.F. Rouet (Eds.), *Reading from words to multiple texts* (pp. 160-179). New York: Routledge.
- Bråten, I. (2008). Personal epistemology, understanding of multiple texts, and learning within Internet technologies. In M.S. Khine (Ed.), *Knowing, knowledge, and beliefs: Epistemological studies across diverse cultures*. (pp. 351-376). New York: Springer.
- Bråten, I., Anmarkrud, Ø., Brandmo, C., & Strømsø, H.I. (2014a). Developing and testing a model of direct and indirect relationships between individual differences, processing, and multiple-text comprehension. *Learning and Instruction*, 30, 9-24.
- Bråten, I., Britt, M.A., Strømsø, H.I., & Rouet, J.-F. (2011). The role of epistemic beliefs in the comprehension of multiple expository texts: Towards an integrated model. *Educational Psychologist*, 46, 48-70.
- Bråten, I., Ferguson, L.E., Strømsø, H.I., & Anmarkrud, Ø. (2013). Justification beliefs and multiple-documents comprehension. *European Journal of Psychology of Education*, 28, 879-902.
- Bråten, I., Ferguson, L.E., Strømsø, H.I., & Anmarkrud, Ø. (2014b). Students working with multiple conflicting documents on a scientific issue: Relations between epistemic

- cognition while reading and sourcing and argumentation in essays. *British Journal of Educational Psychology*, 84, 58-85.
- Bråten, I., Gil, L., Strømsø, H.I., & Vidal-Abarca, E. (2009). Personal epistemology across cultures: Exploring Norwegian and Spanish university students' epistemic beliefs about climate change. *Social Psychology of Education*, 12, 529-560.
- Bråten, I., Strømsø, H.I., & Ferguson, L.E. (in press). The role of epistemic beliefs in the comprehension of single and multiple texts. In P. Afflerbach (Ed.), *Handbook of Individual Differences in Reading: Text and Context*. New York: Routledge.
- Bråten, I., Strømsø, H.I., & Samuelstuen, M.S. (2008). Are sophisticated students always better? The role of topic-specific personal epistemology in the understanding of multiple expository texts. *Contemporary Educational Psychology*, 33, 814-840.
- Buehl, M.M. (2008). Assessing the multidimensionality of students' epistemic beliefs across diverse cultures. In M.S. Khine (Ed.), *Knowing, knowledge, and beliefs: Epistemological studies across diverse cultures* (pp. 65-112). New York: Springer.
- Chinn, C.A., Buckland, L.A., & Samarapungavan, A. (2011). Expanding the dimensions of epistemic cognition: Arguments from philosophy and psychology. *Educational Psychologist*, 46, 141-167.
- Chinn, C.A., Rinehart, R.W., & Buckland, L.A. (2014). Epistemic cognition and evaluating information: Applying the AIR model of epistemic cognition. In D.N. Rapp & J.L.G. Braasch (Eds.). *Processing Inaccurate Information: Theoretical and Applied Perspectives from Cognitive Science and the Educational Sciences* (pp.425-453). Cambridge, MA: MIT Press.
- DeBacker, T.K., Crowson, H.M., Beesley, A.D., Thoma, S.J., & Hestevold, N.L. (2008). The challenge of measuring epistemic beliefs: An Analysis of three self-report instruments. *The Journal of Experimental Education*, 76, 281-312.

- Ericsson, K.A., & Simon, H.A. (1980). Verbal reports as data. *Psychological Review*, 87, 215–251.
- Ericsson, K. A., & Simon, H. A. (1993). *Protocol analysis: Verbal reports as data*. Cambridge, MA: MIT Press.
- Ferguson, L.E. & Bråten, I. (2013). Student profiles of knowledge and epistemic beliefs: Changes and relations to multiple-text comprehension. *Learning and Instruction*, 25, 49-61.
- Ferguson, L.E., Bråten, I., & Strømsø, H.I. (2012). Epistemic cognition when students read multiple documents containing conflicting scientific evidence: A think-aloud study. *Learning and Instruction*, 22, 103-120.
- Ferguson, L.E., Bråten, I., Strømsø, H.I., & Anmarkrud, Ø. (2013). Epistemic beliefs and comprehension in the context of reading multiple documents: Examining the role of conflict. *International Journal of Educational Research*, 62, 100-114.
- Gerjets, P., Kammerer, Y., & Werner, B. (2011). Measuring spontaneous and instructed evaluation processes during web search: Integrating concurrent thinking-aloud protocols and eye-tracking data. *Learning and Instruction*, 21, 220-231.
- Gil, L., Bråten, I., Vidal-Abarca, E., & Strømø, H.I. (2010). Understanding and integrating multiple science texts: Summary tasks are sometimes better than argument tasks. *Reading Psychology*, 31, 30-68.
- Gill, M.G., Ashton, P.T., & Algina, J. (2004). Changing preservice teachers' epistemological beliefs about teaching and learning in mathematics: An intervention study. *Contemporary Educational Psychology*, 29, 164-185.
- Greene, J.A., Azevedo, R., & Torney-Purta, J. (2008). Modeling epistemic and ontological cognition: Philosophical perspectives and methodological directions. *Educational Psychologist*, 43, 142-160.

- Greene, J.A., Muis, K.R., & Pieschl, S. (2010a). The role of epistemic beliefs in students' self-regulated learning with computer-based learning environments: Conceptual and methodological issues. *Educational Psychologist*, 45, 245-257.
- Greene, J.A., Torney-Purta, J., & Azevedo, R. (2010b). Empirical evidence regarding relations among a model of epistemic and ontological cognition, academic performance, and educational level. *Journal of Educational Psychology*, 102, 234-255.
- Greene, J.A., Torney-Purta, J., Azevedo, R., & Robertson, J. (2010c). Using cognitive interviewing to explore elementary and secondary school students' epistemic and ontological cognition. In L.D. Bendixen & F.C. Feucht (Eds.), *Personal epistemology in the classroom: Theory, research, and implications for practice* (pp. 368-406). Cambridge, UK: Cambridge University Press.
- Greene, J.A. & Yu, S.B. (2014). Modeling and measuring epistemic cognition: A qualitative re-investigation. *Contemporary Educational Psychology*, 39, 12-28.
- Hagen, Å., Strømsø, H.I., & Bråten, I. (2009, August). *Epistemic beliefs and external strategy use when learning from multiple documents*. Paper presented at the biennial conference of the European Association for Research on Learning and Instruction, Amsterdam, The Netherlands.
- Hofer, B.K. (2000). Dimensionality and disciplinary differences in personal epistemology. *Contemporary Educational Psychology*, 25, 378-405.
- Hofer, B.K. (2004). Epistemological understanding as a metacognitive process: Thinking aloud during online searching. *Educational Psychologist*, 39, 43-55.
- Hofer, B.K., & Pintrich, P.R. (1997). The development of epistemological theories: Beliefs about knowledge and knowing and their relation to learning. *Review of Educational Research*, 67, 88-140.

- Iordanou, K., Kendeou, P., & Muis, K. (2014). *Epistemological Understanding and Meta-Level Processing of Evidence When Reading a Science Text*. Submitted manuscript.
- Jacobson, M. J., & Spiro, R. J. (1995). Hypertext learning environments, cognitive flexibility, and the transfer of complex knowledge: An empirical investigation. *Journal of Educational Computing Research*, 12, 301-333.
- Kammerer, Y., Bråten, I., Gerjets, P., & Strømsø, H.I. (2013). The role of Internet-specific epistemic beliefs in laypersons' source evaluations and decisions during Web search on a medical issue. *Computers in Human Behavior*, 29, 1193-1203.
- Kendeou, P., Braasch, J.L.G., & Bråten, I. (2014). *Optimizing Conditions for Learning: Situating Refutations in Epistemic Cognition*. Submitted manuscript.
- Kienhues, D., Bromme, R., & Stahl, E. (2008). Changing epistemological beliefs: The unexpected impact of short-term intervention. *British Journal of Educational Psychology*, 78, 545-565.
- Kienhues, D., Stadtler, M., & Bromme, R. (2011). Dealing with conflicting or consistent medical information on the web: When expert information breeds laypersons' doubts about experts. *Learning and Instruction*, 21, 193-204.
- Kintsch, W. (1988). The role of knowledge in discourse comprehension construction-integration model. *Psychological Review*, 95, 163-182.
- Kintsch, W. (1998). *Comprehension: A paradigm for cognition*. New York: Cambridge University Press.
- Kuhn, D., Cheney, R., & Weinstock, M. (2000). The development of epistemological understanding. *Cognitive Development*, 15, 309-328.
- Kuhn, D., & Pease, M. (2008). What needs to develop in the development of inquiry skills? *Cognition & Instruction*, 26, 512-559.

- Leu, D.J., Jr., Kinzer, C.K., Coiro, J., & Cammack, D.W. (2004). Toward a theory of new literacies emerging from the Internet and other information and communication technologies. In R.B. Ruddell, & N. Unrau (Eds.), *Theoretical models and processes of reading* (5th ed., pp. 1570-1613). Newark, DE: International Reading Association.
- Linn, M., Shear, L., Bell, P., & Slotta, J. (1999). Organizing principles for science education partnerships: Case studies of students' learning about “rats in space” and “deformed frogs”. *Educational Technology Research and Development*, 47, 61-84.
- Mason, L., Boldrin, A., & Ariasi, N. (2010a). Epistemic metacognition in context: Evaluating and learning online information. *Metacognition and Learning*, 4, 67-90.
- Mason, L., Boldrin, A., & Ariasi, N. (2010b). Searching the Web to learn about a controversial topic: Are students epistemically active? *Instructional Science*, 38, 607-633.
- McNamara, D. S., & Magliano, J. P. (2009). Towards a comprehensive model of comprehension. In B. Ross (Ed.). *The psychology of learning and motivation*, 51, (pp. 297-284). New York: Elsevier.
- Muis, K. R. (2007). The role of epistemic beliefs in self-regulated learning. *Educational Psychologist*, 42, 173-190.
- Muis, K. R., Bendixen, L. D., & Haerle, F. (2006). Domain-general and domain-specificity in personal epistemology research: Philosophical and empirical reflections in the development of a theoretical framework. *Educational Psychology Review*, 18, 3-54.
- Perfetti, C. A., Rouet, J.-F., & Britt, M. A. (1999). Toward a theory of documents representation. In H. van Oostendorp & S. R. Goldman (Eds.), *The construction of mental representations during reading*. Mahwah, NJ: Erlbaum.
- Perry, W.G. (1970). *Forms of intellectual and ethical development in the college years: A scheme*. New York: Holt, Rinehart & Winston.

- Porsch, T., & Bromme, R. (2011). Effects of epistemological sensitization on source choices. *Instructional Science*, 39, 805-819.
- Prensky, M. (2001). Digital natives, digital immigrants Part 1. *On the Horizon*, 9, 1-6.
- Rouet, J.-F. (2006). *The skills of document use: From text comprehension to Web-based learning*. Mahwah, NJ: Erlbaum.
- Rukavina, I., & Daneman, M. (1996). Integration and its effect on acquiring knowledge about competing scientific theories from text. *Journal of Educational Psychology*, 88, 272-287.
- Sandoval, W.A., & Morrison, K. (2003). High school students' ideas about theories and theory change after a biological inquiry unit. *Journal of Research in Science Teaching*, 40, 369-392.
- Schommer, M. (1990). Effects of beliefs about the nature of knowledge on comprehension. *Journal of Educational Psychology*, 82, 498-504.
- Schraw, G., & Sinatra, G.M. (2004). Epistemological development and its impact on cognition in academic domains. *Contemporary Educational Psychology*, 29, 95-102.
- Seljö, R. (2012). Literacy, digital literacy and epistemic practices: The co-evolution of hybrid minds and external memory systems. *Nordic Journal of Digital Literacy*, 1, 5-20.
- Spiro, R.J., Coulson, R.L., Feltovich, P.J., & Anderson, D.K. (1988). *Cognitive flexibility theory: Advanced knowledge acquisition in ill-structured domains* (Tech. Rep. No. 441). Urbana-Champaign, IL: University of Illinois, Center for the Study of Reading.
- Spiro, R.J., Coulson, R.L., Feltovich, P.J., & Anderson, D.K. (1994). Cognitive flexibility theory: Advanced knowledge acquisition in ill-structured domains. In R.B. Ruddell, M.R. Ruddell, & H. Singer (Eds.), *Theoretical models and processes of reading* (pp. 602-615). Newark, DE: International Reading Association.

- Spiro, R.J., & Jehng, J. (1990). Cognitive flexibility and hypertext: Theory and technology for the non-linear and multidimensional traversal of complex subject matter. D. Nix, & R. Spiro (Eds.), *Cognition, education, and multimedia* (pp. 163-205). Hillsdale, NJ: Erlbaum.
- Stahl, E., & Bromme, R. (2007). The CAEB: An instrument for measuring connotative aspects of epistemological beliefs. *Learning and Instruction, 17*, 773-785.
- Strømsø, H.I., Bråten, I., Anmarkrud, Ø., & Ferguson, L.E. (2014). *Beliefs About Justification for Knowing when Ethnic Majority and Ethnic Minority Students Read Multiple Conflicting Documents*. Submitted manuscript.
- Strømsø, H.I., Bråten, I., Britt, M.A., & Ferguson, L.E. (2013). Spontaneous sourcing among students reading multiple documents. *Cognition and Instruction, 31*, 176-20.
- Strømsø, H.I., Bråten, I., & Samuelstuen, M.S. (2008). Dimensions of topic-specific epistemological beliefs as predictors of multiple text understanding. *Learning and Instruction, 18*, 513-527.
- Torgersen, L. (2004). Ungdommers digitale hverdag. Bruk av PC, Internett, TV-spill og mobiltelefon, blant elever på ungdomsskolen og videregående skole. [Young people's digital life. Use of PC, Internet, games and mobile phones among students at lower- and upper-secondary school; in Norwegian]. *Norsk Institutt for forskning om oppvekst, velferd og aldring. Rapport 8/04*. Retrieved July 10, 2013 from http://www.ungdata.no/asset/93/2/93_2.pdf
- Trautwein, U., & Lüdtke, O. (2007). Predicting global and topic-specific certainty beliefs: Domain-specificity and the role of the academic environment. *British Journal of Educational Psychology, 77*, 907-934.
- Tsai, C.-C. (2008). The use of Internet-based instruction for the development of epistemological beliefs: A case study in Taiwan. In M.S. Khine (Ed.), *Knowing*,

- knowledge, and beliefs: Epistemological studies across diverse cultures* (pp. 273-285).
New York: Springer.
- Valanides, N., & Angeli, C. (2005). Effects of instruction on changes in epistemological beliefs. *Contemporary Educational Psychology*, 30, 314-330.
- Vygotsky, L. (1978). *Mind in society: The development of higher psychological processes*.
Cambridge, MA: Harvard University Press.
- Warren, J., Kuhn, D. & Weinstock, M. (2010). How do jurors argue with one another?
Judgment and Decision Making, 5, 64–71.
- Wood, P.K., & Kardash, C.A. (2002). Critical elements in the design and analysis of studies of epistemology. In B.K. Hofer, & P.R. Pintrich (Eds.), *Personal epistemology: The psychology of beliefs about knowledge and knowing* (pp. 231-260). Mahwah, NJ: Erlbaum.
- Yang, D. C., & Tsai, Y. F. (2010). Promoting sixth graders' number sense and learning attitudes via technology-based environment. *Educational Technology & Society*, 13, 112–125.