credible and trustworthy source. For some students, the fact that a teacher could question the authority of a text was baffling. One such student described a set of conflicts between the lectures of his high school world history teacher and the textbook for the course, and the ambiguity this created for students, particularly when they inquired about preparing for an exam:

> We'd say 'which do you want us to use, the lecture or the book?' ... And he said this quote I'll remember till the day I die. He said 'Books lie.' (pause) That's what he told us! We didn't know what to do, it was so tough. (And what did he mean, 'books lie'?) I have no idea! He was a really weird man. And no one wanted to argue with him, because he was the authority (20a).

Texts had been a paramount authority to this student, and reconciling this with the teacher's judgment had been insurmountable for him at the time.

In most of the cases cited from high school experiences, students were overwhelmingly in favor of the book as the higher authority over their high school teachers. One commented on a discrepancy about the scientist who discovered DNA: "Basically, I remember the book, because I didn't trust the teacher. I would just think the people writing the book would know more what they were talking about. They would know more about the field." (6a) Others offered similar views.

Although it might be expected that students would see college professors as perhaps more authoritative sources of information than their high school teachers, given the relative preparation involved and the difference in roles, such changes do not occur immediately, and these students, interviewed during their first semester of college, were still likely to suggest that the textbook would be a more reputable and trustworthy source. They were pragmatic about this, of course, distinguishing between what they would give as a test answer and what they might actually believe. For example, one student commented that the psychology professor had alerted the students that a particular explanation during the lecture differed from that of the text:

> He obviously believes he was right and the book was wrong. And so he just told us to listen to him—for the test. But when it came down to it, I think if I were to go back a few years from now, I'd look in the book... Maybe he's an expert in his field, but the person who wrote the book was also an expert in psychology or otherwise he wouldn't have used that book, so I think I would trust the book a lot... Other professors are going to find that same book to teach psychology from, so it's him going against 100 different psychology professors... (17a)

Students who could not give specific examples were asked what they would do if such an occasion should arise and how they would resolve it. Some who argued for the book were very matter of fact about it, assuming that books are right, e.g., "I would just tell myself that this guy doesn't know what he's talking about." Others who said they would be more likely to accept the information in the book presented the position that texts represent the views of multiple sources, validated in the publishing process, and seemed confident that this would carry more weight.

> Books have normally been reviewed by many people or written by many people, so you know it's the opinion of more than one person. What the teacher is saying could just be their own opinion (8a).

Among those who would want to consider giving credence to the instructor over the book, there were conflicting ideas about how to evaluate the instructor's view. Four of the students presented the position that it had to do with their feelings toward the instructor, such as the student who said the following: "You have to base it on the person. You lean toward the instructor unless you don't have a good relationship with him (16a)." A few spoke of respect as well. None of the students gave particular reasons about why the instructor might deliberately contradict the book or under what set of circumstances this would be considered valid. Given the frequency with which this is likely to occur in college classrooms, this may need more explicit attention in introductory courses.

This question seemed to address concerns about what constitutes expertise and authority at the college level and how it is to be evaluated. Some seemed to be making such judgments as they might have in high school, while others were aware of a differing nature of expertise. As one student said:

> I think I'd consult a third source or a fourth source. Here at the college level you see instructors to be more competent and you also assume the information in the book is reliable. So I think that another source would have to be the determining factor—maybe another textbook, another professor in the same department, maybe someone who has tenure in the field, maybe has a little more knowledge (5a).

There are also new "higher" authorities for some students:

> I think I'd have to go and find out for myself, maybe through the Internet. And I'd look at when the book was published. And if the lecturer cited their sources, maybe I'd go check on those. But I'd probably go on the Internet because it's so much easier (21a).

This student's response raises the continuing nature of the role educators need to play in assisting students in making responsible judgments about the evaluation of the source of knowledge, not a trivial matter in education, particularly with increased student use of the Internet as a source of information, an arena that needs additional attention by those interested in students' epistemological understanding (Hofer, 2004).

6.9. What source of knowledge do you most trust?

In the second interview, toward the end of the term, students were asked what source of knowledge they most trusted. This provided a means of understanding the relationship between the multiple sources of knowledge externally available to them, as well as their view of themselves as knowers. As seen in responses to the question in the first interview about conflicting sources of knowledge, at one level students simply accept books as authorities. One student seemed to find the very issue of "trust" problematic:

> Probably a book. Hmm. I don't even think about trusting. I just take it for what it is (23b).

Others saw both texts and lecturers as venerable sources of knowledge:

> I think I'd stick with books. Books are kind of like instructors. I know one of our chemistry instructors wrote our book, so that's about as good as you can get (3b).

Others distinguished between texts and instructors, preferring the concrete, seemingly less opinionated and more certain view of a book:

> Books—because they have so many sources and they have been checked over and over again. In a lecture you can ask a question and they answer based on what's on top of their head, but a book is more concrete (9b).

> I'd have to say textbook. It seems like textbooks, stuff we learn, are facts, almost. (Almost?) Well, I'm sure in the past people have learned from books that weren't accurate. So they had to change them. That's why they come out with new books. But if it's a textbook it's not like one guy's opinion. It's something that's generally held to be true (1b).

While those two students seemed to see texts as embodying a view of knowledge as fairly certain and simple, others showed a more evaluative stance toward texts, with regard for the process by which information is justified.

> Probably books. While they can be presented with a little twist on the facts, they've generally been reviewed by people who know the information they're presenting, have gone through several different channels before they get published, so they're generally accepted truths. In a lecture, if the professor doesn't agree with something and has his own personal biases he can flip the information around. And in a class discussion students can twist the discussion any way they want to (8b).

Only a few students talked about their own ability to evaluate information that they encountered in textbooks or lectures, a position that seemed fairly recent:

> Coming from high school, I think maybe I am still pretty much naive in that once something is printed it is pretty well—you know, just accepted. You can't just print anything. But I think this is just from high school, you know. (What makes you think this is naive?) Just because you read and you never question it, whereas now you can look at—I end up looking at who wrote the textbook, and you see some different views, where they are coming from. I think you have to take that in perspective a lot more now (18b).

This ability to reflect on their own shifting views on external authorities as a source of knowledge was evident in several interviews; by contrast, those who expressed a firmer reliance on texts as authorities said that they had always held that view. Support for this shift in views as a developmental progression was provided by several of the students. Some talked about a newfound ability to evaluate and integrate ideas:

> I guess I look at everything, ideas from everything, try to put them together, try to weigh what each person is saying, what each source is saying, and try to think what's the best— not truth, but the best sense you can make out of it (2b).

Asked if this had changed over time, she replied,

> When I was younger I just went with what the book said and what the teacher said, and they were usually the same because the teacher taught out of the book, and if the teacher said it, it must be true. I think that's how I was earlier. (When did that change, do you think?) Later high school. And now. I'm still changing, I think.

This new view of self as a maker of meaning, with the ability to step back and evaluate ideas and to listen to one's own beliefs as well, was described by several students. Asked what source of knowledge they most trusted, a few students responded that they had learned to trust themselves as a source of knowledge:

> I think probably my self, just learning to believe—whether learning how to study, or reading something and turning it into terms I can understand myself (25b).

6.10. 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. In the reflective judgment model (King & Kitchener, 1994), individuals at lower levels justify beliefs through observation or authority, or on the basis of what feels right, when knowledge is uncertain. Only at higher stages do individuals use rules of inquiry and begin to personally evaluate and integrate the views of experts.

6.11. Critical incidents and instructor talk

There were several key issues in the class observations that were used as the basis for questions relevant to epistemological beliefs about the justification of knowledge. In the first interview, students were reminded of a particular statement that had been made by one of the chemistry instructors: "One of the most powerful tools science has is reproducibility," and asked what they thought this meant, in their own words. In the second interview, a comment that had been made by the psychology professor was utilized in a similar manner: "Scientific theories cannot be verified. They can at most be falsified." For most students the concept of falsification represented a general maxim they had heard throughout secondary school science classes, even though they were not all able to interpret it clearly. But surprisingly, there were a few students in this group (all of whom had extensive high school science preparation) for whom the idea seemed jarring.

> Scientific theories cannot be verified? I would think they *can* be verified. I'm sure they can be falsified also. Well, by scientific study and experiment you can prove something is true, I would think. You can also prove that it's not (20b).

> I think scientific theories can be verified. I think if they were to be done by other people. They can be falsified, too. I think that once something is proven, it can totally be done like a couple hundred times in different ways (17b).

For these individuals, this was consistent with their beliefs about knowledge as certain and concrete, as evidenced earlier in their interviews. Others recall having heard this statement many times and seem to accept it on faith as a tenet of scientific practice.

> I've heard this so many times that it's kind of funny now. You can never prove something is absolutely correct. You can only prove it's wrong. Because somebody may come along tomorrow and prove that you're wrong, but they can never prove that their idea is right. I think this is right. (She looks puzzled.) (4b)

Others attribute the principle to the ever-changing knowledge base:

> You really can't prove a scientific theory 100 percent. Because you never know what kind of evidence could pop up later that could prove it's wrong (6b).

> I think that's true. We're always coming up with new ideas. There's no absolute truth because we're always coming up with new experiments, new data, that proves something that we once believed was wrong (2b).

As evidenced in these statements, some students see new knowledge as something that "pops up," a phrase repeated in several interviews, and others imagine a more active process of knowledge development by scientists and scholars engaged in research. However, the research process, the role of falsification, and the justification process were notably vague for most students. The majority of students responded to this statement by describing the relative ease of falsification over verification:

> I think that scientific evidence is expanding so much today that it's easy to find contradictory information that can disprove an already existing theory than to completely verify what's supposedly an indisputable truth (5b).

> That's like that rule with hypotheses. They always teach you when they teach you the scientific method that all you can do is disprove it, but you can never prove a hypothesis is correct. (Why not?) Because there's always an exception to the rule. There can always be like one case. Statistically there's always going to be one case where something is not true. You can falsify, but you can never verify (13b).

Others envision the need for falsification as a defense against personal interpretation and bias:

> I think it's a lot easier to verify the truth than to disprove it. Like you could arrange your experiment to get at what you're looking at—it's very easy to do that... You're just studying what you want and what you're trying to prove is correct. The idea of falsifiability is important, because you're looking at things that would disprove your theory (24b).

Responses to this general principle, heard repeatedly throughout science classes, may indicate the need for instructors to bring more specificity to such teachings, with rationale, context, and examples. Assumptions by faculty members that students share some common understanding of scientific practices and principles may be unfounded.

7. Discussion

The purpose of this study was to explore the four hypothesized dimensions of epistemological theories in context and to identify how these dimensions as manifested in classroom context are interpreted by students within the early academic acculturation of the first year of college. As an exploratory case study, this research provides some initial attempts at addressing these issues in an interpretive manner, and creates a foundation for future work.

7.1. Dimensionality of epistemological theories in context

This study provides evidence for each of the four dimensions of epistemological theories—simplicity of knowledge, certainty of knowledge, source of knowledge, and justification for knowing—as instantiated in the instructional environment.

Although in two previous survey studies (Hofer, 2000; Qian & Alvermann, 1995) simple knowledge and certain knowledge were not readily distinguishable in a factor analysis, this qualitative approach provided considerable evidence for students' beliefs about the relative simplicity or complexity of knowledge, as distinct from views about certainty.

Although the dimensions can be distinguished from one another both conceptually and empirically, it is less clear to what degree the dimensions form a coherent way of making meaning for the individual, as suggested in the developmental theories (e.g., King & Kitchener, 1994) or whether they can be independent of one another, as suggested by Schommer (1994). Are particular beliefs about the certainty of knowledge, for example, typically aligned with particular beliefs about the simplicity of knowledge? In the synthesis of research on dimensions, as noted earlier, it was proposed that epistemological theories are divided into two categories: beliefs about knowledge (certainty and simplicity) and beliefs about the process of knowing (source and justification). Perhaps it would be most likely that those beliefs in the same category would be at similar positions, although this needs to be tested.

Thus a next step in this line of research would be to examine how these dimensions are interrelated within individuals studied. This might be particularly useful in understanding the potential impact of instructional practices. Does a change in one's view about the certainty of knowledge, for example, lead to other epistemological changes? Where does the change process begin, how is it initiated, and how interdependent are the dimensions in one's individual epistemological development? Considerable work is needed in designing studies that can better address these questions.

This study provided an exploratory examination of how students make sense epistemologically of selected instructional practices in large introductory college courses. The four commonplaces suggested by Schwab (1978)—the learner, the teacher, the milieu, and the subject matter—are interactive in this process. It appears that instructional practices are interpreted through the lens of students' epistemological assumptions, but that these perspectives are evolving and instructors have the power to influence them. This is evident in an examination of each of the dimensions.

7.1.1. Simplicity of knowledge

In regard to beliefs about the *simplicity of knowledge*, students seemed to perceive testing practices as providing some indicators about the relative simplicity or complexity of knowledge, although there is a complex interaction between beliefs, task demands, and how the instructor presents the task, contextualizes it within the course goals, and prepares students for it. Students with a relatively simple view of knowledge were comfortable with multiple choice tests and less so with open-ended problems. However, their discomfort with open-ended problems appeared to be ameliorated within a course where such practices were explained and where they were helped to prepare for the tests, and although this is far too small a group of students and too short a time span to make generalizations about change, there was at least some suggestion that these students were developing a more complex view of knowledge as a result.

This kind of interaction between student beliefs and how instructors present and provide support and rationale for tasks that may challenge students' beliefs needs considerable more study and is an important area to address. By contrast, students with a relatively simple view of knowledge seemed to find their discomfort with open-ended problem solving exacerbated in a classroom where the instructional style suggested a simple, formulaic view of knowledge but the tests required synthesis and integration. Ultimately what these findings suggest is that task demands alone provide only a partial explanation of why students select certain study strategies, nor do epistemological beliefs fully explain this process; understanding how the two interact will help us know more about how instructors can address this effectively.

7.1.2. Certainty of knowledge

In regard to *certainty of knowledge* and instructional practices, it appears, as noted earlier, that these students are likely to have moved beyond the level of a dualist view of knowledge. Stripped of such beliefs about certainty, these students may accept all opinions as equally valid. Thus when instructors in the social and natural sciences discuss the tentative nature of explanations within the disciplines, as arose in these courses, this may not be interpreted as an ongoing struggle for better explanations within an agreed upon set of standards of inquiry, but as simply a confirmation of the general uncertainty of knowledge. It is likely that instructors assume students hear such pronouncements as they are intended. But more work is needed to help students clarify an understanding of basic underlying ideas about knowledge, its origins, and its evolving character within a field.

7.1.3. Source of knowledge

Beliefs about the *source of knowledge* include both student views of external authority as well as their perception of themselves as knowers. From the interviews, it appeared that students might have views of authority that were reinforced by high school instructional practices and which give considerable credence to the primacy of the text. Naive beliefs about texts as embodiment of truth have shown considerable persistence into college (Wineburg, 1991), and this appeared to be evident in these students. This seemed to represent not only naiveté about texts but also a lack of knowledge about the training, expertise, and roles of college professors. Selecting the book over the instructor as an authority with greater credibility slights the contribution faculty members make in integrating, synthesizing, and evaluating knowledge in order to organize and teach a course. Making the process more explicit—for example, explaining why lecture material is sequenced differently than an assigned textbook, or explaining the multiple sources that have contributed to a particular lecture—may assist students in understanding more about the nature of instructional expertise, as well as how experts evaluate knowledge claims.

In regard to epistemological perceptions of the self as knower, there appeared to be distinct differences in how the two chemistry classes approached the issue of the construction of knowledge and the role of the individual as a maker of meaning. Students in organic chemistry were strongly encouraged to join study groups, a process facilitated by the instructor, and were given both oral and written encouragement to

engage in thinking aloud about chemistry with their peers; nothing similar was provided in general chemistry. Very few of the subjects in this study were actually involved in these study groups, however, so although this aspect of instructional practice was queried, there were too few participating to interpret its significance epistemologically. Small group participation is certainly another aspect of instruction that needs epistemological investigation, building on earlier findings that there is a relation between constructivist group work and more sophisticated beliefs about math, for example (Hofer, 1999). It would be valuable to know if such participation affects students' beliefs about the source of knowledge in particular.

7.1.4. Justification for knowing

From the interviews on instructional practices and the *justification for knowing*, it appeared that this dimension is fairly unsophisticated in this group of undergraduates. Their responses to a range of instructor comments about the conduct of scientific inquiry suggest that they are interpreting these ideas within a rather limited framework of understanding and that it will take more than repeating these maxims to achieve understanding of the evaluation of knowledge claims in these fields. Many had naive notions of the basic processes of scientific research and may need more direct instruction with specific examples, as well as guided practice in the evaluation of research.

7.2. Epistemology and identity

What also emerged in the process of interviewing students during the tumultuous first months of college was the sense that altering these beliefs might also alter a sense of self. Particularly during the second interview some students spoke directly of the process of change and how it altered a sense of identity. As one student, struggling to articulate changing views on the issue of evolution and the disjuncture between his new beliefs and those of his family and church, said, quite poignantly, "Who will I be if I believe that?" Interviewed just before Thanksgiving (and just prior to his first trip home since arriving at college), he had already experienced intellectual and epistemological transformations that created profound unease about returning home to face those he once accepted as infallible authorities—parents, teachers, his parish priest. The impact of college—and of the epistemological development that can occur in such an environment—is that it can challenge both beliefs and knowledge and thus a sense of identity and one's relationship to others. Belief change during adulthood has been reported as relatively rare, generally caused by a shift in authority or a gestalt shift (Pajares, 1992). Such beliefs may be at their most malleable during adolescence, and particularly early in college, precisely because authority does shift for many students, calling existing beliefs into question. Continuing work is needed on the relation between epistemological development, identity, and affect.

7.3. Limitations

This study was based on a small sample of students, interviewed at two time points during their first term of college. Such a slice of life represents a relatively

restricted range of epistemological theories, although there was certainly variation in their views and the changes during this time were notable. To capture a larger range of beliefs, it would be valuable to include students at different levels of study and to talk with them more frequently and over a longer time span. Also, although efforts were made to select students enrolled in similar courses within the same institution, it is obvious that this is only a small part of their college experience. It was clear from the interviews, as it is in the literature (Baxter Magolda, 1992), that there are many aspects of the college experience that affect students' epistemological development. Furthermore, although restricting observations to the lecture component of these students' classes made it possible to find common ground in their academic experiences, a more complete understanding of what transpires in these courses may have been sacrificed. Instructors generally do not intend for their lectures to stand alone, but see them as one component of the instructional process, complemented by the text, discussion sections, and labs. More work is also needed to examine the effect of instructional practices in smaller settings with more opportunities for direct engagement. Finally, it would be desirable to study a larger number of participants enrolled in courses with distinctly differing epistemological assumptions and to examine belief change on a pre- and post-test measure.

7.4. Educational implications

This study suggests that addressing prevailing conceptions of a discipline may be an important aspect of an introductory course, as well as determining what conceptions it may be desirable to convey. Students do not arrive in college as blank slates in regard to either epistemological theories or beliefs about disciplines. Students who enroll in science classes during the first year of college have generally had a full complement of science courses in high school, many at the advanced placement level. Many such courses are geared toward successful testing in order to ensure college admission. Far fewer students have taken a course in psychology, but they are surrounded by the popularized version of the field and may have considerable confusion about the boundaries and credibility of psychology as an academic discipline. If introductory courses fill a broader role in providing many students with the only academic exposure they will have to a field, we may want to think more about including more explicit attention to epistemological premises. Greater attention to research methods and principles of justification in a field may be one way to do this. Students need instruction not only in *what* psychologists and chemists know, but *how* they know what they know.

There are multiple challenges for instructors implied in this work. First-year introductory courses play a powerful part in students' socialization to college study and to entire disciplines of inquiry. We need to know more about how instruction of these classes fits with the expressed purposes of both the first year of college and the introductory-level courses. Finally, it appears that students filter their perceptions of instructional practice through their own epistemological perspectives, a finding congruent with the existing body of research in this field. But such perceptions are malleable, and faculty members may be most effective when they take such filters into

account, address epistemological assumptions, provide the rationale for particular instructional practices, and address not only what there is to know in a field, but how it is we know, and how what we know can be justified.

References

Andre, T., & Windschitl, M. (2003). Interest, epistemological belief, and intentional conceptual change. In G. M. Sinatra & P. R. Pintrich (Eds.), *Intentional conceptual change* (pp. 173–197). Mahwah, NJ: Erlbaum.

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. (2001). *Making their own way: Narratives for transforming higher education to promote self-development.* Sterling, VA: Stylus.

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.

Bendixen, L. D. (2002). A process model of epistemic belief change. In B. K. Hofer & P. R. Pintrich (Eds.), *Personal epistemology: The psychology of beliefs about knowledge and knowing* (pp. 191–208). Mahwah, NJ: Erlbaum.

Blumenfeld, P. C. (1992). The task and the teacher: Enhancing student thoughtfulness in science. *Advances in Research on Teaching, 3,* 81–114.

Boyes, M. C., & Chandler, M. (1992). Cognitive development, epistemic doubt, and identity formation in adolescence. *Journal of Youth and Adolescence, 21*(3), 277–303.

Burr, J. E., & Hofer, B. K. (2002). Personal epistemology and theory of mind: Deciphering young children's beliefs about knowledge and knowing. *New Ideas in Psychology, 20,* 199–224.

Creswell, J. W. (1998). *Qualitative inquiry and research design: Choosing among five traditions.* Thousand Oaks, CA: Sage.

Crooks, T. J. (1988). The impact of classroom evaluation practices on students. *Review of Educational Research, 58*(4), 438–481.

Denzin, N. K. (1989). *The research act* (3rd ed.). Englewood Cliffs, NJ: Prentice Hall.

Dole, J. A., & Sinatra, G. M. (1998). Reconceptualizing change in the cognitive construction of knowledge. *Educational Psychologist, 33,* 109–128.

Doyle, W. (1983). Academic work. *Review of Educational Research, 53*(2), 159–199.

Evertson, C. M., & Green, J. L. (1986). Observation as inquiry and method. In M. C. Witrock (Ed.), *Handbook of research on teaching* (3rd ed.). New York: Macmillan.

Fielding, N. G., & Fielding, J. L. (1986). *Linking data.* Newbury Park, CA: Sage.

Geertz, C. (1973). Thick description: Toward an interpretive theory of culture. In C. Geertz (Ed.), *The interpretation of cultures* (pp. 3–30). New York: Basic Books.

Hofer, B. K. (1999). Instructional context in the college mathematics classroom: Epistemological beliefs and student motivation. *Journal of Staff, Program, and Organizational Development, 16*(2), 73–82.

Hofer, B. K. (2000). Dimensionality and disciplinary differences in personal epistemology. *Contemporary Educational Psychology, 25,* 378–405.

Hofer, B. K. (2001). Personal epistemology research: Implications for learning and teaching. *Educational Psychology Review, 13*(4), 353–383.

Hofer, B. K. (2002). Epistemological world views of teachers: From beliefs to practice. *Issues in Education: Contributions from Educational Psychology, 8,* 166–173.

Hofer, B. K. (2004). Epistemological understanding as a metacognitive process: Thinking aloud during online searching. *Educational Psychologist, 39*(1), 43–55.

Hofer, B. K., & Pintrich, P. R. (1997). The development of epistemological theories: Beliefs about knowledge and knowing and their relation to learning. *Review of Educational Research,* 88–140.

Hofer, B. K., & Pintrich, P. R. (Eds.). (2002). *Personal epistemology: The psychology of beliefs about knowledge and knowing.* Mahwah, NJ: Erlbaum.

Kardash, C. M., & Howell, K. L. (2000). Effects of epistemological beliefs and topic-specific beliefs on undergraduates' cognitive and strategic processing of dual-positional text. *Journal of Educational Psychology, 92*, 524–535.

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. (2002). The reflective judgment model: Twenty years of research on epistemic cognition. In B. K. Hofer & P. R. Pintrich (Eds.), *Personal epistemology: The psychology of beliefs about knowledge and knowing* (pp. 37–61). Mahwah, NJ: Erlbaum.

Kitchener, R. (2002). Folk epistemology: An Introduction. *New Ideas in Psychology, 20*, 89–105.

Kuhn, D. (1991). *The skills of argument.* Cambridge: Cambridge University Press.

Kuhn, D., Cheney, R., & Weinstock, M. (2000). The development of epistemological understanding. *Cognitive Development, 15*, 309–328.

Mason, L. (2003). Personal epistemologies and intentional conceptual change. In G. M. Sinatra & P. R. Pintrich (Eds.), *Intentional conceptual change* (pp. 199–236). Mahwah, NJ: Erlbaum.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis.* Thousand Oaks, CA: Sage.

Pajares, F. (1992). Teachers' beliefs and educational research: Clearing up a messy construct. *Review of Educational Research, 62*(3), 307–332.

Patton, M. Q. (1990). *Qualitative evaluation and research methods.* Newbury Park, CA: Sage.

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.

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*(2), 119–167.

Qian, G. (2000). Relationship between epistemological beliefs and conceptual change learning. *Reading and Writing Quarterly, 16*, 59–74.

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.

Schoenfeld, A. H. (1985). *Mathematical problem solving.* San Diego, CA: Academic Press.

Schommer, M. (1990). Effects of beliefs about the nature of knowledge on comprehension. *Journal of Educational Psychology, 82*, 498–504.

Schommer, M. (1994). 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., 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-Aikins, M. (2002). An evolving theoretical framework for an epistemological belief system. In B. K. Hofer & P. R. Pintrich (Eds.), *Personal epistemology: The psychology of beliefs about knowledge and knowing* (pp. 103–118). Mahwah, NJ: Erlbaum.

Schraw, G., & Olafson, L. (2002). Teachers' epistemological world views and educational practices. *Issues in Education: Contributions from Educational Psychology, 8*, 99–148.

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.

Stake, R. E. (1995). *The art of case study research.* Thousand Oaks, CA: Sage.

Wineburg, S. (1991). Historical problem solving: A study of the cognitive processes used in the evaluation of documentary and pictorial evidence. *Journal of Educational Psychology, 83*, 73–87.

Wood, P., Kitchener, K. S., & Jensen, L. (2002). Considerations in the design and evaluation of a paper-and-pencil measure of epistemic cognition. In B. K. Hofer & P. R. Pintrich (Eds.), *Personal epistemology: The psychology of beliefs about knowledge and knowing.* Mahwah, NJ: Erlbaum.

Yin, R. K. (1989). *Case study research: Design and methods.* Newbury Park, CA: Sage.