

The Development of Epistemological Theories: Beliefs About Knowledge and Knowing and Their Relation to Learning

Barbara K. Hofer and Paul R. Pintrich
University of Michigan

There have been a number of research programs that have investigated students' thinking and beliefs about the nature of knowledge and knowing, including definitions of knowledge, how knowledge is constructed, and how knowledge is evaluated. However, these different research programs have pursued varying definitions and conceptual frameworks and used quite different methodologies to examine students' epistemological beliefs and thinking. In the first section of this article, we provide a critical and comprehensive review of these different research programs. In the second part of this article, we identify nine crucial theoretical and methodological issues that need to be resolved in future research on epistemological theories. As these issues are addressed in future research, there will be more consensus regarding the nature of epistemological theories, and their relation to cognition, motivation, and learning will be made more explicit.

Epistemology is an area of philosophy concerned with the nature and justification of human knowledge. A growing area of interest for psychologists and educators is that of personal epistemological development and epistemological beliefs: how individuals come to know, the theories and beliefs they hold about knowing, and the manner in which such epistemological premises are a part of and an influence on the cognitive processes of thinking and reasoning.

Piaget (1950) used the term *genetic epistemology* to describe his theory of intellectual development, initiating the interest of developmental psychologists in this intersection of philosophy and psychology. These interests were an important step in the growing reaction to the dominance of behaviorism, which had removed knowing altogether from learning (Kohlberg, 1971). Bringing knowing back into the picture was central to emerging theories of moral judgment and development (Gilligan, 1982; Kegan, 1982; Kohlberg, 1969, 1971). Along parallel lines, Perry's (1970) attempts to understand how students interpreted pluralistic educational experiences had led to a theory of epistemological development in college students.

We would like to thank our colleagues at the University of Michigan—Helen Harrington, Bill McKeachie, Allison Ryan, Henry Wellman, and Allison Young—for stimulating conversations and helpful comments regarding the development of the ideas presented here, although we take full responsibility, of course, for their current representation. In addition, two anonymous reviewers provided useful feedback on an earlier version of the manuscript.

Since that time, research on epistemological beliefs and reasoning has addressed six general issues: (a) refining and extending Perry's developmental sequence (King & Kitchener, 1994; King, Kitchener, Davison, Parker, & Wood, 1983; Kitchener, 1986); (b) developing more simplified measurement tools for assessing such development (Baxter Magolda & Porterfield, 1985; Knefelkamp, 1974; Moore, 1989; Widick, 1975); (c) exploring gender-related patterns in knowing (Baxter Magolda, 1992; Belenky, Clinchy, Goldberger, & Tarule, 1986); (d) examining how epistemological awareness is a part of thinking and reasoning processes (King & Kitchener, 1994; D. Kuhn, 1991); (e) identifying dimensions of epistemological beliefs (Schommer, 1990, 1994b); and, most recently, (f) assessing how these beliefs link to other cognitive and motivational processes (Butler & Winne, 1995; Hofer, 1994; Ryan, 1984a, 1984b; Schommer, 1990, 1993a; Schommer, Crouse, & Rhodes, 1992; Schutz, Pintrich, & Young, 1993).

However, in all this research there is very little agreement on the actual construct under study, the dimensions it encompasses, whether epistemological beliefs are domain specific or how such beliefs might connect to disciplinary beliefs, and what the linkages might be to other constructs in cognition and motivation. In addition, there have been no attempts to conceptually integrate the early Piagetian-framed developmental work on epistemological beliefs to newer cognitive approaches such as theory of mind or conceptual change. The purpose of this article is to review these intersecting strands of research, identify issues that need to be resolved, and suggest some possibilities for consensus that can guide future research efforts. To accomplish this purpose, the article is divided into two sections: a critical review of different epistemological models and a discussion of nine issues for future research.

Review of Epistemological Models

Psychological research on epistemological development began in the mid-1950s, and in the decades since there have been three simultaneous and intersecting-lines of research which cut across the six general issues. Led by the initial work of Perry (1970), most researchers in the field have posited models that are to some degree structural, developmental sequences. One group has been largely interested in how individuals interpret their educational experiences (Baxter Magolda, 1987, 1992; Belenky et al., 1986; Perry, 1970, 1981). Perry pioneered these endeavors with a sample that was almost entirely male; in response, Belenky et al. investigated "women's ways of knowing" with an exclusively female sample. Baxter Magolda, intrigued by gender implications of these two lines of research, chose to investigate similar concerns with both men and women.

A second group of researchers have been interested in how epistemological assumptions influence thinking and reasoning processes, focusing on reflective judgment (King & Kitchener, 1994; Kitchener & King, 1981; Kitchener, King, Wood, & Davison, 1989; Kitchener, Lynch, Fischer, & Wood, 1993) and skills of argumentation (D. Kuhn, 1991, 1993). The theories and models differ somewhat depending on the focus of the inquiry and the populations studied, but there have been some points of convergence about what individuals believe knowledge is and how it is they know.

The third and most recent line of work has taken the approach that epistemological ideas are a system of beliefs that may be more or less independent rather

than reflecting a coherent developmental structure (Ryan, 1984a, 1984b; Schommer, 1990, 1994b). These beliefs may influence comprehension and cognition for academic tasks, and this work has been the most concerned with classroom learning.

The central theories and models of epistemological development and epistemological beliefs are outlined below. For each program of research we discuss (a) the methodology, (b) the overall model, (c) linkages to other motivational or cognitive constructs, and (d) the theoretical and methodological issues that emerge from this review of the research.

/ Perry's Scheme of Intellectual and Ethical Development

Nearly all the existing psychological work on epistemological beliefs can be traced to two longitudinal studies by William Perry (1970) that began in the early 1950s at Harvard's Bureau of Study Counsel. This work culminated in a developmental scheme of the "abstract structural aspects of knowing and valuing" (p. 14) in college students. This scheme has served as a heuristic for understanding how college students make meaning of their educational experiences and as a platform for multiple lines of research on epistemological beliefs.

Method

Interested in how students appeared to be responding differentially to the pluralistic intellectual and social environment of the university, Perry set out to collect descriptive accounts of students' experiences. In order to select a range of students for initial interviews, he developed an instrument that he called a Checklist of Educational Values (CLEV). Perry based the CLEV on authoritarian personality research (Adorno, Frenkel-Brunswik, Levinson, & Sanford, 1950) and Stern's Instrument of Beliefs (Stern, 1953), operating on a prevailing assumption of the period that differences in student responses to the relativistic world they encountered in college were largely attributable to personality. Questions from the CLEV—such as "The best thing about science courses is that most problems have only one right answer"—survive intact in some current epistemological beliefs research (Schommer, 1990, 1993a; Schommer et al., 1992).

Perry administered the CLEV to a random sample of 313 first-year students in 1954–1955 and then invited 31 students (27 men, 4 women) for annual interviews that began with the question, "Would you like to say what has stood out for you during the year?" The goal of the interview was to encourage students to express what was salient in their experience in their own terms and to avoid dictating the structure of the response. Readings of the transcripts of these early interviews led Perry and his staff to conclude that college students' ways of construing their world were not so much a matter of personality as evidence of a logically coherent, cognitive developmental process.

Based on these interviews, Perry and his colleagues outlined a scheme of intellectual and ethical development that included a sequence of nine positions, along with the transitional steps that appeared to provide transformation from one level to another, and then launched a second longitudinal study to validate the scheme, with a randomly selected group of 109 first-year students (85 men, 24 women) from the entering classes of 1958–1959 and 1959–1960 who were followed for their four years of college. Only two women were included in the

results of this study, although Perry (1970) reported that the women's experiences essentially fit the developmental scheme; the rationale for eliminating the other 22 women is unclear.

Model

Perry's scheme of intellectual and ethical development postulates an ongoing, qualitative reorganization of the making of meaning. Although levels in the scheme are designated as "positions" rather than stages, and Perry makes no claims for this as a formal developmental process, the scheme itself and the inherent developmental mechanisms share much with other Piagetian-type developmental schemes. The positions appear to represent an invariant sequence of hierarchically integrated structures. Change is brought about through cognitive disequilibrium; individuals interact with the environment and respond to new experiences by either assimilating to existing cognitive frameworks or accommodating the framework itself.

The nine positions of the scheme have typically been clustered into four sequential categories (Knefelkamp & Slepitzka, 1978; Kurfiss, 1988; Moore, 1994): *dualism*, *multiplicity*, *relativism*, and *commitment within relativism*. The basic scheme is as follows (see Table 1).

Dualism. Positions 1 and 2 are characterized by a dualistic, absolutist, right-and-wrong view of the world. Authorities are expected to know the truth and to convey it to the learner.

Multiplicity. Position 3 represents a modification of dualism, with the beginning of the recognition of diversity and uncertainty. Authorities who disagree haven't yet found the right answer, but truth is still knowable. By Position 4, dualism is modified again; areas in which there are no absolute answers are outside the realm of authority. An individual at this position is inclined to believe that all views are equally valid and that each person has a right to his or her own opinion.

Relativism. Position 5 is the watershed of the scheme, as individuals make the shift from a dualistic view of the world to a view of contextual relativism that will continue, with modifications, through the upper stages. A major shift is in the perception of self as an active maker of meaning. At Position 6 individuals perceive knowledge as relative, contingent, and contextual and begin to realize the need to choose and affirm one's own commitments.

Commitment within relativism. The final positions, 7 through 9, reflect a focus on responsibility, engagement, and the forging of commitment within relativism. Individuals make and affirm commitments to values, careers, relationships, and personal identity. Developments in the upper positions are described by Perry as more qualitative than structural, and are not marked by formative change. Although proposed as part of the scheme, these positions were not commonly found among college students.

Perry did not conduct further research to explore linkages between his conception of epistemological development and student learning, but he did speculate in later work on possible connections among cognitive styles, learning strategies, and development (Perry, 1981). "When students radically revise their notions of knowledge, would they not be likely to change their ways of going about getting it?" (p. 102). Perry hypothesized that changes in students' views of the nature of

TABLE 1

Models of epistemological development in late adolescence and adulthood

Intellectual and ethical development (Perry)	Women's ways of knowing (Belenky et al.)	Epistemological reflection (Baxter Magolda)	Reflective judgment (King and Kitchener)	Argumentative reasoning (Kuhn)
<i>Positions</i>	<i>Epistemological perspectives</i>	<i>Ways of knowing</i>	<i>Reflective judgment stages</i>	<i>Epistemological views</i>
Dualism	Silence Received knowledge	Absolute knowing	Pre-reflective thinking	Absolutists
Multiplicity	Subjective knowledge	Transitional knowing	Quasi-reflective thinking	Multiplicists
Relativism	Procedural knowledge (a) Connected knowing (b) Separate knowing	Independent knowing		Evaluatists
Commitment within relativism	Constructed knowledge	Contextual knowing	Reflective thinking	

Note. Stages and positions are aligned to indicate similarity across the five models.

knowledge and the role of authority will lead to observable changes in manner of studying, as expressions of changes in altered modes of learning and cognition.

Discussion

Perry was the first to suggest that how college students made meaning of their educational experiences was not a reflection of personality but an evolving developmental process. He provided an interactionist model for interpreting students' epistemological responses to the college environment. A central contribution of the scheme has been the articulation of the dualistic, multiplicative, and relativistic points of view that characterize the epistemological outlook of many college students. The popularization of Perry's work has made the teaching of students at these levels more explicable to a generation of college faculty. Perry charted a course for others to follow and has continued to assist those who have attempted to further his line of study.

There were numerous limitations to the original study, however. Perry (1970) noted several: Participants were student volunteers from a single college, the investigators who abstracted the scheme had also served as the interviewers, and validation was conducted in relation to the data from which the scheme itself was derived. In addition, the sample was largely composed of White, elite, male college students educated at Harvard during the 1950s.

As Perry (1970) and others have noted (King & Kitchener, 1994; Kurfiss, 1988; Pascarella & Terenzini, 1991), the scheme's lower positions are more explicitly epistemological than the upper positions, which shift "away from spatial-cognitive restructuring to emotional and aesthetic assessments" (Perry, 1970, p. 205). Thus, while the epistemological movement from dualism to relativism is fairly clearly noted, how knowledge is construed beyond these positions is less well defined. In a later work, Perry (1981) cited the relevance of dialectical thought (Basseches, 1980) to his scheme and noted also that it is at the later positions, in the affirmation of commitment, that "themes of epistemology, intellectual development, ethics, and identity merge" (p. 97). There are also concerns about whether the responses form a true structural, developmental trajectory or are more an artifact of the socialization process in the values of a Western liberal arts education (Moore, 1994).

One of the persistent difficulties faced by those who wished to utilize the scheme as more than a theoretical lens has been the difficulty in operationalizing the scheme and in measuring change (Pascarella & Terenzini, 1991). This challenge has been taken on by a number of researchers who have attempted to modify the scheme and to develop more precise, less time-consuming means of evaluating epistemological development, either through interviews or written assessments (Baxter Magolda, 1992; Baxter Magolda & Porterfield, 1985; Benack & Basseches, 1989; King & Kitchener, 1994; Knefelkamp & Slepitzka, 1978; Moore, 1989; Ryan, 1984a, 1984b).

The first written measure, designed by Knefelkamp and Widick (and originally known as the KneWi), is the Measure of Intellectual Development (MID), a production task measure based on essay prompts about students' conceptions of knowledge and learning, scored only by trained raters. The Learning Environment Preferences (LEP) (Moore, 1989) was designed as a computer-scored, recognition task version of the MID, based on a review of MID essays. The LEP consists of

65 items across five “domains”: view of knowledge/learning, role of instructor, role of student/peers, classroom atmosphere and activities, and role of evaluation/grading. The Measure of Epistemological Reflection (MER), developed by Baxter Magolda (1987), has provided a paper-and-pencil production task assessment of similar issues, particularly focused on classroom learning. These will be discussed in more detail in a later section on general methodological issues.

Regardless of these theoretical and methodological difficulties, Perry’s work laid the ground for the several decades of research that followed, and each of the models that follows can be traced back to these origins.

Women’s Ways of Knowing

Perry’s work came under attack in the late 1970s for the limitations of generalizing from an elite male sample to the general population of college students. Gilligan (1982), in challenging Kohlberg’s (1969) theory of moral development on the basis that a male sample had led to a normative view of a morality of rights void of notions of responsibility and care, provided a broader critique of psychological theories derived from male experience. Such theories often provide a model for human development against which women are judged deficient. With women omitted from the theory building stage, the models that are developed often lead to research on traditionally masculine attributes and values.

In this context, Belenky et al. (1986) were interested in issues of women as knowers and learners; they were concerned that “nowhere is the pattern of using male experience to define the human experience seen more clearly than in models of intellectual development” (p. 7). Beginning with the framework supplied by Perry, they set out to understand themes of knowing particular to women. Their interview study led to the development of “women’s ways of knowing,” a model consisting of five different perspectives “from which women view reality and draw conclusions about truth, knowledge, and authority” (p. 3). While they were explicitly interested in the intellectual and epistemological development of women, they concluded that women’s ways of knowing are intertwined with self-concept.

Method

Belenky et al. (1986), similarly to Gilligan (1982) in her study of women’s moral development, made the controversial decision to include only women in their study. Perry (1970) had claimed that the women’s transcripts could be mapped onto the pattern of development he had identified in men, but Belenky et al. were interested in listening for themes that might emerge when women were the source of the study. In an interview–case study approach, they interviewed 135 women, of whom 90 were enrolled in one of six diverse academic institutions (or were recent alumnae) and 45 were involved in human service agencies where they were seeking information or assistance with parenting. Researchers were committed to a phenomenological approach, allowing interviewees to provide their own frames of meaning throughout semi-structured interviews that ranged from 2 to 5 hours in length.

The interview protocols began similarly to Perry’s, with the question “What stands out for you in your life over the last few years?” but then accompanied by the question “What stays with you?” Other sections included question sets derived

from the framework of Gilligan (1982) and Kohlberg (1969), and there were sections on gender, relationships, education, and ways of knowing. The protocol section on ways of knowing used for those in school (or recent alumnae) differed from the one used for those out of school. Individuals from the more educated group were asked to respond to one or more comment cards that gave statements about conceptions of knowledge; responses were probed for further clarification about reliance on expertise and conceptions of truth. This was followed by particular examples that required intellectual judgment and justification. The less educated women received five shorter questions on the role of expertise in their own learning.

Sections of the interview that were based on the work of Gilligan, Kohlberg, and Perry were separated out and scored independently. Initial attempts were made to classify the data using Perry's scheme; the lack of fit led to the development of a new classification scheme of five epistemological perspectives.

Model

The model that Belenky et al. (1986) propose provides "a set of epistemological perspectives from which women know and view the world" (p. 15). These are not presented as stages, but the authors provide some speculation about developmental paths. The data were primarily cross-sectional, and the change process can only be inferred from retrospective accounts. Within the resulting model, by contrast to the implicit visual metaphor in Perry's "views," the positions are organized around the metaphor of voice. In Table 1, the epistemological perspectives of Belenky et al. are lined up to coincide with the relevant positions of Perry's model.

In the position of *silence*, women experience a passive, voiceless existence, listening solely to external authority. The next position, parallel to Perry's position of dualism, is *received knowledge*, a perspective of either-or thinking in which there is only one right answer and all ideas are perceived as good or bad, true or false. Women in this position see knowing as originating outside the self; unlike women who are silenced, they can reproduce and speak about this knowledge, although the origin is external. These women also differ from Perry's male dualists, who in choosing the "right" answer saw themselves as aligned with authority; women in this position were not inclined to identify with authority.

Subjective knowledge is still dualistic, but the source of truth is now within the self. Belenky et al. (1986) describe subjectivism as interchangeable with Perry's multiplicity position, but note gender differences in meaning. Men were described as asserting a "right" to their own opinion, wresting authority from others; women in this study are more likely to see truth as an intuitive reaction, personally experienced.

In the position of *procedural knowledge*, women demonstrate reasoned reflection, applying objective, systematic procedures of analysis. Procedural knowing, however, can take two forms, which Belenky et al. (1986) describe as epistemological orientations. Using conceptual distinctions as Gilligan (1982) and Lyons (1990), they describe these as *separate knowing* and *connected knowing*. Separate knowing is impersonal and detached, best evidenced in critical thinking, and the hallmark of traditional, rigorous undergraduate education. "While subjectivists assume everyone is right, separate knowers assume that everyone—including themselves—may be wrong" (Belenky et al., 1986, p. 104). Connected knowing

is still procedural, but "truth emerges through care" (p. 102) and the capacity for empathy. The mode of knowing is personal and emphasizes understanding over judgment. These epistemological orientations are not described as gender specific but as possibly gender related.

Constructed knowledge represents an integration of subjective and objective strategies for knowing. "All knowledge is constructed and the knower is an intimate part of the known" (Belenky et al., 1986, p. 137). Knowledge and truth are contextual. The individual sees herself as a participant in the construction of knowledge, one whose own frame of reference matters; furthermore, these frames of reference can be constructed and reconstructed by the knower. This process leads to modes of inquiry that Belenky et al. see as indicative of postformal operational thought.

Discussion

Belenky et al. (1986) pushed the field by extending Perry's work to encompass women's perspectives. They retained the phenomenological method but added more structured questions in order to ground their findings in existing frameworks. Interviewing only women may have enabled them to create epistemological categories drawn from women's voices only, but this choice of approach also opened their work to criticism of its claims. Although they acknowledged that similar categories could be found in men's thinking, their study provided no means to assess the gender-related nature of the findings.

The work also was notable in the inclusion of women not in school; however, the decision to vary the interview protocol for the two populations makes it difficult to draw meaningful conclusions about the resulting difference in epistemological perspectives. A serious concern is the ordering of the interview. A section on "Relationships" precedes the sections on "Education" and "Ways of Knowing." Given their finding that many women have a relational, connected approach to knowing, it is hard to know the degree to which this may have been primed by the interviewers in these earlier questions; such context effects have been demonstrated to influence question interpretations (Strack, Schwarz, & Wanke, 1991).

One of the major conceptual differences with Perry's work is that Perry's positions are descriptive of the *nature* of knowledge and truth, while Belenky et al. focus more on the *source* of knowledge and truth. In a later article, Clinchy (1990), a coauthor of the study on women's ways of knowing, reported that the research team revised their definition of epistemological perspective to emphasize source rather than nature of knowledge, focusing on questions such as the following: "How does the woman conceive of herself as a knower? Is knowledge seen as originating outside or inside the self? Can it be passed down intact from one person to another, or does it well up from within? Does knowledge appear effortlessly in the form of intuition or is it attained only through an arduous process of construction?" (Clinchy, 1990, p. 58).

Throughout their model, the role of self in relation to others and to knowledge plays a critical part. Belenky et al. (1986) note that a "transformation of understanding of self begins to generalize and affect how women think about truth, knowledge and expertise" (p. 138), a process they describe as operating in the Piagetian manner of horizontal decalage. Changes in self-knowledge thus precede

an understanding of a view of self in relation to knowledge and truth. These developments ultimately lead toward a view of one's self as a constructor of knowledge and the view that "answers to all questions vary depending on the context in which they are asked and on the frame of reference of the person doing the asking" (p. 138).

Considerable use has been made of the "women's ways of knowing" model by educators, particularly at the college level. The most useful heuristic seems to have been the distinction between separate knowing and connected knowing, which has served as a means for understanding gender-related approaches to learning. The authors of the study have provided suggestions on both connected education for women and connected teaching, which have been adapted at the classroom and institutional level (Belenky et al., 1986; Clinchy, 1990; Clinchy, Belenky, Goldberger, & Tarule, 1985). They advocate a model of teachers as "participant-observers" who model and display their thinking processes in public dialogue, a classroom culture that accepts the voicing of uncertainty, standards of evaluation that are coconstructed by teachers and students, and classes in which knowledge is created not through conflict but consensus.

3 Epistemological Reflection Model

Baxter Magolda's work began as an attempt to quantify students' ways of thinking as evidenced in Perry's (1970) scheme. Initial work centered on the development and validation of the Measure of Epistemological Reflection (MER) (Baxter Magolda, 1987; Baxter Magolda & Porterfield, 1985), a written instrument developed in studies of both undergraduate and graduate students. Confronted with patterns of responses that did not neatly fit the scheme, and intrigued by the discrepancies in findings between the men in Perry's study and the women in the study of Belenky et al. (1986), Baxter Magolda became interested in possible gender-related implications. Accordingly, she designed a longitudinal study of epistemological development and how epistemological assumptions affect interpretation of educational experiences.

Method

In 1986 Baxter Magolda began a 5-year longitudinal study of 101 randomly selected students (of whom 51 were female and 3 from minority populations) from Miami University in Ohio. She conducted annual open-ended interviews and gave participants the Measure of Epistemological Reflections (MER), to be completed and returned later. Seventy complete longitudinal sets were interpreted in the development of the epistemological reflection model (Baxter Magolda, 1992).

The first-year interview was designed to address six areas of epistemological development: the roles of the learner, instructor, peers, and evaluation in learning; the nature of knowledge; and decision making. In subsequent years the interview was modified to include questions about the nature of knowledge, out-of-class learning, and student changes in response to learning experience. The coding structure was derived from Perry's first five positions and the five perspectives of Belenky et al. (1986). Following Loevinger's (1976) work on ego development, Baxter Magolda initially analyzed the interview data by organizing student responses into categories and themes. Later reflection on this process and a transfor-

mation in her own thinking about research led to a more naturalistic, qualitative reinterpretation of the data and the development of the model.

Model

The epistemological reflection model contains four qualitatively different “ways of knowing,” each with particular epistemic assumptions: absolute, transitional, independent, and contextual. Baxter Magolda (1992) reports that each of these leads to “particular expectations of the learner, peers, and instructor in learning settings, as well as to an understanding of how learning should be evaluated and how educational decisions are made” (p. 29). The definition of epistemology that emerges from these categories is focused more on the nature of learning as situated in the college classroom context and less on assumptions about knowledge itself.

Within Baxter Magolda’s model (see Table 1; her ways of knowing are aligned with Perry’s positions and with Belenky et al.’s perspectives), *absolute* knowers view knowledge as certain and believe that authorities have all the answers. *Transitional* knowers discover that authorities are not all-knowing and begin to accept the uncertainty of knowledge. Those who are *independent* knowers question authority as the only source of knowledge and begin to hold their own opinions as equally valid. *Contextual knowers* are capable of constructing an individual perspective by judging evidence in context. Expertise itself is subjected to evaluation. Knowledge evolves, “continually reconstructed on the basis of new evidence and new contexts” (p. 189). Contextual knowing was not common in the study sample, found only in 2% of senior interviews and 12% of fifth-year interviews.

By studying both men and women longitudinally, Baxter Magolda was able to build on previous single-sex studies such as those of Perry and Belenky et al. Baxter Magolda (1992) did not find that ways of knowing were segregated by gender, but rather reported gender-related reasoning patterns that cut across the first three ways of knowing. These are described as representing a continuum of differences in how students justify epistemic assumptions within each of the ways of knowing. Within *absolute knowing*, the two patterns are *receiving*, used more often by women than by men in the study, and *mastery*, a pattern more common to the men. The patterns for *transitional knowers* are *interpersonal* (more likely among women) and *impersonal* (more likely among men). Patterns for *independent knowers* are “interindividual” (more likely among women) and “individual” (more likely among men). Baxter Magolda hypothesizes that the patterns may converge in contextual knowing. Baxter Magolda acknowledges a connected, narrative approach as equal, and equally complex, to the objectivist approach more common to men, but often posited as the “main line of development” in theories such as Perry’s.

Discussion

Baxter Magolda identified a gap in the preceding work, attempted to explore gender-related patterns of epistemological development by studying both men and women, and conducted a longitudinal study in order to examine developmental patterns. Her overall findings appear consistent with those of Belenky et al. in suggesting that there may be gender-related patterns in knowing, but that both

patterns appear among both genders. How these patterns develop, the degree to which these modes of knowing are socialized, and the influence that schooling plays are all avenues for further research.

As in Perry's study, Baxter Magolda's sample consisted of college students at one institution, in this case a mid-size Midwestern university where students were of traditional age, mostly White (97%), and largely from middle-class, two-parent families. Baxter Magolda did provide thick description of the institutional context and the student culture to enable judgments about the transferability of the findings, consistent with the qualitative approach of the study (Lincoln & Guba, 1985). The experiences of these students may not have been representative of minority students, nor is it likely that students at this institution encountered some of the stimulating, unsettling experiences of students exposed to a more diverse, multicultural environment. Comparative work with other populations is needed. Baxter Magolda explored potential implications for relating the "patterns of knowing" to diverse student populations by examining issues of voice, authority, peer relationships, socialization processes, and patterns of subordination and domination in the college setting. The initial scope of the study was to examine how epistemological assumptions affected interpretations of educational experiences, but this was limited by the fact that epistemology, as it appears to have been defined in this study, largely consisted of student perceptions of learning experiences.

4 / Reflective Judgment Model

Building on the work of Perry (1970), as well as Dewey's (1933, 1938) work on reflective thinking, King and Kitchener have studied the epistemic assumptions that underlie reasoning (King & Kitchener, 1994; King et al., 1983; King, Kitchener, Wood, & Davison, 1989; Kitchener, 1983, 1986; Kitchener & King, 1981; Kitchener et al., 1989; Kitchener et al., 1993). Fifteen years of interview studies with individuals from high school students through middle-age adults have led to the refinement of their reflective judgment model, a seven-stage developmental model that focuses on epistemic cognition, or "the ways that people understand the process of knowing and the corresponding ways they justify their beliefs about ill-structured problems" (King & Kitchener, 1994, p. 13). King and Kitchener argue that reflective judgment is an ultimate outcome and developmental endpoint of reasoning and the ability to evaluate knowledge claims.

Method

The method used to assess reflective judgment is an interview built around four ill-structured problems. Participants are asked to state and justify their point of view and respond to six follow-up questions designed to tap assumptions about knowledge and how it is gained. The problems typically concern how the pyramids were built, the safety of chemical additives in food, the objectivity of news reporting, and the issue of creation and evolution.

Transcripts from the reflective judgment interviews are scored by trained, certified raters in a three-round process. Interrater reliability coefficients, typically calculated on the more conservative Round 1 ratings, have averaged in the high .70s (King & Kitchener, 1994). Test-retest reliability has been reported as acceptable (.71) to strong (.87). Internal consistency of individual scores across the four

problems as measured by coefficient alpha indicated a median alpha level across studies of .77. Within each stage, the scoring rules are divided into two sections: the *nature of knowledge* and the *nature of justification*; each of these has three subsections. The nature of knowledge consists of one's *view of knowledge*, "*right versus wrong*" *knowledge*, and *legitimacy of differences in viewpoints*. The nature of justification consists of the *concept of justification*, *use of evidence*, and the *role of authority in making judgments*.

Model

The reflective judgment model consists of seven qualitatively different stages that describe how individuals perceive and reason about ill-structured problems. Throughout each of the reflective judgment stages, the focus is on both the individual's conception of the nature of knowledge and the nature or process of justification for knowledge. The model was pilot tested and refined, beginning in the late 1970s, through both cross-sectional and longitudinal studies. A central contribution of the scheme is the theoretical elaboration of the structural and epistemological aspects of the upper levels of Perry's original scheme. Construction of these upper stages was initially guided by reviews of a broad range of work on reflective thinking and ego, social, and epistemological development (Broughton, 1975; Dewey, 1933, 1938; Harvey, Hunt, & Schroder, 1961; Lakatos, 1970; Loevinger, 1976; Popper, 1969).

Within the seven-stage model proposed by King and Kitchener (1994) there are three levels (see Table 1): *pre-reflective* (Stages 1, 2, and 3), *quasi-reflective* (Stages 4 and 5) and *reflective* (Stages 6 and 7). In the pre-reflective stages, individuals are unlikely to perceive that problems exist for which there may be no correct answer. At Stage 1, hypothesized as typical in young children but not identified in pure form in any of the subjects in King and Kitchener's studies, knowledge is simple, concrete, and absolute and needs no justification. There is a one-to-one correspondence between what one observes and truth. Stage 2, similar to Perry's dualism, posits a true reality known by authorities, but not by everyone. By Stage 3 there is a recognition of temporary uncertainty, that authorities may not currently have the truth. This temporary uncertainty allows for judgments based on personal opinion. As shown in Table 1, these pre-reflective stages are similar to the initial positions in the other models displayed.

Quasi-reflective thinking characterizes the reasoning of Stages 4 and 5, which are marked by a growing realization that one cannot know with certainty. Beginning at Stage 4, knowledge and the justification of knowledge are perceived as abstractions, but are poorly differentiated. Paralleling Perry's multiplicity period (see Table 1), this stage is marked by the view that each person is entitled to her or his own opinion. Stage 5, similar to Perry's period of relativism, is characterized by the belief that knowledge is contextual and relative. "What is known is always limited by the perspective of the knower" (King & Kitchener, 1994, p. 62). At this stage individuals are capable of relating two abstractions and can thus relate evidence and arguments to knowing, although the ability to coordinate these into a well reasoned argument is not yet present. As shown in Table 1, quasi-reflective thinking cuts across several different positions or perspectives of other models.

Reflective thinking emerges in Stages 6 and 7. Knowledge is actively con-

structed and must be understood contextually; judgments are open to reevaluation. At Stage 6, the action of knowing shifts, moving the knower from spectator to active constructor of meaning. Knowledge is uncertain and contextual, but it is now possible to coordinate knowing and justification to draw conclusions across perspectives. Expert authority is again cited, but now it is critically evaluated. Conclusions remain limited and situational at this stage. Stage 7 thinking is marked by the use of critical inquiry and probabilistic justification to guide knowledge construction. Through this process individuals are able to determine that some judgments are more reasonable or valid than others, but with an awareness that all conclusions may be reevaluated.

Applying Flavell's (1971) criteria for stages to the reflective judgment model, King and Kitchener claim that it is a developmental stage model, as the stages have an underlying organization, are qualitatively different, and appear to form an invariant sequence. Mechanisms of developmental change are Piagetian; assumptions about knowledge develop through assimilation and accommodation of existing cognitive structures as individuals interact with the environment. The authors are less sanguine about Flavell's and others' notions that development is abrupt and discontinuous, or that a person operates from only one structure at any given time. As in Perry's scheme, King and Kitchener make no assumptions that an individual's reasoning fits only one stage at any point in time. They concur with Fischer (Bidell & Fischer, 1992; Fischer & Pipp, 1984; Kitchener & Fischer, 1990) that individuals have both an optimal and a functional level, and the difference between them is an individual's developmental range, a concept that is similar to Vygotsky's (1962) zone of proximal development. In this view, stage change may be marked by rapid spurts of growth, followed by a plateau that permits generalization across domains. The Reflective Judgment Interview, which requires individuals to reason aloud spontaneously, elicits responses that might be more at the functional level than at the optimal level, as King and Kitchener (1994) note. Their Prototypic Reflective Judgment Interview, which includes contextual support and prompts for the interviewee, was developed as a means of tapping the optimal level (Kitchener et al., 1993). Currently under development is the Reflective Thinking Appraisal, a written instrument for assessing reflective judgment.

Results from their longitudinal study show that (a) higher-stage reasoning was more evident, and lower-stage reasoning less evident, over time; (b) higher educational attainment was correlated with higher stages of reflective judgment; developmental spurts coincided with college attendance; and a strong linear relationship existed between age and stage (King & Kitchener, 1994; Kitchener & King, 1981). For example, King and Kitchener (1994) reported results from both cross-sectional and longitudinal studies of over 1,700 individuals from teenagers through adulthood. Across these studies, mean scores of both first-year college students and college sophomores were 3.6, with a mean for juniors of 3.7, and seniors at 4.0, not quite half a stage higher than first-year students. Studies of adult college students report means identical to the traditional-age group during both the first year of college (3.6) and the senior year (4.0). Thus the typical graduating senior, according to these findings, has attained only the lowest rung of quasi-reflective thinking. The greatest gain in reflective judgment appears in graduate students, with those in the early phases of graduate training averaging 4.6 and

upper-level students averaging 5.3. Among the existing studies, consistent use of Stage 6 reasoning appears only at the advanced doctoral level. Graduate students in social science programs scored higher than those in mathematical science, possibly an effect of the relative emphasis on ill-structured problems. Studies of nonstudent adults indicate a strong relationship between reflective judgment and prior college attendance.

Given the interest in gender differences in ways of knowing, Kitchener and King (1994) examined results of their 10-year study and found no gender differences in the first two testings, but found that men scored at higher stages than women in the latter two of the four testing periods. They speculate that this may be attributable to differences in educational attainment, given that men in the study were substantially more likely to have pursued postbaccalaureate education during that time. Of 14 other studies utilizing the Reflective Judgment Interview, 7 found no gender differences, and 6 of the other 7 reported higher scores among males (King & Kitchener, 1994).

Linkages to Other Constructs

Reflective judgment has been characterized by King and Kitchener as falling within the broad domain of intellectual development, and one of the issues in their work has been distinguishing the construct from conceptually similar ones, such as critical thinking. They make the distinction that critical thinking is more concerned with the solving of closed, well-structured problems and that epistemic assumptions have been ignored in the work on critical thinking. Empirical studies on the relationship between critical thinking and reflective judgment suggest that they are related but different constructs (King & Kitchener, 1994). Similarly, low to moderate correlations between critical thinking and verbal reasoning have led King and Kitchener to conclude that these may also be related, but can be distinguished from one another. Other studies have investigated the relationship between reflective judgment and various aspects of character development, with results suggesting a moderate relationship between reflective judgment and psychosocial development, and the possibility that the development of reflective judgment may be a necessary but not sufficient condition for moral judgment (King & Kitchener, 1994).

Discussion

King and Kitchener (1994) have provided the most extensive developmental scheme with epistemological elements. Although based primarily on studies of college students, this research program has been more explicitly derived from developmental psychological models than research on college student development and higher education. The model is particularly noteworthy for its elaboration of the upper levels of Perry's scheme and for the specification of dimensions of epistemic cognition. It has been widely used by others interested in the construct and may be most useful for educators who see reflective judgment as a desirable educational outcome.

It may be problematic, however, that actual reflective judgment, noted in Stages 6 and 7, appears to have been attained by only a minute fraction of those interviewed and has appeared consistently only among advanced graduate students. The rarefied nature of its existence and its appearance only among the

academic elite could be cause for questioning either current educational practices (if one believes that this is an important developmental outcome of education) or biases reflective only of advanced schooling practices.

The focus of the reflective judgment model is on the perception and resolution of ill-structured problems, and it is from individual responses to these problems that epistemic assumptions are extrapolated. This approach to epistemological development enabled the authors to define an area of intellectual development that they claim had not been tapped by studies on critical thinking. In terms of epistemological beliefs, however, it is not likely that they are tapped *only* by reasoning about ill-structured problems. Students are likely to have ideas about knowledge and knowing that are activated in everyday educational settings and which affect their learning on a routine basis. Responses to the hypothetical problems posed in the interviews may tell us little about how student beliefs are aroused in actual experiences. It may be more difficult to figure out how to capture this, however.

In addition, there are some other limitations. First, only trained raters have been permitted to utilize the Reflective Judgment Interview, which has limited its use and restricted scrutiny of the methodology of rating. Wider use may be available when the Reflective Thinking Appraisal is available. Existing studies have primarily utilized interviews with White college students, so less is known about other populations; information about gender differences is still inconclusive.

We know little about how reflective judgment develops in context and just how education makes a difference. And although it appears that education is correlated with stage, and that reflective judgment is tied to the goals of a liberal arts education, it is surprising how little development actually takes place during college, reported as less than half a stage on the average. Classroom-level studies are needed to investigate how these changes come about and the characteristics of educational environments that might foster them.

5 *Argumentative Reasoning*

Interested in the thinking that occurs in everyday lives, D. Kuhn (1991) pursued the notion of thinking as argumentative reasoning. Kuhn's work on informal reasoning was an attempt to study how individuals responded to everyday, ill-structured problems that lack definitive solutions. Although the primary purpose of the study was to investigate argumentative thinking, the attempt to understand how and why individuals reasoned also elicited beliefs about knowledge, and a portion of the study focused specifically on epistemological perspectives.

Method

A critical element of Kuhn's design was the inclusion of a broader sample of subjects. The participants were from four age groups: teens, 20s, 40s, and 60s. There were 40 subjects in each age cohort, and within each cohort gender and educational level (college and noncollege) were equally represented. Participants were individually interviewed twice for 45 to 90 minutes each time, in settings familiar to the participants, such as home or work environments. In the interest of eliciting reasoning about complex, real-world phenomena, Kuhn selected three current urban social problems as the basis for the interviews. Subjects were asked to generate causal explanations for each of these topics: (a) What causes prisoners

to return to crime after they're released?, (b) What causes children to fail in school?, and (c) What causes unemployment? Individuals were expected to explain how they came to hold a view and to justify the position with supporting evidence. Participants were also asked to generate an opposing view, provide a rebuttal to that position, and then offer a remedy for the problem. The final segment of the interview explicitly asked for epistemological reflection on the reasoning presented.

Kuhn noted that there were several sections of the interview which provided indicators of the epistemological standards that underlay argumentative reasoning. These sections included questions regarding *proof* (e.g., "Is there anything someone could do or say to prove that this is the case?," "Could someone prove that you were wrong?"), *expertise* (e.g., "Do experts know for sure what causes ____?"), *multiple viewpoints* (e.g., "Is more than one point of view possible regarding the question of what causes ____?," "Could more than one point of view be right?"), *origins of theories* (e.g., "Can you remember what it was that led you to believe that this is the case?"), and *certainty* (e.g., "How sure are you of your view compared to an expert?"). However, although these multiple dimensions of epistemological beliefs were identified, the development of epistemological categories was based only on questions regarding expertise, and no specific information was provided about the procedure used.

Model

Kuhn reports that the epistemological thought evidenced in the interview broadly resembles the forms reported by Perry (1970), Kitchener, King, and others (King et al., 1983; Kitchener & Fischer, 1990; Kramer & Woodruff, 1986). She defines three categories of epistemological views: absolutist, multiplist, and evaluative (which are aligned with Perry's, Belenky et al.'s, and Baxter Magolda's positions, as shown in Table 1).

Absolutists view knowledge as certain and absolute, stress facts and expertise as the basis for knowing, and express high certainty about their own beliefs. *Multiplists* deny the possibility of expert certainty and are skeptical about expertise generally. They see that experts not only disagree but are inconsistent over time. The multiplist position is marked by "radical subjectivity." In the devaluing of experts, multiplists are likely to give weight to emotions and ideas over facts. In this framework, beliefs take on the status of personal possessions, to which each individual is entitled. The result is that all views may have equal legitimacy, and one's own view may be as valid as that of an expert. While the *evaluative* epistemologists also deny the possibility of certain knowledge, they recognize expertise and view themselves as less certain than experts. Most importantly, they understand that viewpoints can be compared and evaluated to assess relative merits. The possibility of genuine interchange with those with conflicting opinions is acknowledged, as is the possibility that theories may be modified as a result. Kuhn claims that argument is at the heart of this process, as it offers a means of influencing others' thinking.

Classification of subjects into these three categories, which appear to be condensed versions of the Perry (1970) and Kitchener and King (1994) schemes, was done by examining responses that regarded the certainty of expertise. Absolutists claimed that experts can know for certain. Multiplists claimed that experts will

never reach certainty and that their own certainty equaled or exceeded that of experts. Those in the evaluative category claimed that while experts could not reach complete certainty, they were relatively more certain.

An analysis of responses of the 169 subjects in Kuhn's study indicated that only 2 subjects were consistently classified across the three topics as in the evaluative category, which may be surprising given the ranges of ages and backgrounds in the study. Eleven others were classified at the evaluative level for two of the three topics, for a total of 13, still a relatively small percentage. This "horizontal decalage" in levels of epistemological beliefs by topic area highlights the importance of considering task and domain effects. Kuhn found no significant gender or age differences. There was a relation between educational background and epistemological level; those in the higher education group were more likely to be in the evaluative category and less like to be absolutist.

Linkages to Other Constructs

Kuhn examined the relationship between epistemologies and argument skills by topic and found results to be weak but in the expected direction, with subjects in the evaluative category most likely to show skills of argument. Three argument skills were identified: generation of genuine evidence, generation of alternative theories, and generation of any form of counterargument. An analysis of the relationship between these individual skills and the overall epistemological category indicated that those in the evaluative category were more likely than others to use counterargument and alternative theory generation. Kuhn concluded that "it is primarily the emergence of the evaluative epistemology that is related to argumentative skill development" (D. Kuhn, 1991, p. 195). At this level, individuals are most likely to see the value of argument and the need for comparing and evaluating alternative claims.

Discussion

Kuhn's contribution to the literature on epistemological understanding has been not in the development of a model, as she appears to use a simplified three-stage representation of Perry's scheme and offers little information as to the empirical validation of this scheme, but in the connection of epistemological theories to reasoning. The skills of argument appear predicated on a level of epistemological understanding that requires contemplation, evaluation, and judgment of alternative theories and evidence. These cognitive processes, according to Kuhn, require the metacognitive ability to be reflective about one's own thinking. In an earlier work, Kuhn, Amsel, & O'Laughlin (1988) claimed that such skills are unlikely prior to early adolescence, a finding congruent with the formal operational thought of Piaget's developmental theory (Inhelder & Piaget, 1958).

Kuhn's work seems least clear in the definition of elements that comprise epistemological theories. The interview protocol is described as addressing epistemological issues of proof, expertise, and certainty. The assignment of responses to levels, however, was based solely on questions relating to expertise, although responses regarding both certainty and proof are provided as illustrations of the three levels. Other elements identified but not well elaborated are classified as strength of argument, origins of theories, and attitudes toward the topic. Clearly the role of evidence is the most delineated of the elements in Kuhn's levels of

epistemological theories, which may be a result of the nature of the study, with its focus on argumentation and the role evidence is given in this process. This focus seems to exemplify the emphasis of Western schooling, and it is not surprising that the graduate-trained philosophers in her study do best.

The study is notable in its focus on ill-structured problems from everyday life and in the use of a broad sample of participants across the life span. This sampling of a broader population on nonacademic issues removes epistemological beliefs from the realm of the classroom and separates issues of knowing from those of teaching and learning processes.

Epistemological Beliefs

Interested in how epistemological beliefs influence comprehension and academic performance, Schommer (1990, 1993b; Schommer et al., 1992) has developed a research program that is more quantitative than that of her predecessors and takes a more analytic view of the components of beliefs. Her examination of conflicting results in other work that attempted to tie Perry's scheme to metacomprehension (Ryan, 1984b) led her to challenge the notion that epistemological beliefs were unidimensional and developed in fixed stages. She proposed a belief system made up of five more or less independent dimensions, which she hypothesized as structure, certainty, source of knowledge, and control and speed of knowledge acquisition. (These do not follow a general stage sequence, so they are not shown in Table 1.) The conceptual origins for the first three were in Perry's work, and the latter two in Dweck and Leggett's (1988) research on beliefs about the nature of intelligence and Schoenfeld's (1983, 1985, 1988) work on beliefs about mathematics.

Method

Schommer has developed a questionnaire consisting of 63 short statements that characterize epistemological beliefs. These are stated in either the negative or the positive extreme on the questionnaire, and respondents rate the statements on a Likert scale from 1 (strongly disagree) to 5 (strongly agree). Two or more subsets of items were written for each of the five proposed dimensions; some of these came directly from Perry's Checklist of Educational Values (CLEV), and others were adapted from Schoenfeld (1983, 1985), Dweck and Leggett (1988), and others. These were reviewed and categorized into 12 subsets by three educational psychologists prior to the piloting of the questionnaire with undergraduates (Schommer, 1990). Factor analysis was performed in this and subsequent studies and has typically yielded four factors, which, stated from a naive perspective, are Fixed Ability, Quick Learning, Simple Knowledge, and Certain Knowledge. However, it is important to point out that the factor analysis reported in these studies was conducted by using the 12 subsets of items as variables, not the 63 items themselves.

Model

Each of the four factors is viewed as a continuum, although they are stated from the naive perspective. *Fixed Ability* is a concept borrowed from Dweck and Leggett (1988), who found that some individuals believe intelligence is a fixed entity and others view it as incremental, believing that it can be improved. Three

subsets of items appear to load on this factor across several studies: Can't Learn How to Learn (sample item: "Self-help books are not much help"), Success Is Unrelated to Hard Work (sample item: "The really smart students don't have to work hard to do well in school"); and Learn the First Time (sample item: "Almost all the information you get from a textbook you will get during the first reading"). One subset, Ability to Learn Is Innate (sample item: "An expert is someone who has a special gift in some area"), was hypothesized as a part of the Fixed Ability factor, but has not consistently loaded there. In two of three recent studies this subset has loaded on the Quick Learning factor.

Quick Learning characterizes the view that learning occurs quickly or not at all; at the other extreme of the continuum is the belief that learning is gradual. Only one subset of items has consistently loaded on this factor, a subset entitled Learning Is Quick (sample item: "Successful students learn things quickly"). The factor *Simple Knowledge* suggests a range of beliefs from that of knowledge as isolated, unambiguous bits to a view of knowledge as highly interrelated concepts. This factor contains the subsets Avoid Ambiguity ("I don't like movies that don't have an ending"), Seek Single Answers ("Most words have one clear meaning"), and Avoid Integration ("When I study I look for specific facts"). Although two or more subsets were written for each factor, only one has consistently loaded on *Certain Knowledge*, the subset Knowledge Is Certain ("The only thing that is certain is uncertainty itself"). This factor was conceptualized as a continuum from the belief that knowledge is absolute to the belief that knowledge is tentative and evolving. The fifth hypothesized dimension, "source of knowledge," (Schommer, 1990, 1994b) does not appear to emerge as a factor from the current questionnaire subsets. Schommer suggests that the continuum would range from authority to reason, but those subsets related to issues of authority have typically loaded on two or more of the other four epistemological dimensions.

Linkages to Other Constructs

The implications of epistemological beliefs for instructional psychology were first explored by Ryan (1984a, 1984b), who extended Perry's work to examine how individual differences in epistemological beliefs might affect comprehension and thus academic performance in college students. Ryan hypothesized that the transition Perry described from dualism to relativism, with the movement from a conception of knowledge as discrete facts to a conception of knowledge as interrelated propositions, would be associated with changes in information processing strategies. In a study of the monitoring of comprehension, Ryan identified students as either dualists or relativists and then assessed their comprehension criteria using Bloom's taxonomy (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956). Dualists reported criteria that involve the knowledge category, and relativists reported criteria that involved higher levels in Bloom's taxonomy, the comprehension or application categories.

Schommer has furthered this investigation of how epistemological beliefs affect academic work. In a series of studies using her questionnaire on epistemological beliefs, she has documented the relation between beliefs about knowledge, strategy use, and performance. In a study of college undergraduates (Schommer, 1990), students completed the questionnaire and then several weeks later were asked to read a passage of text as if preparing for a test, supply a concluding

paragraph, rate their degree of confidence in comprehending the material, and complete a mastery test. Belief in quick learning predicted oversimplified conclusions, low test scores, and overconfidence. Those who believed in certain knowledge were likely to generate inappropriately absolute conclusions.

In a second study of college undergraduates (Schommer et al., 1992), students completed the epistemological questionnaire and then read a statistical passage. They rated their comprehension confidence, then completed a mastery test and a study strategy inventory. Higher confidence and better performance were negatively correlated with belief in simple knowledge. Path analysis also suggested that epistemological beliefs may have an indirect effect on academic performance, as belief about knowledge may affect study strategies.

Schommer has conducted several other related studies on epistemological beliefs. Results of a study of junior college and university students indicated differences on all four dimensions, with university students more likely to believe in fixed ability and junior college students more likely to believe in simple knowledge, certain knowledge, and quick learning (Schommer, 1993a). A study of epistemological beliefs of high school students indicated that there were no differences between gifted students and others in ninth grade, but that by the end of high school, gifted students were less likely than others to believe in simple knowledge and quick learning (Schommer & Dunnell, 1994). Differences in beliefs during high school years were the focus of a cross-sectional study that indicated a linear trend in all epistemological beliefs except fixed ability from freshman to senior year. In the same study, epistemological beliefs also predicted GPA, and gender differences were found in two dimensions, with females less likely to believe in fixed ability or quick learning (Schommer, 1993b). In a study of adults, education predicted simple and certain knowledge; the more exposure to education, the less likely individuals were to subscribe to these beliefs (Schommer, 1992). Recent work on the domain independence of beliefs indicated that epistemological beliefs are moderately similar across social science and mathematics (Schommer & Walker, 1995).

Discussion

Schommer's central contributions have been in three areas: (a) suggesting that epistemological beliefs may be a system of dimensions that are relatively independent of one another, (b) initiating an empirical investigation of the study of several proposed dimensions, and (c) initiating an important and insightful line of research that links epistemological beliefs to issues of academic classroom learning and performance. At the same time, there are some conceptual and measurement issues that remain unresolved in this model.

Conceptually, the theoretical rationale for the four dimensions is somewhat problematic. Two of the factors, Simple Knowledge and Certain Knowledge, appear consistent with the other epistemological models and theories we have reviewed here. Fixed Ability, however, seems well outside the construct of epistemological beliefs, and it is not surprising that while it continues to appear as a factor it does not follow the patterns of other dimensions or appear to be a useful predictor in Schommer's research. This seems to have been interpreted as evidence that the dimensions operate independently; in fact, it may be indicative of the lack of relation between Fixed Ability and the other dimensions. As conceived

by Dweck and Leggett (1988), the idea that an individual holds either an entity view or an incremental view of ability is part of one's implicit theory of intelligence. These beliefs about ability can have motivational power, as they lead to either performance or mastery goals. Views of intelligence, however, have not typically been thought of as part of the construct of epistemological beliefs, though they may be indirectly related to learning in that they motivate goal choice and thus affect the academic behavior that ensues. It seems to us that fixed ability beliefs concern the nature of intelligence as a personal, psychological trait of an individual. As such, it is not clearly a dimension regarding the nature of knowledge as a general epistemological and philosophical question. Although beliefs about the nature of knowledge and the nature of intelligence or ability may be correlated with one another, they are separate constructs, and it seems more useful and theoretically fruitful to keep them separate.

The dimension quick learning is also problematic from a nature of knowledge perspective. It seems that quick learning is a perception of the difficulty of the task of learning and a general expectation or goal regarding learning. Although beliefs about learning are probably related to beliefs about knowledge, they can be distinguished conceptually. A belief about what knowledge is and how it can be described is not the same as a belief about how quickly one might go about learning. Although they may be correlated, it seems useful to separate quick learning beliefs from beliefs about the certainty or absolute nature of knowledge. The idea of quick learning may also be related to implicit theories of intelligence and ability. A student who thinks that ability is fixed may be likely to believe that learning then takes place quickly or not at all, as a consequence of one's ability. As noted earlier, in some of Schommer's studies the subset of items defined as Innate Ability has loaded on the factor Quick Learning. Beliefs about whether learning is quick may predict comprehension and performance, but this does not mean it is an epistemological belief about the nature of knowledge or how knowledge is justified.

Schommer's fifth hypothesized dimension, source of knowledge, has yet to be empirically validated as a factor in her studies. Stated in the naive perspective as Omniscient Authority, this dimension is conceptualized as a continuum that ranges from the belief that knowledge is handed down from authority to the belief that it is derived from reason. Two subsets were written for this dimension: Don't Criticize Authority (sample item: "People who challenge authority are overconfident") and Depend on Authority (sample item: "How much a person gets out of school depends on the quality of the teacher"). Source of knowledge may be more complex and multidimensional than this would indicate, including not only views of authority but the role of the self as knower, as suggested by Belenky et al. (1986).

In terms of the measurement issues, construct validity issues regarding the content representativeness and content relevance (see Messick, 1989) of the items plague much of Schommer's epistemological beliefs instrument. A number of items are vague remnants of personality measurement with questionable relevance, unlikely to serve well as very precise indicators of beliefs about knowledge. For example, skepticism about the value of self-help books might not be the best indicator that one does not believe in the ability to learn how to learn (the subset of which it is a part), much less indicative of belief in fixed ability. These

items may introduce a rather high degree of construct-irrelevant variance in the instrument. In general, a careful examination of the specific items does not lead to confident judgments that the items are good representations or samples of the content domain of epistemological beliefs (Messick, 1995). Furthermore, the phrasing of items selected from other sources varies in a way that makes it difficult to determine whether the respondent is referring to personally held epistemological beliefs or perceptions of others' generalized beliefs. The items include first-person stems ("I often wonder how my teacher really knows") as well as those phrased in second-person format ("You should evaluate the accuracy of information in a textbook if you are familiar with the topic") and third-person format ("Nothing is certain but death and taxes").

As mentioned previously, the absence of confirmatory factor analysis on the full slate of 63 items, not just the subset of items, also raises doubts about the evidence presented for the substantive validity of the questionnaire. It is not clear from the factor analyses whether the full set of 63 items would actually load onto the four or five proposed factors because no item analysis has been reported, only factor analyses of the a priori subsets of items. Furthermore, given that the items in the subsets have not been empirically verified by Schommer and that the credibility of the factors thus rests on the degree to which the subsets load as variables, it is of serious concern that for two of the factors, Quick Learning and Certain Knowledge, only one subset has consistently loaded across multiple studies. In one recent study by Qian and Alvermann (1995), an attempt to factor analyze the items led to a three-factor model, with simple and certain knowledge combined and the reduction of the questionnaire to 32 items (those with a factor loading greater than .30).

Measuring epistemological beliefs in paper-and-pencil questionnaire format is an attractive and expedient alternative to interviews and has made it possible for Schommer and others (e.g., Dunkle, Schraw, Bendixen, & Grosskopf, 1994) to pursue multiple studies that identify the relation between beliefs about knowledge and other cognitive processes and actual learning. This is a very important contribution to the field by Schommer and an important area for future research. However, considerable questions remain about this approach, as well as about this particular use of survey methodology. Although each of the dimensions is conceptualized as a continuum, it may be difficult to assume that a continuum of epistemological beliefs can be represented or measured by simply stating extreme positions and registering degrees of agreement. More recently, Schommer has begun to outline the possibility that beliefs may be better represented as a frequency distribution, but there is no empirical substantiation of this as yet (Schommer, 1994a, 1994b).

In proposing that epistemological beliefs are a system of more or less independent dimensions, Schommer claims that learners could be sophisticated in some beliefs but not in others. The question still remains regarding the extent to which these dimensions are independent and whether there might be reason to expect some covariance among dimensions, even if not the structural alignment predicted by stage theory. Given the strength of previous research on epistemological development, more evidence is needed to identify the range of dimensions and to test their independence than exists in Schommer's studies to date.

Theoretical and Methodological Issues for Future Research on Epistemological Theories

Across the various models of what individuals think that knowledge is and how one comes to know are numerous theoretical and methodological issues. We have organized them into nine general issues. First, the general definition of the construct varies across the field, as do the boundaries. Second, there has also been a lack of conceptual clarity about the elements or dimensions that constitute individual epistemological theories or beliefs. Third, although some researchers agree that views about knowledge progress in developmental sequence (King & Kitchener, 1994; Perry, 1970), the proposed stages vary somewhat across models. Others have questioned a developmental stage conceptualization and have posited dimensions that operate more or less independently of one another (Schommer, 1994b). A fourth issue concerns how epistemological beliefs might be related to other aspects of cognitive development, age, and education. A fifth issue concerns the mechanisms by which individuals acquire and change their perspectives on knowing. The majority of existing research has been with college students, and we know little about the origins of these ideas or their early influences. A sixth issue concerns the domain specificity-generalizability issue. A growing body of literature has also arisen about discipline-specific beliefs (Lampert, 1990; Mtetwa & Garofalo, 1989; Roth & Roychoudhury, 1994; Schoenfeld, 1983, 1988, 1992; Stodolsky, Salk, & Glaessner, 1991), but little has been done to assess the interaction of these beliefs with more general epistemological beliefs, nor to resolve broader issues of domain specificity in epistemological beliefs. The seventh issue revolves around the relations between epistemological beliefs and individuals' cognition, motivation, and learning. The eighth issue concerns the nature of gender, ethnic, and cultural differences as context. Finally, there are methodological issues that need to be addressed. Each of these issues will be discussed in more detail below.

Construct Definition

Defining the construct based on existing research is problematic, as there are discrepancies in naming the construct as well as in defining the construct, to the extent that it is sometimes unclear to what degree researchers are discussing the same intellectual territory. There are three general issues regarding the definition of the construct. First, there are differences in the labeling of the construct that reflect different theoretical assumptions about the nature of the construct. Second, there are disagreements about the boundaries of the construct in terms of what is included or excluded as part of the construct. Finally, the nature of the relations between epistemological thinking and general thinking and reasoning varies in the different models. We discuss each of these three issues in more detail below.

In terms of the first issue, each of the models describes the construct with a different label that signifies different theoretical assumptions about both the nature of the construct and its function. Researchers vary in approaching the construct as (a) a cognitive developmental structure, (b) a set of beliefs, attitudes, or assumptions that affect cognitive processes, or (c) a cognitive process itself. *Epistemological development* (Boyes & Chandler, 1992; Perry, 1981) implies that these ideas are part of a structurally coherent, logically sequenced developmental process. The work of King and Kitchener (1994) and their colleagues proposes

that their *epistemological assumptions* are organized as cognitive developmental structures. Although these models recognize different components of epistemological thinking, the cognitive structures and the accompanying general levels or stages proposed in the models imply that the components are not separable or orthogonal dimensions.

On the other hand, *epistemological standards* or *attitudes*, the terms favored by Ryan (1984a, 1984b), and *epistemological beliefs*, the term used by Schommer (1994a), are not organized into stages or levels, and the different beliefs or attitudes can be orthogonal and can show variation within individuals that is not organized in a stagelike structure. In addition, attitudes and beliefs may connote a personal conviction or simply an unverified opinion, not a reasoned cognitive structure. Yet another conceptualization of the construct has been that of *epistemological style* (Martin, Silva, Newman, & Thayer, 1994), suggested as a more traitlike construct that represents a stable individual difference in beliefs about epistemology.

Beliefs has been a particularly slippery term in the psychological literature, though a number of individuals have attempted to distinguish beliefs from attitudes, typically arguing that attitudes are more affective and beliefs more cognitive (Fishbein & Ajzen, 1975). Richardson (1996) offers a definition of beliefs claimed to be congruent across anthropology, social psychology, and philosophy: "Beliefs are thought of as psychologically-held understandings, premises or propositions about the world that are thought to be true" (p. 4). Fenstermacher (1994) has pressed for greater conceptual clarity in the distinction between *beliefs* and *knowledge*, terms that recently have been used somewhat interchangeably in the teacher education literature. He makes the distinction that knowledge has higher epistemic status than beliefs, and that knowledge has justifiable, supportable claims. In the context of epistemological models, this distinction would be applicable to models that focus on students' reasoning and justification for their epistemological thinking (e.g., King & Kitchener, 1994; Perry, 1981), in contrast to models that describe students' epistemological beliefs as relatively unexamined beliefs or assumptions (e.g., Schommer, 1994b).

Besides the issue of form, the second issue concerns the content of individuals' epistemological beliefs and thinking. Table 2 displays a summary of the different constructs from the various theories and models. Table 2 was developed by comparing and contrasting the different aspects of the theories and models and categorizing these features into a general framework. Across those whose work has been reviewed, there seems to be some agreement about ideas that cluster as two core sets of concerns: the nature of knowledge and the nature or process of knowing, although not all of the models reviewed deal fully with both (see Table 2). These two general epistemological dimensions have also been pointed out by Fenstermacher (1994) in his review of the nature of knowledge in research on teaching.

There is less agreement in the existing literature on whether beliefs about learning, intelligence, and teaching are also a part of this terrain. As can be seen in Table 2, some of the models we have reviewed have included these constructs in their research on epistemological beliefs, although all the models exclude beliefs about intelligence except for Schommer's. The inclusion of learning and pedagogical concerns may have stemmed from the early focus of inquiry, which

TABLE 2
Components from existing models of epistemological beliefs and thinking

Researcher(s)	Core dimensions of epistemological theories		Peripheral beliefs about learning, instruction, and intelligence	
	Nature of knowledge	Nature of knowing	Nature of learning and instruction	Nature of intelligence
Perry	<i>Certainty of knowledge:</i> Absolute ↔ Contextual Relativism	<i>Source of knowledge:</i> Authorities ↔ Self		
Belenky et al.		<i>Source of knowledge:</i> Received ↔ Constructed Outside the self ↔ Self as maker of meaning		
Baxter Magolda	<i>Certainty of knowledge:</i> Absolute ↔ Contextual	<i>Source of knowledge:</i> Reliance on authority ↔ Self <i>Justification for knowing:</i> Received or mastery ↔ Evidence judged in context	Role of learner Evaluation of learning Role of peers Role of instructor	

TABLE 2 (continued)

Researcher(s)	Core dimensions of epistemological theories		Peripheral beliefs about learning, instruction, and intelligence	
	Nature of knowledge	Nature of knowing	Nature of learning and instruction	Nature of intelligence
King & Kitchener	<p><i>Certainty of knowledge:</i> Certain, right/wrong ↔ Uncertain, contextual</p> <p><i>Simplicity of knowledge:</i> Simple ↔ complex</p>	<p><i>Justification for knowing:</i> Knowledge requires no justification ↔ Knowledge is constructed, and judgments are critically reevaluated</p> <p><i>Source of knowledge:</i> Reliance on authority ↔ Knower as constructor of meaning</p>		
Kuhn	<p><i>Certainty of knowledge:</i> Absolute, right/wrong answers ↔ Knowledge evaluated on relative merits</p>	<p><i>Justification for knowing:</i> Acceptance of facts, unexamined expertise ↔ Evaluation of expertise</p> <p><i>Source of knowledge:</i> Experts ↔ Experts critically evaluated</p>		

TABLE 2 (continued)

Researcher(s)	Core dimensions of epistemological theories		Peripheral beliefs about learning, instruction, and intelligence	
	Nature of knowledge	Nature of knowing	Nature of learning and instruction	Nature of intelligence
Schommer	<p><i>Certainty of knowledge:</i> Absolute ↔ Tentative and evolving</p> <p><i>Simplicity of knowledge:</i> Isolated, unambiguous bits ↔ Interrelated concepts</p>	<p><i>Source of knowledge:</i> Handed down from authority ↔ Derived from reason</p>	Quick learning	Innate ability

was on college students' understanding of their educational experiences, and the fact that Perry cast a wide net in his attempt to understand student perceptions of a pluralistic university. He mentions epistemology as a part of his scheme of "intellectual and ethical development," which is seen as encompassing the ways in which students make meaning of their experiences.

Those who built on Perry's work and attempted to design written means of assessment of the Perry scheme often veered from a focus on the epistemological. For example, the Learning Environment Preferences (LEP; Moore, 1989) and the Measure of Epistemological Reflection (MER; Baxter Magolda, 1992; Baxter Magolda & Porterfield, 1985), commonly used measures of the Perry scheme, seem to confound perceptions of educational experience with epistemology. Only one question set in the MER, which asks whether one instructor can be more correct than another if they give different explanations, might be construed as explicitly epistemological, although the instrument is identified as an epistemological assessment tool. A more typical question is "Do you prefer classes in which the students do a lot of talking or where students don't talk very much?" Similarly, the LEP, more accurately named, is a checklist of educational preferences for learning and instructional styles. Although these instruments were designed to measure aspects of Perry's model, a careful review of Perry's positions does not show these issues of classroom learning and teaching as part of the original scheme. Accordingly, we have not listed issues of classroom learning and teaching (such as role of instructor, role of peers, classroom atmosphere, grading and evaluation) in Table 2 as part of Perry's model.

It is not clear if beliefs about learning, intelligence, and teaching should be considered as central components of epistemological beliefs. On one hand, they do not explicitly deal with the nature of knowledge or knowing in terms of how knowledge is defined and justified as most philosophical and psychological treatments have defined this domain. As shown in Table 2, they are not represented in all the models to the same extent as beliefs about the nature of knowledge and knowing. In terms of conceptual clarity, it seems to us that the domain of epistemological beliefs should be limited to individuals' beliefs about knowledge as well as reasoning and justification processes regarding knowledge. On the other hand, beliefs about learning and teaching are related to how knowledge is acquired, and in terms of the psychological reality of the network of individuals' beliefs, beliefs about learning, teaching, and knowledge are probably intertwined.

A third confounding in the definition of the construct concerns the differences between epistemological assumptions about the process of knowing and general thinking and reasoning processes, such as argumentation skills and inductive reasoning. Because thinking and reasoning processes, such as forms of argument (D. Kuhn, 1991) and reasoning about ill-structured problems (King & Kitchener, 1994), elicit epistemological assumptions, it has been meaningful to study them together, but they can be separated conceptually. In fact, by distinguishing between epistemological beliefs and thinking and reasoning processes, greater clarity can be achieved about the nature of these constructs as well as the relations between them.

Epistemological thinking is described as a cognitive process, as in epistemic cognition (Kitchener, 1983) or epistemic reflection (Baxter Magolda, 1992), or simply as ways of knowing (Belenky et al., 1986), which involve the ways in

which individuals think about the process of knowing. As shown in Table 2, the different models have included the nature of knowing, which involves beliefs about the source of knowledge, ranging from a reliance on experts to provide knowledge to more self-constructive processes. A second aspect of the nature of knowing involves the role of evidence and the processes of justifying knowledge. These processes are usually assumed to be cognitive processes of a higher level than simple inductive reasoning or general critical thinking. Kitchener (1983) suggests that epistemological cognition is to be distinguished from both cognition and metacognition, and that epistemic cognition is a third-order monitoring process of the epistemic nature of problems. Wilkinson and Schwartz (1987) also speak of epistemological orientation as a higher-order process that guides cognitive processes. This distinction between thinking about how knowledge is generated and justified in comparison to more specific inductive reasoning and thinking is important to maintain in future research.

Given this analysis of the three issues regarding the definition of the construct of epistemological beliefs, we propose that the content of the construct of epistemological beliefs be limited to individuals' beliefs about the nature of knowledge and the processes of knowing. We recognize that beliefs about learning, intelligence, and teaching are related to epistemological beliefs and that general thinking and reasoning processes are also related to epistemological thinking. However, we think that this delimitation of the construct will provide clarity to the research and theorizing in the field and lead to more progress in our understanding of the structure and function of epistemological beliefs than more global and inclusive definitions.

In terms of the form or structure of epistemological beliefs, we propose that individuals' beliefs about knowledge and the process of knowing be considered as personal *theories*. This proposal is in line with the conceptual change literature (Carey, 1985; Vosniadou & Brewer, 1994; Wellman & Gelman, 1992) as well as the research on theory of mind (Wellman, 1990) which suggests that individuals' knowledge in a domain is structured in ways analogous to how theories are structured in science. As in the conceptual change literature, this proposal to represent epistemological beliefs and thinking as a personal theory that an individual holds seems to be a good compromise between the overly general stage models that do not allow for within-stage variation in the structure of beliefs (i.e., the problem of horizontal decalage) and models that suggest that epistemological beliefs and thinking can be orthogonal dimensions and do not necessarily have to cohere into some more comprehensive structure.

It remains to be seen empirically if individuals' personally held epistemological beliefs and thinking can best be characterized as a theory. However, Wellman (1990) suggests three criteria for considering a body of knowledge as a theory. First, Wellman notes that a theory should have some coherence among its constitutive ideas and concepts. At one end of a continuum of coherence is discrete facts and ideas that are not well connected. At the other end is a formal theory, such as a scientific theory with theorems and principles, which provides a coherence to the ideas and concepts. As a body of knowledge approaches the theory end of the continuum, the ideas and concepts become more interconnected, and individual concepts are defined in terms of their relations with other ideas and concepts in the domain. Given the previous research on epistemological beliefs and thinking

reviewed here, it appears that individuals' beliefs about knowledge and how they think about knowledge are interconnected in complex and coherent ways. As an examination of Table 2 shows, the different aspects of beliefs about the nature of knowledge and process of thinking are interrelated in a way that could be considered theory-like. Of course, we are not suggesting that individuals have a formal epistemological theory as would a professional philosopher, but rather that individuals' ideas about knowledge are towards the theory end of the continuum and are not just discrete, unrelated bits of knowledge.

Wellman's (1990) second criterion for considering a body of knowledge as a theory is that it make some ontological distinctions between certain entities and processes in the domain. That is, the theory helps to specify what is in the domain and how the objects in the domain are to be categorized. As can be seen in Table 2, the different models all seem to make some distinction between the nature of knowledge and the process of knowing. In addition, the models distinguish between the certainty of knowledge and the source of knowledge. These distinctions do seem to have implications for individuals' thinking. For example, from the research we have reviewed, it does appear that if an individual makes an ontological commitment to a particular stance regarding the certainty of knowledge (i.e., absolutist versus relativistic), then they will perceive and think about their experience in a certain manner. This supports that idea that individuals' epistemological beliefs can function as a theory which can guide their subsequent thinking as in other theory-driven processes (e.g., scientific thinking as theory-driven).

The third criterion suggested by Wellman (1990) involves the idea that a theory provides a causal-explanatory framework for the phenomena in the domain. For example, it appears that individuals do have "naive" theories in the domains of biology, physics, and psychology and that these naive theories do include various causal-explanatory frameworks for the phenomena in those domains (see Wellman & Gelman, 1992). It is not clear if this is the case with epistemological beliefs, although it may be that aspects of the nature of knowledge can act as constraints on the processes of knowing. For example, if one believes that knowledge is absolute, then it makes sense that the source of knowledge would be authority figures. This may not be a strong exemplar of a causal-explanatory framework, and certainly more empirical research is needed to test our proposal that epistemological beliefs can best be represented as theories. Although it seems likely that the first two criteria can be applied to epistemological beliefs as theories, it is not clear if the causal-explanatory framework criterion is applicable. Nevertheless, we think that conceptualizing epistemological beliefs and thinking in terms of individuals' theories about the nature of knowledge and processes of thinking will be helpful in clarifying and defining the construct.

Dimensions

As noted in Table 2, personal epistemological theories are made up of multiple dimensions. These dimensions appear explicitly in some of the developmental models (Baxter Magolda, 1992; King & Kitchener, 1994) and must be inferred in others (D. Kuhn, 1991; Perry, 1970), but all the models include content related to the nature of knowledge and the processes of knowing. The specific content of these dimensions varies somewhat across the different models, and an attempt will

be made here to identify common elements within the proposed construct of *epistemological theories*. When we eliminate those dimensions that relate explicitly to educational experience or to learning rather than knowing (e.g., *role of the instructor* in Baxter Magolda's model or *quick learning* in Schommer's model) and those that are not represented in other models except one (e.g., *fixed ability* in Schommer's model), the remaining dimensions can be clustered under the two areas identified earlier, *beliefs about the nature of knowledge* and *the nature or process of knowing* (see Table 2).

We propose that these two general areas represent the core structure of individuals' epistemological theories. Within these two general areas of nature of knowledge and nature of knowing, we suggest that there are two dimensions each, providing four dimensions of epistemological theories. As shown in the italicized headings in the cells of Table 2, under *nature of knowledge* we suggest that there are two dimensions: *certainty of knowledge* and *simplicity of knowledge*. Within the area of *nature of knowing* we propose two other dimensions: *source of knowledge* and *justification for knowing*. The four dimensions we have included are represented in most of the models summarized in Table 2. In addition, the aspects we have excluded are not represented in many of the models, and some of those aspects are less clearly epistemological in nature. We hypothesize that these four dimensions should be considered the core of an individual's theory, while the other beliefs about learning, teaching, and intelligence may be related to the core dimensions but are peripheral to an individual's theory, analogous to the distinction between core and peripheral ideas in the conceptual change literature (Pintrich, Marx, & Boyle, 1993). Of course, this model of four dimensions will need to be explicitly tested in empirical research.

It may be that the more peripheral ideas about learning and teaching are developmental precursors to the core ideas about epistemology. The research we have reviewed suggests that epistemological thinking is relatively late-developing, yet children have a fair amount of early experience with learning and teaching situations in home, school, and community settings. Accordingly, epistemological theories are not framework theories in the sense that children's theories of biology, physics, and psychology are assumed to be in the cognitive developmental literature (Wellman, 1990; Wellman & Gelman, 1992). However, considering the four dimensions to be aspects of an individual's personal theory of epistemology does suggest that the dimensions are related to each other in coherent and internally consistent ways, do make some important distinctions about knowledge, and may provide a causal-explanatory framework for thinking about knowledge.

We turn now to a description of the four dimensions.

Nature of Knowledge

What one believes knowledge is underlies most of the models presented. In the developmental schemes, this is viewed as a progressive understanding that moves from the view of knowledge as absolute to a relativistic view and then to a contextual, constructivist stance. In Schommer's factor analysis, nature of knowledge is captured in the factors *Simple Knowledge* and *Certain Knowledge*. The various aspects of the nature of knowledge can be defined further along two dimensions (see Table 2):

Certainty of knowledge. The degree to which one sees knowledge as fixed or

more fluid appears throughout the research, again with developmentalists likely to see this as a continuum that changes over time, moving from a fixed to a more fluid view. At lower levels, absolute truth exists with certainty. At higher levels, knowledge is tentative and evolving. Openness to new interpretation is a key element of King and Kitchener's (1994) highest stage of reflective judgment, and D. Kuhn (1991) speaks of evaluative epistemologists (the highest level) as open to the possibility that their theories may be modified by genuine interchange.

Simplicity of knowledge. As conceptualized by Schommer, knowledge is viewed on a continuum as an accumulation of facts or as highly interrelated concepts. Within other schemes, the lower-level view of knowledge is as discrete, concrete, knowable facts; at higher levels individuals see knowledge as relative, contingent, and contextual.

Nature of Knowing

Beliefs about the process by which one comes to know have been a central part of the study of epistemological development. This includes beliefs about the source of knowledge and the justification for knowing, which includes evaluation of evidence, the role of authority, and the process of justification (see Table 2).

Source of knowledge. At lower levels of most of the models, knowledge originates outside the self and resides in external authority, from whom it may be transmitted. The evolving conception of self as knower, with the ability to construct knowledge in interaction with others, is a developmental turning point of most models reviewed. Perry (1970) described this awareness as one of the shifts in his model, when "the person, previously a holder of meaning, becomes a maker of meaning" (p. 87). He speaks of a "rebirth" in those who "experience in themselves the origin of meanings, which they had previously expected to come to them from outside" (p. 92). Similarly, King and Kitchener (1994) describe a shift in the action of knowing in the higher stages, with the knower moving from spectator to active constructor of meaning. Belenky et al. (1986) provided the most extensive elaboration on the issue of source of knowledge, which became the focal point in their study of how women come to know. Baxter Magolda (1992) describes an evolution in knowing that focuses on shifts in the role of learner, the role of peers, and the role of instructor. Schommer (1990, 1994b) has postulated source of knowledge as a fifth dimension in her theory of epistemological beliefs, although its existence has not been demonstrated empirically. She has attempted to measure source in a more limited fashion, focusing on beliefs about authority.

Justification for knowing. This dimension includes how individuals evaluate knowledge claims, including the use of evidence, the use they make of authority and expertise, and their evaluation of experts. As individuals learn to evaluate evidence and to substantiate and justify their beliefs, they move through a continuum of dualistic beliefs to the multiplistic acceptance of opinions to reasoned justification for beliefs.

} *Developmental Progression and Stage Issues*

Most of those who have studied epistemological beliefs have concluded that there is some developmental progression of these beliefs in the movement to adulthood, particularly for those who experience a college education. King and Kitchener, with results from 15 years of both cross-sectional and longitudinal

studies, make the strongest claims, stating that the sequence in their model consists of stages, with an invariant, hierarchical sequence that is structurally integrated. Others, as Kurfiss (1988) notes, have chosen to use the terms *position* and *perspective* rather than accept the deterministic, integrative assumptions of stage models, yet most present a hierarchical sequence with developmental implications (see Table 1). In spite of the various approaches, methodologies, samples, and designs, there is agreement across studies as to the general trend of development. Within these models it appears that the view of knowledge is transformed from one in which knowledge is right or wrong to a position of relativism and then to a position in which individuals are active constructors of meaning, able to make judgments and commitments in a relativistic context.

Dannefer (1984) notes that developmental theories may fall into the trap of ontogenetic reductionism—the practice of treating socially produced and patterned phenomena as rooted in the characteristics of the individual organism. Although Piagetian theory and most of the epistemological schemes covered here have presumed an interactionist model, the study of epistemological beliefs has treated them as individual cognitive constructs. No studies to date have attempted to look at beliefs in a more situated fashion, although Roth and Roychoudhury (1994) go so far as to suggest that “it might be more appropriate to speak of epistemological positions only in specific contexts rather than as descriptors of an individual’s views in general” (p. 17). More research is needed to examine the contextual nature of epistemological theories. Moreover, there is a need for cross-cultural research on the development of epistemological theories. The common developmental endpoint of most of the models of epistemological development may be a socially constructed artifact of Western schooling and culture (Moore, 1994). As Piagetian research and theory was criticized for assuming an inherent and logical endpoint of development based on Western culture (Laboratory of Comparative Human Cognition, 1983), research on epistemological theories must avoid this same problem, although there has been little cross-cultural research to date.

4 *Relation to Cognitive Development, Age, and Education*

There are a number of issues in how epistemological development relates to cognitive development and whether particular levels of development or sets of beliefs have cognitive antecedents. Other developmental models, such as Kohlberg’s (1971) scheme of moral development, have presumed a correspondence between ethical and intellectual judgment. Kohlberg claimed that his stages of moral judgment were both parallel and isomorphic to Piaget’s stages. Although such one-on-one correspondence between cognitive and epistemological development might be unlikely, certain intellectual preconditions might be necessary but not sufficient for certain types of epistemological beliefs to be possible. Using Piaget’s stages as a heuristic, for example, it seems that a concrete knower might have difficulty viewing knowledge in constructivist terms, and that certain types of abstract formal reasoning would be necessary for any of the higher-order assumptions about knowledge (Inhelder & Piaget, 1958). King (1977) administered both the Reflective Judgment Interview and tasks that assessed formal operations to high school juniors, college juniors, and graduate students and found that although 91% had achieved formal operations, reflective judgment scores ranged from

Stage 2 to Stage 7, with extremely low correlations between formal operations and reflective judgment. However, it was not possible to test whether formal operations were a necessary but not sufficient condition for higher stages of reflective judgment, given the lack of variability in the sample as assessed by formal operations tasks.

It is also plausible, as many have suggested (Commons, Richards, & Armon, 1984; Commons, Sinnott, Richards, & Armon, 1989), that there are higher-order stages of thinking in late adolescence and adulthood which transcend formal operations. Dialectical thinking as proposed by Basseches (1980, 1984), for example, might provide a more sufficient condition for the higher-order processes inherent in using relativistic epistemological beliefs (Benack & Basseches, 1989). More research is needed to define both these upper stages of intellectual development and their relation to epistemological theories.

There is clearly a positive relation between both age and education and epistemological development, but it is unclear where the process of epistemological understanding begins, as few studies exist below college level, and fewer yet below high school. It seems unlikely that most first-year college students spent their previous academic years as dualists, an inference many have made in reading the studies of college student development. One plausible explanation is that such development is recursive. Boyes and Chandler (1992), using a four-stage model based on the work of Perry, Kitchener and King, Kuhn, and others, found all epistemic levels represented among the high school students in their study. They speculate that studies of college-age students indicating only or predominately lower-level epistemic levels may suggest a second pass through the developmental levels during this time. It is also possible that individuals may retreat to safer, more established positions when in new environments and that there may be affective issues involved, such as the effects of anxiety and negative feelings associated with challenges to strongly held ideas. More longitudinal studies are needed, particularly those that track students' epistemological development through the educational transition from middle school to high school and from high school to college.

Outside of Piaget's original work on genetic epistemology in children, which was admittedly broader in scope, younger children's epistemological beliefs have received very little attention, perhaps in part because the studies of college students seem to suggest that not much could have happened prior to that period. In one study, Kuhn demonstrated difficulty in identifying pre-epistemological awareness in preadolescents (D. Kuhn et al., 1988). Mansfield and Clinchy (1985), in an unpublished study of 4-, 7-, and 10-year-olds and young adults, categorized individual responses regarding justifications for truth and suggested a developmental sequence that moved from absolutism in early childhood toward an acceptance of subjectivity.

A recent hypothesis (Montgomery, 1992) is that children do have beliefs about knowing and knowledge and that these are part of their theory of mind (Wellman, 1990). Montgomery suggests that investigation of these beliefs in children fit within developmental studies of "folk epistemology." Also, from the perspective of research on theory of mind, a study of personal changes in worldview over a 3- to 4-year period indicates that the period of early adolescence ties in with the onset of epistemological reasoning (Reich, Oser, & Valentin, 1994).

We know very little about the development of beliefs about knowledge after college or the sociocultural context for their development outside academic programs. Belenky et al. (1986) included a population engaged in nonformal educational experiences as parents, but the direct influence of these experiences was not the intent of the study. Kuhn (1991) found that her sample of experts who were trained in graduate philosophy programs were most likely to evidence the higher epistemic positions and therefore the skills of argument. King and Kitchener (1994) demonstrated that upper-level doctoral students evidenced the higher stages of reflective judgment. This is not surprising given the correspondence between graduate education and the highly rational, objective, intellectual skills of argument and judgment that these studies measure. It would be valuable to identify and assess adult populations in work settings to learn more about epistemological development into middle and late adulthood, whether other developmental patterns exist, and how sociocultural context mediates such development.

5 *Acquisition and Change*

Little empirical evidence exists for how ideas about knowledge and knowing become part of one's cognitive makeup. Within the models that purport to be developmental, some interactionist mechanism is presumed to be operational. From a Piagetian perspective, the trigger for change would be some form of cognitive disequilibrium, leading to assimilation or accommodation. Perry (1970) described the motivation for development as an interaction between innate motives toward autonomy and environmental support and constraints.

Given the sample populations of most studies, it is not surprising that the environmental press for change often seems to come from educational encounters, although exactly how this happens needs much more attention. Belenky et al. (1986) included noncollege women in their study, but the limitations of primarily single interviews made it difficult to gain much of a sense of what seemed to prompt change in epistemological theories. They speculate on the powerful impact of parenthood as "initiating an epistemological revolution" in many of the women they interviewed, and speak more broadly of the fact that women were prompted to change by encountering situations in which old ways of knowing were challenged. For some women in their broader sample, transitions had occurred in the return to schooling.

Although there is little empirical evidence for precisely what fosters epistemological development or how epistemological beliefs are altered, numerous suggestions have been made for promoting the progression described in most of the schemes reviewed, typically along the lines of challenging the existing ideas by presenting ideas one level higher to foster cognitive conflict and restructuring. In this sense, the models basically propose a disequilibrium mechanism for change in epistemological beliefs. This is similar to the arguments in the conceptual change literature regarding the conditions for conceptual change. These conditions include the following: Individuals must be dissatisfied with existing beliefs, must find the alternatives intelligible and useful, and must see a way to connect new beliefs with earlier conceptions. Pintrich, Marx, and Boyle (1993) have proposed that this model of conceptual change may be limited because it does not consider motivational and contextual factors. Future research on the mechanisms of epistemological theory change should examine not only cognitive and equili-

bration mechanisms for change, but also the motivational mechanisms that can constrain or facilitate such changes. Moreover, the contextual factors that can constrain or prompt change need to be considered, given that most of the extant research has examined individuals' beliefs only in a relatively decontextualized manner.

For example, one important avenue for exploration is to develop a deeper understanding of how beliefs are communicated in the classroom environment. This seems far more complicated than some of the current recommendations would suggest. Schommer (1990) suggests that "teachers can inform children in grade school that knowledge is integrated, that prior knowledge should be accessed, and that many times there is more than one right answer" (pp. 503-504). Even in cases where teachers may think they are communicating a more constructive way of knowing, actual practices may contradict this. Schoenfeld's (1988) observations of well meaning teachers in high school mathematics classes led him to conclude that students "developed perspectives regarding the nature of mathematics that were not only inaccurate, but were likely to impede their acquisition and use of other mathematical knowledge" (p. 144). Although teachers might talk about wanting students to think about mathematics and to understand it, the "classroom structure provided reinforcement for memorization and the reward structure promoted it" (p. 161).

Identification of the various instructional elements that carry epistemological impact is essential and may require observational and ethnographic studies. These elements might include the nature of tasks both in and out of class, testing and other evaluation practices, patterns of teacher and student talk, classroom structure, the physical arrangement of the classroom, reward systems, and textbook organization and language. We also need to know more about the intersection of teachers' epistemological theories (Lyons, 1990) and those of students. A socio-cultural approach that employs multiple methods may be needed to pursue these issues.

A sociocultural view of learning (Cole, 1992; Newman, Griffin, & Cole, 1989; Vygotsky, 1962; Wertsch, 1991; Wertsch & Sammarco, 1985) would shift the focus of study away from universal mechanisms in the individual, prominent in the developmental models, to the possibility of the situated and contextual nature of epistemological theories. The notion that the role of the student is to become part of a community of practice (Lave, 1988; Lave & Wenger, 1991) has fostered a reconceptualization of schooling as a cognitive apprenticeship in which students are socialized to the values and beliefs of the academic enterprise. Enculturation to the discipline, however, may go awry when the beliefs that are situated in the classroom are not those that facilitate further learning or interests in the discipline, as has been noted as commonplace in the field of mathematics (Schoenfeld, 1988). In much the same manner, epistemological theories may develop as the individual moves through different schooling and disciplinary contexts.

6 Domain Specificity Versus Domain Generality

There has been a strong shift in cognitive psychology away from general mechanisms toward domain-specific descriptions of information processing (Ceci, 1989; Sternberg, 1989), fostered in particular by studies of differences in the cognitive processes of novices and experts (Chi, Hutchinson, & Robin, 1989).

Developmental psychology has taken a parallel turn, particularly in neo-Piagetian theories of child development, which arose, in part, in response to the unevenness in developmental level observed across domains (Case, 1992). The Piagetian explanation for differences across these domains has been that of horizontal decalage, the lag in operations or processes across tasks or domains. This explanation has not been satisfactory for most researchers and probably only represents a description of domain or content area differences in thinking, not an explanation. A relevant example of horizontal decalage is a study by de Lisi and Staudt (1980), who found a relation between academic major and performance on three different tasks used to assess formal operations in college students using a within-subject design. Physics majors were much more likely to display formal operations on the pendulum problem in contrast to formal operational tasks that reflected literary or social science content. In the same manner, English majors and social science majors for the most part only showed formal operations on the tasks that reflected their domain of expertise. The role of domain differences in epistemological thinking has not been explored in much detail.

Of course, the meaning and boundary of *domain* is problematic. Alexander (1992) describes domain knowledge broadly as individual knowledge about a particular field of study, encompassing declarative, procedural, and conditional knowing. She makes the case that the difference between domain knowledge and discipline knowledge is at the individual level, dependent on the extensiveness and organization of knowledge. Alexander gives the example that a third grader's limited unorganized conception of biology renders it a domain, while a medical student's knowledge of biology is at the disciplinary level. However, in most studies of epistemological beliefs, *domain* is often used interchangeably with *academic discipline*, although Perry (1970), in a footnote in his original study, noted domains of interest as academic, extracurricular, interpersonal, vocational, and religious. These are clearly different from traditional disciplinary domains, and there may be lower levels of "domain" knowledge based on actual content knowledge, given Alexander's argument.

In any event, the issue of domain specificity has had only marginal attention within the epistemological models critiqued earlier. This is partially due to the cognitive developmental heritage of many of the models that have as an underlying presumption that epistemological beliefs and thinking are general and transcend domain boundaries. Schommer recently tested the assumption of domain independence in epistemological beliefs and concluded that the majority of college students showed a moderately consistent level of epistemological beliefs across domains (Schommer & Walker, 1995). The method used was simply to ask students to keep a particular domain in mind as they completed a self-report instrument and then to have them rate several disciplines. Disciplinary differences were found in only one study of reflective judgment cited by King and Kitchener (1994), in which social science graduate students were higher in epistemic reasoning than those in mathematical sciences, even with GRE scores partialled out, a difference that may reflect emphases in disciplinary training.

Sternberg (1989) has suggested that the issue of domain specificity versus domain generality in cognition is a false dichotomy and that the descriptions are not opposed but complementary, operating in an interactive fashion. "Development has elements that are both domain general and domain specific, and the

question becomes one of understanding which elements are which" (p. 117). This may be a fruitful line of research in the area of epistemological beliefs, as a growing body of literature addresses beliefs about knowledge within particular disciplines, particularly in the math and science areas (Buerk, 1985; Carey & Smith, 1993; Donald, 1986, 1990; King, 1977; Lampert, 1990; Roth & Roychoudhury, 1994; Schoenfeld, 1983, 1988; Stodolsky et al., 1991). This disciplinary or domain perspective has yet to be well integrated with the more domain-general research on epistemological development. Using the idea of epistemological thinking as theory-like, it is possible that both generalized beliefs about knowledge and those specific to domains exist in an interconnected network of ideas. However, much more research is needed to explore the nature of this network and to determine which of the dimensions of epistemological theories are domain specific and which are domain general.

There are, however, some hints from the work on disciplinary beliefs that suggest how epistemological theories might vary as a function of disciplines and domains. For example, many students believe that mathematics is associated with certainty and getting the right answer quickly and that the teacher is the arbiter or source of knowledge (Lampert, 1990). Schoenfeld (1992) has created a list of typical student beliefs about the nature of mathematics, such as the beliefs that a math problem has one and only one right answer, that it is important to be able to get the answer quickly, that there is only one way to solve any math problem, that math is a solitary activity done by individuals in isolation, and that mathematics learned in school has little value in the real world. Within a broader study of attitudes and beliefs about learning math and social studies, Stodolsky et al. (1991) have tapped naive views of disciplinary differences among fifth graders, which they suspect arise from general instructional patterns at the elementary school level. Math appeared more fixed and immutable to the students, and social studies less sharply defined. These data can be interpreted in terms of the four dimensions of epistemological theories. They suggest that students would believe that the certainty of knowledge is high in mathematics and that the simplicity dimension is also high given the common belief that there is only one way to solve a problem. The data also suggest that in terms of the nature of knowing, the source is the teacher or something external to the learner, and justification of knowledge also comes from the teacher or the field.

There has also been a body of work addressing epistemological beliefs in the sciences. In one small study, interviews with college students enrolled in introductory physics suggested epistemological beliefs in three areas: beliefs about the structure of physics knowledge, beliefs about the content of physics knowledge, and beliefs about learning physics (Hammer, 1994). Roth and Roychoudhury (1994) examined what they called epistemological commitment in high school physics students and identified differences between constructivist and objectivist beliefs, the latter of which was predominant in spite of a curriculum that emphasized the former. They tag objectivism as the default epistemology for those in Western schooling, a pattern which could change as broader pedagogical practices are altered by an emphasis on constructivist teaching. Carey and Smith (1993) also discuss the difficulties of teaching a constructivist approach to science, which appears to be at odds with the common sense epistemology of seventh grade students. In both these studies, most students had a more realist or objectivist view

of the nature of knowledge that suggested that they view knowledge in science as certain, and that while science may not necessarily be simple, there are discrete facts to be known that are not perceived as relative or contextual. In terms of the nature of knowing, these findings also suggest that students' view of science is dependent on authority for justification. Of course, most of these studies in math and science have not used within-subject designs, so it is not possible to separate out general age-developmental differences and domain differences. There is a need for more research that uses within-subject designs to tap students' epistemological theories across different domains.

Research on domain differences is complicated by the fact that academic disciplines do have differing knowledge structures and epistemological assumptions, and this needs to be considered within this work (Donald, 1995; Schwab, 1964, 1978). Defining characteristics of the disciplines include the criteria and validation processes used to determine knowledge (Donald, 1986). For example, faculty members in English language and literature rely more on peer judgment and less on empirical evidence than those in either natural or social sciences (Donald, 1990). Discipline-specific ways of knowing and reasoning have been found among the teaching practices and goals of high school teachers (Langer, 1994). Donald (1990) suggests further study of the determining characteristics of the disciplines and how these might intersect with instruction and student learning. What remains for continued study is how epistemological assumptions and patterns of reasoning might differ across fields as individuals advance in their professions. Expert-novice studies at multiple levels of professional development within and across disciplines could prove useful in this area.

7 Relations to Motivation and Cognition

The most recent body of work on epistemological beliefs has been the exploration of the linkages between these beliefs and motivation, learning, cognition, and academic performance (Hofer, 1994; Ryan, 1984b; Schommer, 1993b; Schommer et al., 1992; Schutz et al., 1993). Perry (1981) had speculated on the connection, suggesting that revisions in student notions of knowledge would be likely to lead to changes in studying strategies, resulting from changes in learning and cognition. As reviewed earlier, Ryan (1984b) initiated empirical work in this area, hypothesizing a change in information processing strategies that would come about as a result of the movement from dualism to relativism, and identifying a correlation between epistemological level and comprehension, as measured by Bloom's taxonomy (Bloom et al., 1956).

Ryan's work was elaborated by Schommer in a series of correlational studies that have explored the relation between epistemological beliefs, strategy use, and academic performance. Typically students have completed the 63-item Likert-scale questionnaire on epistemological beliefs, then performed a set of tasks to assess comprehension in either reading or statistics. In one study participants also completed a study strategy inventory. Statistical correlations have been found between particular dimensions of epistemological beliefs and performance. In the initial study (Schommer, 1990), the findings were that "belief in quick learning predicted oversimplified conclusions, poor performance on the mastery tests, and overconfidence in test performance. Belief in certain knowledge predicted inappropriately absolute conclusions" (p. 498). In a later study (Schommer et al.,

1992) higher confidence and better performance were negatively correlated with belief in simple knowledge. Schommer used a path analysis model to suggest that epistemological beliefs may have an indirect effect on academic performance, as belief about knowledge may affect study strategies (Schommer, 1993b).

In this way, epistemological theories may function as a standard or goal against which to compare comprehension or learning. For example, if one believes that knowledge is simple, then there is no reason to attempt to use deeper processing strategies such as elaboration; simple memorization will suffice. Research in self-regulated learning (Zimmerman, 1994) suggests that learners must have a goal or criteria against which to assess their progress or learning. This goal serves to initiate or stop various self-regulatory processes, such as the use of cognitive or metacognitive control strategies (Butler & Winne, 1995). These goals are usually conceptualized as personal goals, but epistemological theories may provide another type of goal that guides self-regulated learning. There is a need for more research to examine this possibility. Epistemological beliefs may also contribute to conceptual change learning (Qian & Alvermann, 1995), another area for further exploration.

Epistemological theories may relate to motivation as well as cognition. Students' motivational orientation has been linked to cognitive engagement and self-regulation in the classroom, and both self-efficacy and intrinsic value have been correlated with use of cognitive strategies, self-regulated learning, and persistence (Pintrich & De Groot, 1990). Schoenfeld (1992) claims that beliefs about mathematics shape behavior in ways that have powerful and often negative consequences. For example, the belief that those who really understand math should be able to work any assigned problem quickly may impede motivation to persist with difficult problems, although continued effort may have led to success. Goal orientation may also be a function of beliefs about the disciplines, varying across subject matters (Stodolsky et al., 1991).

Two exploratory studies have made attempts to link epistemological beliefs with motivation and cognition. In one unpublished correlational study (Schutz et al., 1993) college students were asked to respond to six items selected from Perry (1970) as either true or false and to explain their answers; responses were coded according to a condensed version of D. Kuhn's (1991) scheme as either absolutist or multiplist-evaluatist. Information about student motivation and learning strategies was obtained through participant completion of the Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich, Smith, Garcia, & McKeachie, 1993). Students who adopted a more sophisticated perspective toward knowledge were more likely to adopt a mastery goal to learning and to engage material more deeply. In another unpublished study of college students enrolled in first-year calculus, Hofer (1994) found a positive correlation between sophistication of epistemological beliefs, as measured by an adaptation of Schoenfeld's (1992) typical beliefs about mathematics, and intrinsic motivation, self-efficacy, self-regulation, and academic performance.

More work of this type is needed to better understand how epistemological theories may hinder or enhance academic performance in their effect on strategy choice and student motivation. Based on the very limited studies to date, it appears that theories about knowledge may be activated by a variety of academic tasks. These theories then influence how individuals approach these tasks in terms of

their motivation and cognition. It is also plausible that the structure of these academic tasks, over time, shapes epistemological theories, which are then difficult to change. For example, students who are given multiple-choice tests composed of low-level items may come to view knowledge as a collection of facts and learn to study for tests by using memorization and rehearsal strategies. Moving to a class where higher-level processes are expected may require not only a change in strategy use, but a change in epistemological theories.

We know little about the malleability of epistemological theories or the discordance students may experience between their theories and the type of classroom environments and tasks they encounter. An exploratory unpublished study of two approaches to calculus instruction, one conventional (lectures, traditional texts, etc.) and one more constructivist (small group work, text with word problems and with no answers provided, etc.) indicated that at the end of the term students in the constructivist sections evidenced more sophisticated beliefs about mathematics (Hofer, 1994). What we do not know is whether these belief changes are enduring or whether some students are simply adaptable. We also do not know what the affective issues are that accompany these changes. Preliminary qualitative evidence from the same program suggests personal resistance from both students and instructors to the idea that college calculus instruction could be approached in this way. Such resistance often takes the form of "But this isn't *math!*" Some surrendering of existing beliefs about what math is and how knowing occurs in math seems necessary for students to succeed in the course. In his discussion of beliefs about mathematics, Schoenfeld (1985) speculates that while the behavior of "reasoning practices" may appear purely cognitive, such behavior may have an affective component and that "it is in this sense that the issue of *belief* straddles the affective and cognitive domains" (p. 155). More qualitative studies, both interviews and observations, are needed to understand the dynamics by which epistemological theories are communicated in a variety of classrooms, the affective dimensions of these theories, the process of theory change, how individuals organize theories, and how these affect motivation, strategy use, cognition, and academic performance.

Gender, Ethnicity, and Culture as Contexts

Gender issues remain a subject worth attention. We have a pioneering study of men only (Perry, 1970), a comparable study of women that describes "women's ways of knowing" (Belenky et al., 1986), one that finds "gender-related patterns" (Baxter Magolda, 1992), and others that either have found no differences or are inconclusive (King & Kitchener, 1994; D. Kuhn, 1991). We need more studies of both genders that explore the potential gender-related patterns in epistemological theories. More importantly, there is a paucity of studies that incorporate minority populations or examine cross-cultural differences, which means that existing theory is based largely on findings from a mainly White, well educated U.S. population. Moreover, we need studies that assess the within-group variability of individuals with the different gender and ethnic groups, rather than assuming a priori that the group differences capture the important variance. Finally, we need theoretical accounts for why there may be gender or ethnic or cultural differences in epistemological theories (Betancourt & Lopez, 1993; Graham, 1994; Porter, 1996). For example, it may be that thinking of gender and ethnicity as different

contexts of development, just as different cultures provide different contexts, would be more beneficial for recent efforts in this area. In this approach, gender and ethnicity could be conceptualized as providing differing opportunities, affordances, and constraints on development, rather than as personal characteristics of the individual that need to be examined or controlled for in research (see Porter, 1996).

Cross-cultural studies of epistemological theories appear nonexistent, and existing frameworks based on U.S. student samples are undoubtedly shaped by underlying cultural beliefs. The formal abstract reasoning that is a hallmark of the higher stages of most schemes has been noted as characteristic of Western-styled schooled cultures (Bidell & Fischer, 1992) and may be less prevalent in others. Existing epistemological models posit a movement toward increased individualism of thought and a freedom from the dictates of authority. It is possible that in a more collectivist culture in which the view of self has interindividual implications, personal theories of knowledge and knowing could evolve toward an acceptance of consensus, not a reliance on independent thinking (Triandis, 1989; Triandis, Bontempo, Villareal, Asai, & Lucca, 1988). This, in turn, might have implications for creativity and scientific discovery. In addition, the degree to which schooling currently fosters the "separate knowing" described by Belenky et al. (1986) might be a Western phenomenon tied up with notions of the separate, bounded self (Markus & Kitayama, 1991).

Cross-cultural studies might also highlight other dimensions of the construct. For example, the *purpose* of knowledge is not currently discussed as a part of existing models, yet there may be cross-national differences in how students come to view the role of knowledge and the extent to which it appears to have only practical, utilitarian purposes. Emphasis on theory building rather than instrumentalism might vary across cultures; clearly it varies across disciplines and within subareas of disciplines. Further study of disciplinary ways of knowing, as well as the extent to which disciplines are themselves cultures, also merits research attention.

9 *Methodological Issues*

The study of epistemological beliefs has advanced through the extraordinary diligence of a small number of researchers committed to identifying an important but elusive belief system. Epistemological theories do not yield themselves up readily and may be best captured as a by-product of certain types of reasoning (King & Kitchener, 1994; D. Kuhn, 1991). The difficulty with this approach, however, is that the interviewer predetermines the framework. When an interviewer asks, for example, "If you were trying to convince someone else that your view is right, what *evidence* would you give to try to show this?" (D. Kuhn, 1991, p. 299) or asks for justification of a point of view (King & Kitchener, 1994), respondents comply within a framework of evidence and justification. If this is the specific domain of interest, this is hardly problematic. On the other hand, by framing the question in terms of evidence and justification, the interviewer may lead the respondent to focus on these dimensions to the exclusion of other more personally salient dimensions.

For this reason, others have argued that a phenomenological form of inquiry is essential to the nature of studying development of this sort. Perry (1970) and

Belenky et al. (1986) chose this approach, seeking to hear how individuals would structure their thoughts and frame their experiences and perceptions of knowing. Not only did Perry ask open-ended questions ("Would you like to say what has stood out for you during the year?"), but his interviews were almost completely unstructured, which may have been not a highly intentional research strategy but, as Moore (1991) notes, a result of the lack of specific focus of the study. Belenky et al. (1986) took a somewhat more structured approach, combining the open-ended questions with more focused ones, plus using a production task.

The more open-ended approach to interviewing may have been most fruitful at the initial stages of the work, as in any field. At this point in the development of models of epistemological theories, however, it seems to make sense to develop more precise means of probing epistemological assumptions, as several have done (Baxter Magolda, 1992; King & Kitchener, 1994; D. Kuhn, 1991). Within the most recent interview studies, the structure has been to provide participants with ill-structured problems and to assess their reasoning and underlying epistemological assumptions. One of the central problems with the interview approach has been replicability. In spite of the vast interest in "women's ways of knowing," it does not appear that work of that magnitude has been repeated, either with another female sample or, equally important, with a mixed-gender design. The Reflective Judgment Interview, which has had the widest use, is available only to those who receive training and certification.

Cost, time, and complexity of interpretation have led several researchers to develop paper-and-pencil methods for assessing epistemological development and epistemological beliefs. Most of these have been based on Perry's scheme, although King and Kitchener are currently at work on the Reflective Thinking Appraisal, a written version of the Reflective Judgment Interview, which will make large-scale assessment of their model possible for the first time.

Written instruments designed for identifying Perry's positions have included the Measure of Intellectual Development (MID), the Learning Environment Preferences (LEP), and the Measure of Epistemological Reflection (MER). The MID is a production-task instrument with an essay stem focusing on students' conceptions of knowledge and learning. (Students are asked to describe the best course they have taken or the ideal learning environment.) The MID must be scored by trained raters, who assess the essay on Positions 2 through 5 of the Perry scheme, assigning a three-digit number that reflects the dominant and subdominant positions. Interrater reliability has been reported as ranging from the .40s for absolute agreement to the .90s for agreement within one third of a position, and correlations with interviews have been reported in the .70s (Moore, 1991). Moore also provides extensive reporting on validity issues of the MID. No significant gender differences have been reflected in MID ratings. As a measure of intellectual development in the college years, the MID would appear to have found little evidence of change in epistemological beliefs across the populations assessed for its norming data, with a "slightly upward, but very flat trend" from 18- to 21-year-olds. The MER, designed by Baxter Magolda (1992; Baxter Magolda & Porterfield, 1985; Moore, 1991) is similar to the MID and provides essay stems in six areas related to classroom learning.

The LEP, a recognition-task instrument with forced-choice items, was designed as a more objective means of assessing the Perry scheme and was constructed

from a review of MID essays. It appears to have a surprisingly low correlation with the MID, however, reported as .36 (Moore, 1991). Additional information on reliability and validity of the LEP appear in two extensive reviews (Moore, 1989, 1991). The LEP does not require trained raters and thus is accessible to a larger number of researchers, although given the ceiling effect of assessing only up to Level 5, it is not likely to be of use in studies of graduate students or well educated adults. Moore (1991) concludes that for measurement of the Perry positions, the MID and MER "are the only acceptable alternatives to in-depth interviews because they allow the student to generate his or her own thinking and meaning-making, rather than reacting to forced-choice items (which essentially reflect the instrument author's meaning-making, not the student's)" (p. 12).

Schommer's measure of epistemological beliefs, a 63-item questionnaire described in detail earlier, is a self-report instrument which does not allow respondents to make their own meaning, but it does provide a relatively efficient method for collecting data on large numbers of students. As such, it has provided a means for studying correlations between epistemological beliefs and cognition and learning. However, it taps only limited aspects of epistemological beliefs and relies on very broadly stated items, some of which may not be most representative of the domain. Finally, although it is used in factor analytic studies, the internal factor structure of the actual 63 items has not been empirically demonstrated by Schommer, and one recent study suggests a three-factor model based on only 32 of the original items (Qian & Alvermann, 1995). In spite of this, use of the instrument is growing, and it offers a means of conducting large-scale quantitative assessments.

Existing methods based on either interviews, production tasks, or questionnaires do little to tell us how epistemological theories actually operate to influence student learning. The press to collect such evidence may increase as the higher education assessment movement gathers force; many institutions are currently working on new methods of collecting evidence of the effect of college on student intellectual development (Ewell, 1991). Researchers intent on better understanding epistemological development and its relation to learning may want to gather more naturalistic evidence with higher ecological validity, perhaps using critical incident techniques immediately following classes, using stimulated recall from videotapes or audiotapes, or conducting exit interviews after exams. Observational measures also need development in order to understand the role of classroom context and its influence on epistemological theories.

A considerable number of other methodological issues remain, beyond those of instrumentation. Most studies have selected a particular age group for study, usually defined by academic grouping and most often college students. We know little about the developmental progression of epistemological theories across educational settings and what the epistemological issues might be in individuals making the transition from middle school to high school, or from high school to college, or from college to work. In terms of development, these transitional periods may represent a time when development is more discontinuous and may provide a unique window on growth and change (see Wigfield, Eccles, & Pintrich, 1996). Research at these transitional periods could provide a good opportunity to examine both individual cognitive-developmental factors as well as contextual opportunities and constraints that influence the development of personal epistemological theories.

Conclusions

As our discussion of the nine issues shows, there are a number of important conceptual and methodological issues to be resolved in future research. We believe that one of the most important issues is the definition and delineation of the construct of epistemological beliefs and thinking. We have proposed the construct of epistemological theories composed of the four dimensions of certainty of knowledge, simplicity of knowledge, source of knowledge, and justification for knowing as a way to help clarify the research and thinking in this area. Although we are not dualists or absolutists and do not believe there is one correct answer, we do hope that our discussion of this issue and our attempt at defining and delineating the construct will provide a base for consensus and a stimulus for future conversations about epistemological thinking.

At the same time, we are aware that current shifts in educational thinking toward a constructivist approach will undoubtedly continue to affect research in this area, as will formulations of feminist epistemology (e.g., Alcoff & Potter, 1992; Bleier, 1986; Riger, 1992) and feminist pedagogy (Lewis, 1993), as well as current changes in the epistemology of educational research (Greene, 1994). These movements may change not only the approach to research but what we find about how people believe they know. Perry (1970) compared the shift in worldview to relativism as parallel on an individual level to paradigm shifts in science (T. S. Kuhn, 1962). Piaget noted that ontogenesis, or individual development, recapitulated sociogenesis, or collective development (Ginsburg & Opper, 1969). We may find similar parallels in this period between constructivism at the individual level, which is described as the higher integrated epistemological level in the scheme of Belenky et al. (1986), for example, and a constructivist, sociocultural approach to knowledge building in the disciplines (Bereiter, 1994). In any case, the examination of the development of epistemological theories will help us to understand students' and teachers' beliefs about knowledge and their thinking about knowledge. This information will then help us better understand the teaching and learning processes in classrooms.

References

- Adorno, T. W., Frenkel-Brunswik, E., Levinson, D. J., & Sanford, R. W. (1950). *The authoritarian personality*. New York: Harper and Row.
- Alcoff, L., & Potter, E. (Eds.). (1992). *Feminist epistemologies*. New York: Routledge.
- Alexander, P. A. (1992). Domain knowledge: Evolving themes and emerging concerns. *Educational Psychologist*, 27(1), 33–51.
- Basseches, M. (1980). Dialectical schemata: A framework for the empirical study of the development of dialectical thinking. *Human Development*, 23, 400–421.
- Basseches, M. A. (1984). Dialectical thinking as a metacognitive form of cognitive organization. In M. L. Commons, F. A. Richards, & C. Armon (Eds.), *Beyond formal operations: Late adolescent and adult cognitive development* (pp. 216–238). New York: Praeger.
- Baxter Magolda, M. B. (1987). The affective dimension of learning: Faculty-student relationships that enhance intellectual development. *College Student Journal*, 21, 46–58.
- Baxter Magolda, M. B. (1992). *Knowing and reasoning in college: Gender-related patterns in students' intellectual development*. San Francisco: Jossey Bass.
- Baxter Magolda, M. B., & Porterfield, W. D. (1985). *Assessing intellectual develop-*

- ment: *The link between theory and practice*. Alexandria, VA: American College Personnel Association.
- Belenky, M. F., Clinchy, B. M., Goldberger, N. R., & Tarule, J. M. (1986). *Women's ways of knowing: The development of self, voice and mind*. New York: Basic Books.
- Benack, S., & Basseches, M. A. (1989). Dialectical thinking and relativistic epistemology: Their relation in adult development. In M. L. Commons, J. D. Sinnott, F. A. Richards, & C. Armon (Eds.), *Adult development: Comparisons and applications of developmental models* (pp. 95–109). New York: Praeger.
- Bereiter, C. (1994). Constructivism, socioculturalism, and Popper's world. *Educational Researcher*, 23(7), 21–23.
- Betancourt, H., & Lopez, S. (1993). The study of culture, ethnicity, and race in American psychology. *American Psychologist*, 48, 629–637.
- Bidell, T. R., & Fischer, K. W. (1992). Beyond the stage debate: Action, structure, and variability in Piagetian theory and research. In R. J. Sternberg & C. A. Berg (Eds.), *Intellectual development* (pp. 100–140). New York: Cambridge University Press.
- Bleier, R. (Ed.). (1986). *Feminist approaches to science*. New York: Teachers College Press.
- Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R. (1956). *Taxonomy of educational objectives. Handbook 1: Cognitive domain*. New York: McKay.
- Boyes, M. C., & Chandler, M. (1992). Cognitive development, epistemic doubt, and identity formation in adolescence. *Journal of Youth and Adolescence*, 21(3), 277–303.
- Broughton, J. M. (1975). *The development of natural epistemology in years 11 to 16*. Unpublished doctoral dissertation, Harvard University, Graduate School of Education.
- Buerk, D. (1985). The voices of women making meaning in mathematics. *Journal of Education*, 167(8), 59–70.
- Butler, D. L., & Winne, P. H. (1995). Feedback and self-regulated learning: A theoretical synthesis. *Review of Educational Research*, 65, 245–281.
- Carey, S. (1985). *Conceptual change in childhood*. Cambridge, MA: MIT Press.
- Carey, S., & Smith, C. (1993). On understanding the nature of scientific knowledge. *Educational Psychologist*, 28(3), 235–251.
- Case, R. (1992). Neo-Piagetian theories of child development. In R. J. Sternberg & C. A. Berg (Eds.), *Intellectual development* (pp. 161–196). New York: Cambridge University Press.
- Ceci, S. J. (1989). On domain specificity ... More or less general and specific constraints on cognitive development. *Merrill-Palmer Quarterly*, 35(1), 131–142.
- Chi, M. T. H., Hutchinson, J. E., & Robin, A. F. (1989). How inferences about novel domain-related concepts can be constrained by structured knowledge. *Merrill-Palmer Quarterly*, 35, 27–62.
- Clinchy, B. M. (1990). Issues of gender in teaching and learning. *Journal on Excellence in College Teaching*, 1, 52–67.
- Clinchy, B. M., Belenky, M. F., Goldberger, N., & Tarule, J. M. (1985). Connected education for women. *Journal of Education*, 167(3), 28–45.
- Cole, M. (1992). Context, modularity, and the cultural constitution of human development. In L. T. Winegar & J. Valsiner (Eds.), *Children's development within social context* (pp. 5–31). Hillsdale, NJ: Erlbaum.
- Commons, M. L., Richards, F. A., & Armon, C. (Eds.). (1984). *Beyond formal operations: Late adolescent and adult cognitive development*. New York: Praeger.
- Commons, M. L., Sinnott, J. D., Richards, F. A., & Armon, C. (Eds.). (1989). *Adult development: Vol. 1. Comparisons and applications of developmental models*. New

- York: Praeger.
- Dannefer, D. (1984). Adult development and social theory: A paradigmatic reappraisal. *American Sociological Review*, 49, 100–116.
- de Lisi, R., & Staudt, J. (1980). Individual differences in college students' performance on formal operation tasks. *Journal of Applied Developmental Psychology*, 1(3), 201–208.
- Dewey, J. (1933). *How we think: A restatement of the relation of reflective thinking to the educative process*. Lexington, MA: Heath.
- Dewey, J. (1938). *Logic: The theory of inquiry*. Troy, MA: Holt, Rinehart & Winston.
- Donald, J. G. (1986). Knowledge and the university curriculum. *Higher Education*, 15, 267–282.
- Donald, J. G. (1990). University professors' views of knowledge and validation processes. *Journal of Educational Psychology*, 82(2), 242–249.
- Donald, J. G. (1995). Disciplinary differences in knowledge validation. In N. Hativa & M. Marincovich (Eds.), *Disciplinary differences in teaching and learning: Implications for practice* (pp. 7–18). San Francisco: Jossey-Bass.
- Dunkle, M. E., Schraw, G., Bendixen, L., & Grosskopf, K. (1994, April). *The relationship between epistemological beliefs and causal reasoning*. Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans, LA.
- Dweck, C. S., & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. *Psychological Review*, 95(2), 256–273.
- Ewell, P. T. (1991). To capture the ineffable: New forms of assessment in higher education. *Review of Research in Education*, 17, 75–125.
- Fenstermacher, G. D. (1994). The knower and the known: The nature of knowledge in research on teaching. *Review of Research in Education*, 20, 3–57.
- Fischer, K. W., & Pipp, S. L. (1984). Processes of cognitive development: Optimal level and skill acquisition. In R. J. Sternberg (Ed.), *Mechanisms of cognitive development* (pp. 45–80). New York: Freeman.
- Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley.
- Flavell, J. (1971). Stage related properties of cognitive development. *Cognitive Psychology*, 2(4), 421–453.
- Gilligan, C. (1982). *In a different voice: Psychological theory and women's development*. Cambridge, MA: Harvard University Press.
- Ginsburg, H., & Oppen, S. (1969). *Piaget's theory of intellectual development*. Englewood Cliffs, NJ: Prentice-Hall.
- Graham, S. (1994). Motivation in African-Americans. *Review of Educational Research*, 64, 55–117.
- Greene, M. (1994). Epistemology and educational research: The influence of recent approaches to knowledge. *Review of Research in Education*, 20, 423–464.
- Hammer, D. (1994). Epistemological beliefs in introductory physics. *Cognition and Instruction*, 12(2), 151–183.
- Harvey, L. J., Hunt, D. E., & Schroder, H. M. (1961). *Conceptual systems and personality organization*. New York: Wiley.
- Hofer, B. (1994, August). *Epistemological beliefs and first-year college students: Motivation and cognition in different instructional contexts*. Paper presented at the annual meeting of the American Psychological Association, Los Angeles.
- Inhelder, B., & Piaget, J. (1958). *The growth of logical thinking from childhood to adolescence*. New York: Basic.
- Kegan, R. (1982). *The evolving self: Problem and process in human development*. Cambridge, MA: Harvard University Press.

- King, P. M. (1977). The development of reflective judgment and formal operational thinking in adolescents and young adults. *Dissertation Abstracts International*, 38, 7233A.
- King, P. M., & Kitchener, K. S. (1994). *Developing reflective judgment: Understanding and promoting intellectual growth and critical thinking in adolescents and adults*. San Francisco: Jossey-Bass.
- King, P. M., Kitchener, K. S., Davison, M. L., Parker, C. A., & Wood, P. K. (1983). The justification of beliefs in young adults: A longitudinal study. *Human Development*, 26, 106–116.
- King, P. M., Kitchener, K. S., Wood, P. K., & Davison, M. L. (1989). Relationships across developmental domains: A longitudinal study of intellectual, moral, and ego development. In M. L. Commons, J. D. Sinnott, F. A. Richards, & C. Armon (Eds.), *Adult development: Comparisons and applications of developmental models* (pp. 57–78). New York: Praeger.
- Kitchener, K. S. (1983). Cognition, metacognition, and epistemic cognition. *Human Development*, 26, 222–232.
- Kitchener, K. S. (1986). The reflective judgment model: Characteristics, evidence, and measurement. In R. A. Mines & K. S. Kitchener (Eds.), *Adult cognitive development: Methods and models* (pp. 76–91). New York: Praeger.
- Kitchener, K. S., & Fischer, K. W. (1990). A skill approach to the development of reflective thinking. In D. Kuhn (Ed.), *Developmental perspectives on teaching and learning thinking skills* (pp. 48–62). New York: Karger.
- Kitchener, K. S., & King, P. M. (1981). Reflective judgment: Concepts of justification and their relationship to age and education. *Journal of Applied Developmental Psychology*, 2, 89–116.
- Kitchener, K. S., King, P. M., Wood, P. K., & Davison, M. L. (1989). Sequentiality and consistency in the development of reflective judgment: A six-year longitudinal study. *Journal of Applied Developmental Psychology*, 10, 73–95.
- Kitchener, K. S., Lynch, C. L., Fischer, K. W., & Wood, P. K. (1993). Developmental range of reflective judgment: The effect of contextual support and practice on developmental stage. *Developmental Psychology*, 29(5), 893–906.
- Knefelkamp, L. L. (1974). *Developmental instruction: Fostering intellectual and personal growth of college students*. Unpublished doctoral dissertation, University of Minnesota.
- Knefelkamp, L. L., & Slepitza, R. (1978). A cognitive-developmental model of career development: An adaptation of the Perry scheme. In C. A. Parker (Ed.), *Encouraging development in college students* (pp. 135–150). Minneapolis: University of Minnesota Press.
- Kohlberg, L. (1969). Stage and sequence: The cognitive-developmental approach to socialization. In D. Goslin (Ed.), *Handbook of socialization theory and research* (pp. 347–480). New York: Rand McNally.
- Kohlberg, L. (1971). From is to ought: How to commit the naturalistic fallacy and get away with it in the study of moral development. In T. Mischel (Ed.), *Cognitive development and epistemology* (pp. 151–235). New York: Academic Press.
- Kramer, D., & Woodruff, D. (1986). Relativistic and dialectic thought in three adult age groups. *Human Development*, 29, 280–290.
- Kuhn, D. (1991). *The skills of argument*. Cambridge, England: Cambridge University Press.
- Kuhn, D. (1993). Science as argument: Implications for teaching and learning scientific thinking. *Science Education*, 77(3), 319–337.
- Kuhn, D., Amsel, E., & O’Laughlin, M. (1988). *The development of scientific thinking skills*. Orlando, FL: Academic Press.

- Kuhn, T. S. (1962). *The structure of scientific revolutions*. Chicago: University of Chicago Press.
- Kurfiss, J. G. (1988). *Critical thinking: Theory, research, practice, and possibilities*. Washington, DC: Association for the Study of Higher Education.
- Laboratory of Comparative Human Cognition. (1983). Culture and cognitive development. In W. Kessen (Ed.), *Handbook of child psychology* (pp. 295–356). New York: Wiley.
- Lakatos, I. (1970). Falsification and the methodology of scientific research programs. In I. Lakatos & A. Musgrave (Eds.), *Criticism and the growth of knowledge* (pp. 91–195). Cambridge, England: Cambridge University Press.
- Lampert, M. (1990). When the problem is not the question and the solution is not the answer: Mathematical knowing and teaching. *American Educational Research Journal*, 27, 29–63.
- Langer, J. A. (1994). Teaching disciplinary thinking in academic coursework. In J. N. Mangieri & C. C. Block (Eds.), *Creating powerful thinking in teachers and students: Diverse perspectives* (pp. 81–109). New York: Harcourt Brace.
- Lave, J. (1988). *Cognition in practice: Mind, mathematics and culture in everyday life*. Cambridge, England: Cambridge University Press.
- Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge, England: Cambridge University Press.
- Lewis, M. G. (1993). *Without a word: Teaching beyond women's silence*. New York: Routledge.
- Lincoln, Y. S., & Guba, E. (1985). *Naturalistic inquiry*. Newbury Park, CA: Sage.
- Loevinger, J. (1976). *Ego development*. San Francisco: Jossey-Bass.
- Lyons, N. (1990). Dilemmas of knowing: Ethical and epistemological dimensions of teachers' work and development. *Harvard Educational Review*, 60(2), 159–180.
- Mansfield, A. F., & Clinchy, B. (1985, April). *A developmental study of natural epistemology*. Paper presented at the biennial meeting of the Society for Research in Child Development, Toronto, Ontario, Canada.
- Markus, H. R., & Kitayama, S. (1991). Culture and the self: Implications for cognition, emotion, and motivation. *Psychological Review*, 98, 224–253.
- Martin, J. E., Silva, D. G., Newman, J. H., & Thayer, J. F. (1994). An investigation into the structure of epistemological style. *Personality and Individual Differences*, 16(4), 617–629.
- Messick, S. (1989). Validity. In R. L. Linn (Ed.), *Educational measurement* (pp. 13–104). New York: Macmillan.
- Messick, S. (1995). Validity of psychological assessment. *American Psychologist*, 50, 741–749.
- Montgomery, D. E. (1992). Young children's theory of knowing: The development of a folk epistemology. *Developmental Review*, 12, 410–430.
- Moore, W. S. (1989). The "Learning Environment Preferences": Exploring the construct validity of an objective measure of the Perry scheme of intellectual development. *Journal of College Student Development*, 30, 504–514.
- Moore, W. S. (1991, April). *The Perry scheme of intellectual and ethical development: An introduction to the model and major assessment approaches*. Paper presented at the Annual Meeting of the American Educational Research Association, Chicago.
- Moore, W. S. (1994). Student and faculty epistemology in the college classroom: The Perry schema of intellectual and ethical development. In K. W. Prichard & R. M. Sawyer (Eds.), *Handbook of college teaching: Theory and applications* (pp. 45–67). Westport, CT: Greenwood Press.
- Mtsetwa, D., & Garofalo, J. (1989). Beliefs about mathematics: An overlooked aspect of student difficulties. *Academic Therapy*, 24(5), 611–618.

- Newman, D., Griffin, P., & Cole, M. (1989). *The construction zone: Working for cognitive change in school*. Cambridge, England: Cambridge University Press.
- Pascarella, E. T., & Terenzini, P. T. (1991). *How college affects students: Findings and insights from twenty years of research*. San Francisco: Jossey-Bass.
- Perry, W. G. (1970). *Forms of intellectual and ethical development in the college years: A scheme*. New York: Holt, Rinehart and Winston.
- Perry, W. G. (1981). Cognitive and ethical growth: The making of meaning. In A. Chickering (Ed.), *The modern American college* (pp. 76–116). San Francisco: Jossey-Bass.
- Piaget, J. (1950). *Introduction a l'epistemologie genetique*. Paris: Presses Univ. de France.
- Pintrich, P. R., & De Groot, E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology*, 82(1), 33–40.
- Pintrich, P. R., Marx, R. W., & Boyle, R. A. (1993). Beyond cold conceptual change: The role of motivational beliefs and classroom contextual factors in the process of conceptual change. *Review of Educational Research*, 63, 167–199.
- Pintrich, P. R., Smith, D. A., Garcia, T., & McKeachie, W. J. (1993). Reliability and predictive validity of the Motivated Strategies for Learning Questionnaire (MSLQ). *Educational and Psychological Measurement*, 53, 801–813.
- Popper, K. R. (1969). *Conjectures and refutations*. New York: Harper and Row.
- Porter, P. (1996). Ethnicity and culture in educational psychology. In D. C. Berliner and R. C. Calfee (Eds.), *Handbook of educational psychology* (pp. 331–357). New York: Macmillan.
- Qian, G., & Alvermann, D. (1995). Role of epistemological beliefs and learned helplessness in secondary school students' learning science concepts from text. *Journal of Educational Psychology*, 87(2), 282–292.
- Reich, K. H., Oser, F. K., & Valentin, P. (1994). Knowing why I now know better: Children's and youth's explanations of their worldview changes. *Journal of Research on Adolescence*, 4(1), 151–173.
- Richardson, V. (1996). The role of attitudes and beliefs in learning to teach. In J. Sikula (Ed.), *The handbook of research on teacher education* (2nd ed., pp. 102–119). New York: Macmillan.
- Riger, S. (1992). Epistemological debate, feminist voices: Science, social values, and the study of women. *American Psychologist*, 47, 730–740.
- Roth, W.-M., & Roychoudhury, A. (1994). Physics students' epistemologies and views about knowing and learning. *Journal of Research in Science Teaching*, 31(1), 5–30.
- Ryan, M. P. (1984a). Conceptions of prose coherence: Individual differences in epistemological standards. *Journal of Educational Psychology*, 76(6), 1226–1238.
- Ryan, M. P. (1984b). Monitoring text comprehension: Individual differences in epistemological standards. *Journal of Educational Psychology*, 76(2), 249–258.
- Schoenfeld, A. (1983). Beyond the purely cognitive: Belief systems, social cognitions, and metacognitions as driving forces in intellectual performance. *Cognitive Science*, 7(4), 329–363.
- Schoenfeld, A. H. (1985). *Mathematical problem solving*. San Diego, CA: Academic Press.
- Schoenfeld, A. (1988). When good teaching leads to bad results: The disasters of "well taught" mathematics classes. *Educational Psychologist*, 23, 145–166.
- Schoenfeld, A. (1992). Learning to think mathematically: Problem solving, metacognition and sense making in mathematics. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 334–370). New York: Macmillan.
- Schommer, M. (1990). Effects of beliefs about the nature of knowledge on comprehen-

- sion. *Journal of Educational Psychology*, 82, 498–504.
- Schommer, M. (1992, October). *Predictors of epistemological beliefs: Comparing adults with only a secondary education to adults with post secondary education*. Paper presented at the meeting of the Mid-Western American Educational Research Association, Chicago.
- Schommer, M. (1993a). Comparisons of beliefs about the nature of knowledge and learning among postsecondary students. *Research in Higher Education*, 34(3), 355–370.
- Schommer, M. (1993b). Epistemological development and academic performance among secondary students. *Journal of Educational Psychology*, 85(3), 406–411.
- Schommer, M. (1994a). An emerging conceptualization of epistemological beliefs and their role in learning. In R. Garner & P. A. Alexander (Eds.), *Beliefs about text and instruction with text* (pp. 25–40). Hillsdale, NJ: Erlbaum.
- Schommer, M. (1994b). Synthesizing epistemological belief research: Tentative understandings and provocative confusions. *Educational Psychology Review*, 6(4), 293–319.
- Schommer, M., Crouse, A., & Rhodes, N. (1992). Epistemological beliefs and mathematical text comprehension: Believing it is simple does not make it so. *Journal of Educational Psychology*, 82, 435–443.
- Schommer, M., & Dunnell, P. A. (1994). A comparison of epistemological beliefs between gifted and non-gifted high school students. *Roeper Press*, 16(3), 207–210.
- Schommer, M., & Walker, K. (1995). Are epistemological beliefs similar across domains? *Journal of Educational Psychology*, 87(3), 424–432.
- Schutz, P. A., Pintrich, P. R., & Young, A. J. (1993, April). *Epistemological beliefs, motivation, and student learning*. Paper presented at the Annual Meeting of the American Educational Research Association, Atlanta, GA.
- Schwab, J. J. (1964). The structure of the disciplines: Meanings and significance. In G. W. Ford & L. Pugno (Eds.), *The structure of knowledge and the curriculum* (pp. 6–30). Chicago: Rand McNally.
- Schwab, J. J. (1978). Education and the structure of the disciplines. In I. Westbury & N. J. Wilkof (Eds.), *Science, curriculum and liberal education* (pp. 229–272). Chicago: University of Chicago Press.
- Stern, G. G. (1953). *Inventory of beliefs*. Chicago: University of Chicago Press.
- Sternberg, R. (1989). Domain-generality versus domain-specificity: The life and impending death of a false dichotomy. *Merrill-Palmer Quarterly*, 35(1), 115–130.
- Stodolsky, S. S., Salk, S., & Glaessner, B. (1991). Student views about learning math and social studies. *American Educational Research Journal*, 28, 89–116.
- Strack, F., Schwarz, N., & Wanke, M. (1991). Semantic and pragmatic aspects of context effects in social and psychological research. *Social Cognition*, 9(1), 111–125.
- Triandis, H. C. (1989). The self and social behavior in differing cultural contexts. *Psychological Review*, 96(3), 506–520.
- Triandis, H. C., Bontempo, R., Villareal, M. J., Asai, M., & Lucca, N. (1988). Individualism and collectivism: Cross-cultural perspectives on self-ingroup relationships. *Journal of Personality and Social Psychology*, 54(2), 323–338.
- Vosniadou, S., & Brewer, W. F. (1994). Mental models of the day/night cycle. *Cognitive Science*, 18(1), 123–183.
- Vygotsky, L. S. (1962). *Thought and language*. Cambridge, MA: MIT Press.
- Wellman, H. (1990). *The child's theory of mind*. Cambridge, MA: Bradford/MIT press.
- Wellman, H. M., & Gelman, S. A. (1992). Cognitive development: Foundational theories of core domains. *Annual Review of Psychology*, 43, 337–375.
- Wertsch, J. V. (1991). *Voices of the mind: A sociocultural approach to mediated action*. Cambridge, MA: Harvard University Press.

- Wertsch, J. V., & Sammarco, J. G. (1985). Social precursors to individual cognitive functioning: The problem of units of analysis. In R. A. Hinde, A.-N. Perret-Clermont, & J. Stevenson-Hinde (Eds.), *Social relationships and cognitive development* (pp. 276–293). Oxford, England: Clarendon Press.
- Widick, C. (1975). *An attribute-treatment interaction model of instruction based on cognitive developmental theory*. Unpublished doctoral dissertation, University of Minnesota, Department of Counseling and Student Personnel Psychology.
- Wigfield, A., Eccles, J. S., & Pintrich, P. R. (1996). Development between the ages of 11 and 25. In D. C. Berliner & R. C. Calfee (Eds.), *Handbook of educational psychology* (pp. 148–185). New York: Macmillan.
- Wilkinson, W. K., & Schwartz, N. H. (1987). The epistemological orientation of gifted adolescents: An empirical test of Perry's model. *Psychological Reports*, *61*, 976–978.
- Zimmerman, B. J. (1994). Dimensions of academic self-regulation: A conceptual framework for education. In D. H. Schunk & B. J. Zimmerman (Eds.), *Self-regulation of learning and performance: Issues and educational applications* (pp. 3–21). Hillsdale, NJ: Erlbaum.

Authors

BARBARA K. HOFER is a doctoral candidate, Combined Program in Education and Psychology, University of Michigan, 1400 SEB, Ann Arbor, MI 48109; bhofer@umich.edu. She specializes in epistemological development, motivation, adolescent development, and culture and cognition.

PAUL R. PINTRICH is Associate Professor and Associate Director, Combined Program in Education and Psychology, University of Michigan, Ann Arbor, MI 48109; pintrich@umich.edu. He specializes in motivation and self-regulated learning, and adolescent development and schooling.

Received June 26, 1995

Revision received June 11, 1996

Accepted September 5, 1996