



Empirical study

Exploring the relations between epistemic beliefs, emotions, and learning from texts [☆]



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ABSTRACT

Conflicting claims about important socio-scientific debates are proliferating in contemporary society. It is therefore important to understand the individual characteristics that predict learning from conflicting claims. We explored individuals' beliefs about the nature of knowledge and knowing (i.e., epistemic beliefs) and their emotions as potentially interrelated sets of learner characteristics that predict learning in such contexts. Undergraduate university students ($N = 282$) self-reported their topic-specific epistemic beliefs and were given three conflicting texts about climate change to read. Immediately after each of the three texts, participants self-reported the emotions they experienced. Following reading and self-report, participants wrote summaries of the conflicting texts. Text-mining and human coding were applied to summaries to construct two indices of learning from conflicting texts that reflected which source's information is privileged in memory. Results from structural equation modeling revealed that epistemic beliefs were consistent in their predictions of emotions, which in turn variously predicted different learning outcomes. In particular, a belief that knowledge is justified by inquiry predicted surprise and curiosity, which at times facilitated learning. In contrast, confusion, predicted by passive reliance on external sources, related to impaired memory of conflicting content. Theoretical and methodological implications are discussed for research on the relations between epistemic beliefs, emotions, and learning about controversial topics.

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1. Introduction

To date, the nature of the internet has been open and democratic and it is often the first resource people access to learn more about various issues of interest. However, when individuals attempt to learn about issues with a socio-scientific basis through online platforms, they are exposed to diverse perspectives and conflicting claims, irrespective of scientific accuracy (Bessi et al., 2015; Kahan, 2015; Kata, 2012). The end result is that it is now commonplace to contend with controversies on important socio-scientific issues, like climate change (Lewandowsky, 2016). Controversy

may be encountered simply by browsing search engine results and news feeds, which present high and low quality information next to each other (Bakshy, Messing, & Adamic, 2015; Barberá, Jost, Nagler, Tucker, & Bonneau, 2015; Barnidge, 2015; Ruiz & Bell, 2014). More insidiously, individuals are also confronted with controversies via deliberate efforts from stakeholders to disseminate misinformation and muddy the waters (Farrell, 2015; Proctor & Schiebinger, 2008). Early research on these issues shows signs that the effects of heightened uncertainty, organized efforts to instill doubt, and individuals' aversion to controversy are generally harmful to learning (Dixon & Clarke, 2013; Kortenkamp & Basten, 2015; Lewandowsky, Ballard, & Pancost, 2015; Penney, 2016).

Nevertheless, navigating digital media online is increasingly necessary to be a full participant in contemporary society and to make informed decisions that have meaningful personal and global implications. Unfortunately, achievement gaps seen in learning

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from traditional media persist with online digital media (Leu et al., 2015). Moreover, rather than exploiting information-rich online environments, disadvantaged individuals may be more vulnerable to misinformation that is pervasive online (Diviani, van den Putte, Giani, & van Weert, 2015). Further compounding these challenges are biases in reasoning inherent in human psychology (Joslyn & Haider-Markel, 2014; Kahan, Peters, Dawson, & Slovic, 2013; Lewandowsky, Ecker, Seifert, Schwarz, & Cook, 2012; Marsh, Cantor, & Brashier, 2016; Sinatra, Kienhues, & Hofer, 2014; Trevors, Muis, Pekrun, Sinatra, & Winne, 2016). There is therefore a pressing need to better understand the impact of representing science knowledge as controversial on learning and to identify what psychological factors and processes increase or mitigate the risk of failing to learn about controversial socio-scientific issues.

Previous research has shown early indications that how individuals learn from conflicting science content is related to their beliefs that knowledge is simple or complex, definitive or tentative, derived by personal reflection, expert testimony, or corroboration of multiple sources (Bråten, Anmarkrud, Brandmo, & Strømsø, 2014). While contending with dissenting viewpoints, these beliefs about the nature of knowledge and knowing – referred to as epistemic beliefs – may be challenged, threatened, upended, or reaffirmed. The degree of incongruity of such experiences with individuals' beliefs may cause them to feel surprised, curious, frustrated, confused, anxious, or even bored (Muis et al., 2015), which in turn affects their learning (Pekrun, 2006; Pekrun & Linnenbrink-Garcia, 2014).

The present paper aims to extend these lines of research by exploring relations between epistemic beliefs, emotions, and learning about a controversial socio-scientific issue. We explore these relations within the context of reading multiple conflicting documents, as texts are a prevalent medium to encounter controversies online (Stadler & Bromme, 2013; Strømsø & Kammerer, 2016). Across many studies, individuals' epistemic beliefs and the emotions they experience during learning are known to separately relate to the outcomes of knowledge construction and learning from reading multiple conflicting documents (Barzilai & Eshet-Alkalai, 2015; Bohn-Gettler & Rapp, 2014; Bråten, Anmarkrud et al., 2014; Bråten, Ferguson, Strømsø, Anmarkrud, 2014; D'Mello & Graesser, 2012; Daley, Willet, & Fischer, 2014). However, what remains relatively less explored are what mediational processes account for the effect of epistemic beliefs on learning from reading and if emotions play a role here. Thus, in the current study, we are among the first to test the propositions that, in the context of reading about controversial science knowledge, epistemic beliefs give rise to emotional experiences that act as one such set of mediational processes between beliefs and subsequent learning.

We first outline theories of learning from reading, including frameworks that integrate epistemic beliefs and learning from multiple conflicting documents. Next, we review theories and empirical evidence for relations between emotions and learning from multiple conflicting documents. Then we review theories and some preliminary evidence supporting the predictive relations between epistemic beliefs, emotions, and learning from multiple conflicting documents to inform the hypotheses of the current study.

1.1. Learning from conflicting documents

Learning from multiple conflicting documents is both a quantitative and qualitative extension of single text comprehension. Commonly, successful learning from reading is defined by the construction of a coherent representation of the text information in a reader's memory (Kintsch, 1988, 1998). According to the construction-integration model, readers will engage in various cognitive processes on text information to transform it into mental

representations of varying levels: the *surface* level represents memory for the explicit wording and grammar of the text; the *text-base* level represents the meaning and structure of the text in each phrase as well as in its entirety; and the *situation model* represents the integration of the textbase with the reader's prior knowledge, which involves qualitatively different types of inferences for its construction compared to other levels of mental representations. In the context of learning from multiple conflicting texts, learners may form an additional level of representation referred to as the *situations model*, which represents the integration of the information described across multiple documents (Bråten, Britt, Strømsø, & Rouet, 2011). Formation of the situations model thus goes beyond memory for text content and represents learning from multiple texts. However, fundamental to the construction of higher quality representations is the efficient processing and memory for concepts and larger units of meaning relayed by texts (van den Broek, 2010).

Indeed, according to the Landscape Model of reading comprehension, such fundamental processes include the continual encoding, integration, and updating of mental representations of semantic concepts in memory (Linderholm et al., 2004; Tzeng, van den Broek, Kendeou, & Lee, 2005; van den Broek, 2010; van den Broek et al., 1999, 2005). Cognitive activation will spread through conceptual networks in long-term memory in a non-controlled and automatic manner and the concepts with the highest level of activation once the process stabilizes will have a higher likelihood of entering conscious awareness and be more likely to be recalled post-reading (van den Broek, Virtue, Everson, Tzeng, & Sung, 2002). Thus, the outcome of these memory-based processes determines those concepts that are privileged in memory and how they are organized into larger units of meaning. These processes will therefore ultimately determine the quality of higher levels of representations that denote successful learning from multiple conflicting documents. Given this importance, in the current research we focus on the impact of controversial representations on memory-based processes and the psychological factors that influence these processes. We next describe how readers' beliefs about knowledge and knowing are predicted to affect how conflicting information is more specifically processed and represented in memory.

1.2. Epistemic cognition and learning from conflicting documents

Bråten et al. (2011) describe how readers' epistemic cognition affects coherence-building processes from multiple documents. Epistemic cognition refers to cognition about the nature of knowledge and knowing, including epistemic beliefs as well as situated epistemic processes for reasoning about specific characteristics of knowledge (Barzilai & Zohar, 2014; Greene, Sandoval, & Bråten, 2016; Sinatra et al., 2014), which can be specific to academic, domain, or topic knowledge (Muis, Bendixen, & Haerle, 2006). For example, individuals may believe that knowledge is composed of isolated facts (i.e., *simplicity* dimension) that, once discovered, remain unaffected by time or human intervention (i.e., *certainty* dimension). To acquire such knowledge requires passive reception from authorities in various fields or reflection on personal opinions (i.e., *source from passive external reception* and *justification by personal opinion* dimensions). In contrast, other individuals may perceive knowledge as interconnected facts organized into broader concepts (i.e., *complexity*). Such knowledge is understood to evolve over time and become more refined with additional reasoning and new evidence (i.e., *uncertainty*). Rather than the source and justification for knowing stemming passively from expert testimony or subjective personal opinion, these individuals believe that the nature of knowing requires justification by rules of inquiry, including evaluation and corroboration of reasons and evidence in support of

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