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Modeling and measuring epistemic cognition: A qualitative re-investigation

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ABSTRACT

Since Perry first proposed that students' beliefs about knowledge and knowing were an important aspect of learning, there has been a proliferation of models of epistemic cognition, and empirical studies of how epistemic cognition relates to learning. Unfortunately, the dominant means of measuring epistemic cognition, self-report instruments, have numerous psychometric problems. These problems prompted us to return to interview methods used by Perry and other seminal researchers, to investigate the degree to which current epistemic cognition models aligned with novices' and experts' cognition. Using an exploratory, multiple case qualitative design, we interviewed middle school students and university professors from two domains, biology and history. We found numerous ways in which the current conceptualizations and measures of beliefs about knowledge and knowing may need to be altered. Our recommendations range from the revision of item wordings to a complete rethinking of the very idea of domain-specificity in epistemic cognition research.

1. A qualitative investigation of expert and novice conceptions of epistemic cognition in biology and history

Research into epistemic cognition (EC; Chinn, Buckland, & Samarapungavan, 2011; Greene, Azevedo, & Torney-Purta, 2008; Hofer & Pintrich, 1997, 2002; Kitchener, 2002; Sandoval & Çam, 2010) has increased exponentially since Perry's (1968/1999) seminal phenomenological interview research on students' beliefs about knowledge and knowing (Hofer & Bendixen, 2012). Researchers have asserted that differences in students' EC influence a multitude of educational outcomes including academic achievement (Buehl & Alexander, 2005; Greene, Muis, & Pieschl, 2010; Hofer, 2000; Schommer, Crouse, & Rhodes, 1992), self-regulated learning (Bråten & Stromso, 2005; Muis, 2007, 2008), web searching (Tu, Shih, & Tsai, 2008) and scientific understanding (Conley, Pintrich, Vekiri, & Harrison, 2004), among many others. Unfortunately, concern about the psychometric adequacy of the most frequently used measures of EC (i.e., self-report instruments) is another common thread running through the relatively brief history of this area of research (e.g., Buehl, 2008; Clarebout, Elen, Luyten, & Bamps, 2001; DeBacker, Crowson, Beesley, Thoma, & Hestevold, 2008; Greene et al., 2008; Hofer & Pintrich, 1997; Wood & Kardash, 2002). The consistently poor evidence regarding the reliability and factorial validity of inferences from scores from self-report instruments of EC cast doubt upon the findings of any study that uses those instruments, including most of the ones that have used quantitative analyses to relate students' beliefs about knowledge and knowing to academic outcomes and covariates (Schraw & Olafson, 2008). Critically, if an instrument is not measuring what researchers believe it is measuring (i.e., if psychometric analyses result in poor validity evidence), then relations between scores on that instrument and any other outcome, such as academic performance, become moot.

It is important to note that some researchers have avoided the psychometric problems of self-report EC instruments by using qualitative data collection and analysis techniques (e.g., Feucht & Bendixen, 2010), or conducting quantitative investigations that have used measures other than self-report such as think-aloud protocols (e.g., Mason, Boldrin, & Ariasi, 2010) interviews (e.g., Sandoval & Çam, 2010) and observation (e.g., Rosenberg, Hammer, & Phelan, 2006). While these studies are exempt from the psychometric critiques described here, it is nonetheless the case that the majority of work in the field of EC over the last ten years has involved quantitative analysis of scores from seemingly problematic self-report instruments (DeBacker et al., 2008). Therefore, the field of EC research finds itself at a difficult crossroads: the number of studies showing relations among epistemic cognition, learning phenomena, and academic outcomes continues to grow, but poor psychometric evidence for the adequacy of measures used in a majority of these studies casts a dark cloud of doubt over their findings.

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While there are many possible explanations for the current state of affairs in EC research, three plausible reasons are that (a) instrument developers need to refine the foci or wording of the self-report items used to measure EC; (b) instrument developers need to consider different ways of measuring EC (e.g., discontinue using Likert-type items, capture student behaviors; Greene et al., 2010; Hofer, 2004; Hofer & Sinatra, 2010; Muis, Bendixen, & Haerle, 2006); or (c) the poor psychometric qualities of instruments derived from conceptual models of EC indicate problems with those models themselves. Researchers continue to explore the first two possible explanations (e.g., Greene, 2009; Greene et al., 2010; Mason et al., 2010; Muis, 2008), and we applaud that work. This study was conceived to investigate the third option. The purpose of this study was to explore novices' and experts' EC, and assess the ways in which current models did and did not align with our participants' EC. To do this, we employed interview methods similar to those utilized by the progenitors of EC research, including Perry (1968), King and Kitchener (1994), Belenky, Clinchy, Goldberger, and Tarule (1986), and Baxter Magolda (1992). We felt that the open-ended, inductive, and exploratory nature of qualitative research was necessary to investigate the conceptual foundations and assumptions upon which researchers have built their quantitative instruments. Such an investigation precludes generalization and proclamation of trends, but does allow for the uncovering of evidence that might otherwise be missed in quantitative analyses where assessments are necessarily constructed from conceptual models, and the assumptions underlying those models (Lewis & Grimes, 1999). We sought to explore, at a deep, foundational level, the models used to conceptualize EC, with the hope of finding potential explanations for the poor psychometric results that plague the field.

2. Literature review

Within the paradigm of qualitative research, the literature review plays a less significant role in the design of empirical work than it does in the quantitative paradigm (Creswell, 2008). While qualitative researchers are certainly informed as to the literature in their respective fields, their focus on participant meaning making, open-ended inquiry, and allowing themes to emerge from the data often includes an intentional de-emphasis of prior theory, so that their participants' voices can be heard clearly. Given our wish to question the underlying conceptual foundations of EC research, we used prior literature to contextualize and motivate our work, but not circumscribe it. Therefore, here we provide an overarching summary of EC models, the critiques that problematize those models and inspire our work, and a discussion of how we used that literature to frame our exploratory multiple-case study. Per the qualitative research paradigm, this brief literature review will be supplemented in the results section, where we will incorporate additional literature to broaden, deepen, and contextualize our findings (Mertens, 2010).

2.1. Models of epistemic cognition

While models of epistemic cognition are numerous and diverse, three of the most prominent kinds are: developmental, multidimensional, and situated resources-based. Developmental models began with the work of Perry (1968/1999) who, after extensive interviews with numerous male Harvard students, proposed that college students progress along a continuum of positions that he named dualism, multiplism, relativism, and commitment with relativism. Following Perry's work, other researchers produced their own models of EC, each building their models off of data from interviews with students (e.g., Baxter Magolda, 1992; Belenky et al., 1986; King & Kitchener, 1994; Kuhn, Cheney, & Weinstock, 2000). While all of these models differed according to the framing of the underlying construct, they had in common representations of meaning making through hierarchical sequences of stage development. Kuhn's work is used extensively today, and is a good representative of the developmental class of EC models. Her model suggested movement from positions of realist, to absolutist, then multiplist, and finally to evaluativist, describing a progression in the engagement of knowledge that was roughly analogous to Perry's model. The transitions from dualism to multiplism and from absolutist to multiplist in the two models both represented a change from purely objective to purely subjective views of knowledge. Relativism and evaluativist positions were characterized by a reconciliation of the two extremes. These developmental models suggested, among other things, that knowledge becomes increasingly contextualized with progress along the developmental continuum.

The first multi-dimensional model of EC was put forth by Schommer (1990). It expanded the research field by advocating for a system of five independent but related dimensions: fixed ability, quick learning, simple knowledge, certain knowledge, and omniscient authority (i.e., source of knowledge). Some researchers (DeBacker et al., 2008; Hofer & Pintrich, 1997; Muis et al., 2006) have claimed that the first two dimensions extend beyond the scope of epistemic concerns. The other three constructs cohere with the dimensions proposed by Hofer and Pintrich (1997) who categorized simple knowledge and certain knowledge as "nature of knowledge" beliefs. Source of knowledge was categorized as a "nature of knowing" belief. To this category, they added justification as a fourth aspect of the construct.

Simple knowledge refers to the view of knowledge as discrete and unrelated facts. Learners along one end of the simple knowledge dimension view facts as unconnected with each other, while learners closer to the other end view facts as highly connected and related. The certain knowledge dimension characterizes the views of learners who consider knowledge as unchanging to be naïve while those who consider knowledge to be "tentative and evolving" (Hofer & Pintrich, 1997, p. 120) as sophisticated. At the naïve end of the source of knowledge dimension, knowledge is viewed as originating outside of the self. Learners more advanced along this dimension believe themselves to be progenitors of knowledge. Justification for knowing refers to the process of evaluating sources and means of knowledge including observation, authority, rules, and "what feels right" (Hofer, 2004, p. 46) at the time.

Hammer and Elby (2002, 2003) championed the situated resources model and criticized the developmental and multidimensional models' inclusion of domain-general, static beliefs. According to Hammer and Elby, learners' epistemologies are actually fine-grained cognitive resources that exist at a level of specificity beyond that of beliefs or theories. Learners display different epistemic behavior based upon the context; in some situations a particular set of cognitive resources may be activated, whereas in a different context a very different set could be activated to influence learning. This view of EC differs greatly from many other models of EC particularly as it regards degree situatedness. Recently, Chinn, Buckland, and Samarapungavan (2011) have proposed a dramatic expansion of the dimensions of EC to include components as diverse as epistemic aims (i.e., people's goals for inquiry such as knowledge or truth), epistemic values (i.e., people's beliefs about the worth of different epistemic aims), and epistemic virtues (i.e., dispositions that are beneficial in the pursuit of epistemic aims, such as open-mindedness). They have also advocated for a consideration of the situated nature of these EC components.

2.2. Recent critiques of models of epistemic cognition

2.2.1. The nature of knowledge

A majority of the dimensional models of EC include two specific beliefs about the nature of knowledge: the degree to which it is