A Developmental Model of Critical Thinking

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The critical thinking movement, it is suggested, has much to gain from conceptualizing its subject matter in a developmental framework. Most instructional programs designed to teach critical thinking do not draw on contemporary empirical research in cognitive development as a potential resource. The developmental model of critical thinking outlined here derives from contemporary empirical research on directions and processes of intellectual development in children and adolescents. It identifies three forms of second-order cognition (meta-knowing)—metacognitive, metastrategic, and epistemological—that constitute an essential part of what develops cognitively to make critical thinking possible.

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Enthusiasm for critical thinking as a goal of education shows no signs of waning. Pluralist conceptions of what education should be achieving—the demand for accountability by diverse constituencies—make critical thinking ever more attractive as a unifying objective of every student's education. Many of the functions education performs—making the discriminations that regulate access to occupations, serving special needs of subgroups—rest on human differences. Developing the competencies that enable people to participate fully as citizens in a democracy remains the unifying purpose, and great promise, of public education.

Indeed, one would be hard pressed to construct a serious counterargument, to claim that we wouldn't like to see students become careful, rigorous thinkers as an outcome of the education we provide them. Yet as a serious social goal, education for thinking is hardly trivial. By most accounts, we remain far from achieving it. A question we might be asking at this point, then, is whether progress is being made in establishing a knowledge base that will support its realization. Are educational researchers making reasonable progress not only in determining how to teach critical thinking but, even more fundamentally, in establishing exactly what it entails?

In making advances regarding these tasks, especially the latter, one might anticipate that educators would rely heavily on a knowledge base provided by researchers who study cognitive development. In fact, however, at least until very recently, the burgeoning critical thinking movement in education has proceeded with little apparent contribution from contemporary cognitive development research. If educators draw on empirical data at all, efforts to define critical thinking skills have tended to be based on an older psychometric literature on abilities (see Ferrari & Sternberg, 1998, for a recent review). Nor, traditionally, have educators looked very much to research on mechanisms of cognitive development for ideas regarding how to foster these skills.

Why has an enterprise held in such wide esteem and of such significance to society not been guided by systematic and extensive empirical research on the nature of thinking and its development? A possible explanation is that relevant research has been either nonexistent or untranslatable into practice. Even if correct, this explanation, it is significant to note, does not apply across the board to other curriculum areas of concern to educators, such as reading and mathematics. To the contrary, research in the development of mathematical understanding and reading skills has expanded enormously in recent years, with researchers paying increasing attention to the relevance of their findings for practice.

A possible explanation for the difference is that, unlike reading or mathematical skills, thinking does not fall within the purview of developmental psychology because it is not a developmental phenomenon. In other words, it does not evidence strong age-related emergence of a sequence of competencies of the sort that researchers have identified in mathematics or reading. Rather, we would like thinking at any age to be sound and rigorous and free of fallacies, and developmental psychologists have no particular expertise to offer in finding ways to get students to think more carefully and rigorously.

In this essay, I argue against such a view, claiming instead that developmental phenomena are currently being studied that are of direct relevance to understanding and fostering critical thinking. Furthermore, I claim, the critical thinking movement has much to gain from a developmental conceptualization of its subject matter—a perspective that has been largely absent—and it has a growing knowledge base of cognitive development research to draw on in this regard. Moreover, a developmental conceptualization has implications for what is perhaps the most pressing practical issue in current efforts to teach critical thinking, the fact that gains most often do not generalize beyond the immediate instructional context.

Do We (Really) Know What Critical Thinking Is?

What does it mean to be accomplished in thinking, and how does this accomplishment manifest itself? What are the component skills or states of partial accomplishment on which a teacher might focus, and how can progress in these

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respects be gauged? The ready base of empirical knowledge that educators can turn to to address these questions in the case of reading or mathematics is largely absent when educators turn their attention to thinking. Nor has the recent history of cognitive development research made things any easier for them. Among trends in the field have been, on one hand, a growing attention to biological endowment and how it constrains development to favor certain forms and domains over others (Gelman & Williams, 1998; Spelke & Newport, 1998) and, on the other, an increasing recognition of the role of culture (Rogoff, 1998). Both, in their respective ways, emphasize specificity at the expense of broad lines of cognitive development of the sort that would be of particular relevance to educators.

In apparent compatibility with this zeitgeist, most educators today favor the view that critical thinking skills must be taught in the context of specific subject matter (Perkins & Salomon, 1989). Countering an historical tradition of learning research employing minimal, arbitrary, and even meaningless content, Brown (1997) elaborates this position, claiming that we cannot expect children to progress in the development of thinking unless we give them something to think about, in other words, unless we engage them in serious learning about meaningful, rich, domain-specific subject matter of the sort contained in the traditional school curriculum.

Although controversy continues to exist in the education literature, it is not my purpose here to debate claims about how best to teach critical thinking nor even to review the relevant evidence. Instead, my purpose in this essay is to argue that whatever the position one takes regarding effective instructional techniques, it remains a crucial task to *define* thinking skills in a way that has generality at least across some broad range of content, is informed by empirical data, and is situated in a developmental framework of where particular cognitive skills come from and where they are headed. None of the psychological or educational literature I have alluded to here, it is worth noting, is incompatible with such an undertaking.

I make the case for the importance of this task on two grounds—conceptual and practical. Conceptually, it is essential that we know precisely what we mean when we refer to critical thinking or thinking skills, if the constructs are to be useful. Brown (1997), for example, while arguing for the need to embed the teaching of thinking skills in rich subject matter instruction, advocates the importance of children attaining "flexible learning and inquiry strategies of wide applicability" (p. 399). The very use of a term such as "inquiry strategies" implies that such strategies are not taken to be entirely domain specific in a conceptual sense—i.e., defined in a way that confines them to a particular body of content. The extent of their empirical (as opposed to conceptual) cross-domain generality—i.e., the extent to which their application in one context is predictive of their application in another—then becomes a matter for empirical investigation. Establishing the two kinds of generality, it should be noted, is a sequential undertaking. Until a cognitive skill is defined conceptually across a range of contexts, one cannot investigate its empirical generality across these contexts.

Theorists and researchers need to know exactly what we mean by such things as "inquiry strategies" if the constructs are to be useful to them. So, too, do practitioners. If we expect teachers to venture beyond the well-specified goals that exist within traditional subject matter areas and embrace thinking skills as educational goals in a serious and committed way, we must aid them to envision these skills in a way that would make them concrete realities rather than vague abstractions. For all of the educational literature aimed at enhancing teachers' awareness of the importance of fostering thinking skills in their students, teachers have been offered remarkably little in the way of concrete examples of what these skills are—what forms they take, how they will know when they see them, how they might be measured. If such skills are really important, a teacher might well infer, I would have a clearer picture of what they are, and I would know how to identify them. Also, this hypothetical teacher might infer, I would see more indication that they are valued in the school community; they would be regularly assessed in my students as a matter of school policy, as are the "basic" skills on which evaluation of teacher performance increasingly has come to rest. What is a perceptive teacher to conclude when developing thinking skills is what gets talked about in abstract terms as a worthy goal and other competencies are the ones repeatedly measured in his or her classroom?

Critical Thinking As Metacognition

In the major portion of this essay, I present one effort—my own—to identify specific intellectual skills that might serve as a focus of middle- and secondary-school educators' efforts to enhance the thinking of their students. A distinctive characteristic of this effort is that it draws directly on contemporary empirical research on cognitive development from late childhood through adolescence and into adulthood (Moshman, 1998). Indeed, the central thesis of this essay is that empirical data regarding the directions and paths in which children's and adolescents' thinking develops stand to inform educators' discussions regarding critical thinking.

A second distinctive characteristic of the present effort is that the developing cognitive competencies I describe as most relevant to critical thinking are metacognitive—rather than cognitive—competencies. In contrast to first-order cognitive skills that enable one to know about the world, metacognitive skills are second-order *meta-knowing* skills that entail knowing about one's own (and others') knowing. Olson and Astington (1993) are the only other researchers studying cognitive development to my knowledge to explicitly link metacognition or meta-knowing to critical thinking.

It should be noted, however, that a concept like metacognition, even if it does not go by this specific name, is by no means new to the philosophical literature on critical thinking. Indeed, something like metacognition figures in the definitions of critical thinking proposed by most educational philosophers who have addressed the topic. It would be a digression from the purposes of the present essay to review this vast literature in any detail. Briefly, however, it is worth noting that although educational philosophers have voiced disagreement with one another regarding how critical thinking should be defined, their respective definitions have tended to contain some element of what heads Paul's (1990) list of multiple facets that define critical thinking: "the art of thinking about your thinking" (p. 32). Paul (1990) is critical of the definitions of other educational philosophers—for ex-

ample, Ennis' (1987; Norris & Ennis, 1989) definition of critical thinking as "reasonable and reflective thinking [concerned with what to do or believe]" (Norris & Ennis, 1989, p. 3) or Siegel's (1988, p. 2) definition as thinking "appropriately moved by reasons"—on the grounds that they rest on concepts such as reasonableness or reflectivity that are not themselves well defined. Although Paul remains critical of it as well, Lipman's (1991) definition of critical thinking as thinking that "can be assessed by appeal to criteria" (p. 116) fares better in this respect. The evaluation of thinking by appeal to criteria implicates metacognition: Thinking necessarily becomes an object of cognition (just as it does in Ennis' definition, in which one is reflecting on what one should believe). Lipman (1991) makes the interesting point, however, that it is possible to think about one's thinking in a completely uncritical manner. Hence, he adds to his definition the further stipulation that in order to qualify as critical thinking, metacognition must be "self-correcting."

Educational philosophers have also concerned themselves with the question identified earlier—are critical thinking skills domain specific or domain general?—and come down variously on the domain-specific (McPeck, 1981) and domain-general (Paul, 1990) sides (although their debates of this issue tend not to have been influenced by empirical evidence). In contrast, an aspect of critical thinking that has received relatively little attention from educational philosophers is its developmental dimension. One important exception to this generalization, however, is the work of the educational philosopher who perhaps had the most to teach us about critical thinking—Dewey.

Dewey, with his deep respect for and involvement in the empirical science of psychology, did not share the conception that prevails today of a dichotomy between the scientific study of human development and the practical world of children in schools. Instead, he saw schools as laboratories of human development, as experiments in the possibilities of human development in arranged environments. Repeatedly in his writings, Dewey made clear that the goal of education could only be development (or what he called "growth"). Education "means supplying the conditions which foster growth" (Dewey, 1916, p. 56), not toward a predetermined end but rather in the direction of "an increase in the range and complexity of situations to which the child is capable of applying reasoned inquiry" (Cahan, 1994, p. 158). Dewey also made it clear that he saw the educator's task as a process of connecting with the young child's interests and purposes, but that one could not stop there. "The real problem of intellectual education," he said, "is the transformation of more or less casual curiosity and sporadic suggestion into attitudes of alert, cautious, and thorough inquiry" (Dewey, 1933, p. 181).

Realizing Dewey's vision, I would claim, can be furthered by knowledge regarding how children's intellects develop—the directions, the processes, and the states of partial accomplishment (Haith & Benson, 1998) that mark this evolution. The empirical data of researchers who study these processes have a central role to play in this endeavor.

The origins of my own concern with the development of meta-knowing skills—the intellectual skills most closely associated with critical thinking—lie in microgenetic studies of the strategies children or adults employ in coordinating existing understandings with new evidence (Kuhn, 1989; Kuhn, Garcia-Mila, Zohar, & Andersen, 1995; Kuhn, Schauble, & Garcia-Mila, 1992; Schauble, 1996). It is through such coordination processes that knowledge is acquired. While much developmental research in recent years has been devoted to detailed description of the evolution of theoretical knowledge within specific domains (Wellman & Gelman, 1998), much less attention has been given to the *process* of theory-evidence coordination that drives this knowledge evolution. I have proposed that a critical change that occurs with development is the attainment of increasing control over this process (Kuhn, 1989). Because it has to do with awareness, understanding, and management of one's cognition (in contrast to simply its execution), this is a meta-knowing attainment. Research I describe in this essay supports the claim that this control increases both with age, in cross-sectional data, and over time, in microgenetic data.

Traditionally in developmental psychology, thinking about thinking has been most closely associated with Piaget's stage of formal operations (Inhelder & Piaget, 1958). Contrary to Piaget's model, however, subsequent research indicates that the second-order "operations on operations" that define his formal operational stage do not emerge in any singular, abrupt, or decisive fashion (Moshman, 1998). In this respect, Piaget's developmental claims appear to have been too strong. In another respect, however, his developmental claims may have been too modest, for the ability to think about one's own thought has sweeping implications that extend far beyond the narrow contexts of scientific inquiry about physical phenomena that Inhelder and Piaget (1958) examined. Thinking about one's thought—in contrast to simply engaging in it—opens up a whole new plane of cognitive operations that do not exist at a simple first-order level of cognition.

Although the divisions are not rigid and aspects of all three appear in many instances of meta-knowing, I discuss meta-knowing here in three broad categories—*metastrategic, metacognitive,* and *epistemological* (Kuhn, in press). The distinction between metastrategic and metacognitive knowing rests on a widely employed dichotomy in cognitive psychology (as well as in philosophy) between procedural knowing (knowing how) and declarative knowing (knowing that). Meta-knowing differs depending on the kind of first-order knowing that is its object. Procedural or strategic knowing entails the exercise of strategies to achieve goals, thus invoking the potential for a second-order *metastrategic* form of knowing that selects and monitors the strategies that are applied—a manager of the repertory of available strategies. *Metacognitive* knowing operates on one's base of declarative knowledge, which also stands to benefit from executive management. What do I know, and how do I know it? Finally, *epistemological* knowing has to do with an individual's broader understanding of knowledge and knowing. It has both a general, philosophical aspect—How does anyone know?—and a personal aspect—What do I know about my own knowing? One might be tempted to dismiss epistemological understanding as of marginal interest, simply a curiosity reflecting children's or lay adults' naive efforts to grapple with philosophical concepts. As I shall argue to the contrary, however, it is of critical importance, in part because of its influence on the other two components. First, however, because it is a developmental story I wish to tell, I begin at the beginning, with a look at the developmental origins of meta-knowing.

Developmental Origins of Meta-Knowing

Metacognitive Knowing

Somewhere in the age range of 3 to 5 years—the exact age being a matter of debate—children acquire the insight that assertions are expressions of someone's belief (Olson & Astington, 1993). It is an attainment, I will claim, that is a critical marker in the development of meta-knowing and lays an essential foundation for critical thinking. It is also the culmination of its own set of developmental precursors. By the time they achieve this insight, children will have developed the ability to represent mental states; they distinguish, for example, thinking about a dog from actually perceiving one (Estes, Wellman, & Woolley, 1989). They also have begun to use mental-state concepts such as desire and intention as a means of explaining their own and others' behavior (Wellman & Gelman, 1998). In these very simple respects, even very young children are able to think about thinking as a human activity that they and others engage in.

And yet, prior to the attainment of the insight I highlight here, young children remain curiously limited in their conceptualization of the products of this thinking—the beliefs people hold and the assertions they make that express these beliefs. A good deal of evidence now exists that children below the age of about 4 regard the universe of assertions that people make, and the beliefs that these assertions represent, as isomorphic to an external reality. An account of an event differs from the event itself only in that one exists on a representational plane whereas the other is perceived directly. In other words, the world is a simple one in which things happen and we can tell about them. There are no inaccurate renderings of events.

A major source of evidence for this characterization of young children's understanding is their poor performance in simple tasks involving the concept of false belief. In the now-classic experimental paradigm from which a burgeoning wave of research on "theory of mind" derives, 3-year-olds believe that a newcomer will share his or her own accurate knowledge that a candy container in truth holds pencils (Perner, 1991; Wimmer & Perner, 1983). It is impossible that the other person could hold a belief that the child knows to be false. And children may even deny that they earlier had professed this false belief before being shown the contents.

Underlying these claims is the naive epistemological theory that beliefs are nothing more or less than mental copies of reality. The implications of this "realist" epistemological stance for critical thinking are profound, rendering it, in effect, moot. If we accept a very broad and general definition of critical thinking as the evaluation of assertions (Olson & Astington, 1993), the realist stance lends little sense to such an activity. If assertions merely duplicate and reflect reality, they do not need to be evaluated. They simply exist, on a plane parallel to physical reality, as representations of the way things are.

Recognition of assertions as belief states, in contrast, implies the understanding that they may conflict with a physical reality. As a result, their truth status becomes susceptible to evaluation. Perner (1991) characterizes this acquisition as the ability to metarepresent—i.e., to mentally model the human representational function. We do not know why this achievement occurs at exactly this time, but apparently the child accrues enough experience with human knowing to link the products of knowing—beliefs and assertions—to the generative process that gives rise to them. Their source is a human representational system that is recognized as having intent and volition to represent what it wishes to represent. Accordingly, an assertion's closest link becomes to this source—the subject who is doing the representing, rather than the object being represented.

The kinds of evaluation that recognition of assertions as belief states makes possible are rudimentary, consisting of no more than comparing an assertion to reality and pronouncing it true or false. Yet this achievement has two important implications. One is the implication of at least some distinction between an assertion and external evidence bearing on it; assertion and evidence must exist as distinct entities if one is to be evaluated in light of the other. Second, the status of evidence and assertion as distinct entities makes it possible for relations to be constructed between them. Paradoxically, achievement in the second respect (establishment of correspondences between assertion and evidence) outstrips achievement in the first (maintenance of the distinction between the two). Young children, for example, readily draw on covariation evidence to make causal inferences (Shultz & Mendelson, 1975). (Noncovariation as evidence for noncausality turns out to be more difficult.) Moreover, in very simple contexts, they can identify such correspondences even when the assertion is contrary to their own beliefs (Ruffman, Perner, Olson, & Doherty, 1993).

More problematic, it turns out, is maintenance of firm differentiation between evidence bearing on an assertion and the assertion itself. The reason may be that making the association between an assertion and the evidence that supports it remains in the realm of first-order, strategic cognition—e.g., observing a character eat green food supports the assertion that she likes green food (Ruffman et al., 1993). Differentiating assertion and evidence as belonging to different epistemological categories, in contrast, is an achievement that entails meta-knowing. At stake are the questions, "What do I know?" and "How do I know it?"

Several studies have documented the difficulty preschoolers have in achieving and maintaining awareness of the sources of their knowledge. The evidence suggests that some time is required beyond the acquisition of false-belief understanding—the understanding that assertions are generated by human minds and therefore differentiated from an external reality—for the child to recognize as significant the sources of their own and others' beliefs. Gopnik and Graf (1988), for example, found preschool children unable to indicate whether they had just learned the contents of a drawer from seeing them or being told about them. Similarly, Taylor, Esbensen, and Bennett (1994) reported preschoolers as showing little ability to distinguish *when* they had acquired knowledge—whether it had just been taught to them or was something they had "always known" (as most of them claimed regarding a newly learned fact).

In Gopnik and Graf's (1988) study, the alternative sources of knowledge that a child was asked to maintain awareness of were arbitrary (whether the contents of a drawer were learned from seeing or being told about them) and might have been dismissed by the child as of no significance once the knowledge had been acquired. In a current study (Kuhn & Pearsall, 1998b), in contrast, we ask preschoolers to make a distinction between alternative sources of knowledge, a

distinction that is of critical epistemological significance. They are asked to differentiate theory, as a source supporting the plausibility of a claim, and evidence, as a source that can support the truth of the claim. Do young children appreciate whether they are claiming something to be true because it makes sense as a way for things to be or on the basis of empirical evidence of its correctness? Young children, we hypothesized, would not be sensitive to this distinction in identifying the sources of their claim that an event had occurred.

We showed preschoolers a sequence of pictures in which, for example, two runners compete in a race. Certain cues suggest a theory as to why one will win—e.g., one has fancy running shoes. The final picture in the sequence provides evidence of the outcome—e.g., one of the runners holds a trophy and exhibits a wide grin. When children are subsequently asked to indicate the outcome and to justify this knowledge, younger children show a fragile distinction between the two kinds of justification—"How do you know?" and "Why is it so?"—i.e., the evidence for their claim (the outcome cue in this case) versus their explanation for it (the initial theory-generating cue). The two appear to jointly support a single representation of a state of affairs that "makes sense," with the respective cues treated as interchangeable contributors to this knowledge state. In the race example, young children often answered the "How do you know [he won]?" question not with evidence (e.g., "He's holding the trophy") but with a theory of why this state of affairs makes sense (e.g., "Because he has fast sneakers"). In another instance, in which a boy is shown first climbing a tree and then down on the ground holding his knee, the "How do you know [that he fell]?" question was often answered with "Because he wasn't holding on carefully."

These findings do not suggest that 4-year-olds can never answer "How do you know?" questions. Indeed, they do so commonly when justifications for their claims are readily available (e.g., "How do you know it's a zebra? Because it has stripes."). Rather, the findings suggest that children who have not yet achieved the epistemological understanding in question do not distinguish justifications of differing epistemological status (such as theory and evidence) when multiple cues suggest different justifications.

These confusions between theory and evidence diminish sharply among 6-year-olds, who are more likely to distinguish the evidence for their claim from a theory that explains it. The question, "How do you know?," becomes a meaningful one, distinct from the question of whether this knowledge claim is a plausible one. It is important to emphasize, however, that 6-year-olds who have achieved this epistemological understanding still differentiate theory and evidence in only a very limited sense and set of contexts. The child is able to distinguish evidence for the claim that an event occurred from a causal theory that makes occurrence of the event plausible. The evidence in question is simply evidence that the event occurred (e.g., the runner won the race), which is the claim under consideration. A theory as to why or how the event occurred is a separate entity. Such a theory can be used to support the plausibility of the claim, but it remains only a theory and, hence, one that properly requires its own supporting evidence. Evidence capable of supporting a causal theory is of more complex forms. These more complex forms of evidence (such as covariation evidence) are those that older children and adults confuse with their own causal theories, as I note later.

It is the development just described during the preschool years that reflects a growing metacognitive capacity to reflect on one's own knowing and, hence, to distinguish theory and evidence as different forms of knowing, rather than demonstrations of children's ability to reason about correspondences between assertions and patterns of evidence, which has been the focus of most studies of early scientific reasoning skill (see Kuhn et al., 1995, for review). I highlight this development here as a foundational achievement in metacognitive and epistemological understanding, as well as the developmental origin of subsequent achievements in scientific thinking (Kuhn & Pearsall, 1998b).

Still to develop, however, is the epistemological insight that different minds can arrive at genuinely different and legitimate understandings of the same evidence. At age 8, children do not make appropriate judgments regarding the mental representations of observers exposed to ambiguous stimuli (Carpendale & Chandler, 1996; Pillow & Henrichon, 1996) and tend to assume that the other will interpret the stimulus in the same way they do. They do not yet realize that two people can hold genuinely different beliefs, except in the case where one party's belief is misinformed and incorrect. Children at this age lack the interpretive or "constructive" theory of mind (Carpendale & Chandler, 1996; Wellman, 1990) that would lead them to understand conflicting representations of the same event as legitimate products of individuals' unique meaning-making efforts. This achievement is an important stepping stone in the development of epistemological understanding, which we return to later. First, we examine the developmental origins of metastrategic knowing.

Metastrategic Knowing

Metastrategic knowing invokes an entirely different, older developmental literature that has remained unconnected to the theory-of-mind literature despite their common concern with meta-knowing. Research on metastrategic awareness of knowing as process is nonetheless consistent with what the theory-of-mind literature would predict. If mental representations are understood as reflecting the external world more than the mental activity of the representor, this mental activity does not assume great significance in its own right and is unlikely to be the object of the child's attention.

Research by Flavell and colleagues confirms this prediction. Although their responses make it clear that they understand thinking as internal mental activity, preschool children show limited awareness of its occurrence or content in themselves or others. They may not acknowledge that a person engaged in making a decision is thinking and, despite explicit cues, are poor at judging what the person has been thinking about. They also show limited awareness of their own thought. When asked, for example, to think about the room in their house where their toothbrush is kept and asked immediately afterward what they have been thinking about, 5-year-olds failed to mention either bathrooms or toothbrushes (Flavell, Green, & Flavell, 1995).

Flavell's recent work grows out of the earliest empirical research in developmental psychology to examine meta-knowing—a literature on meta-memory (Brown, 1975, 1978; Flavell & Wellman, 1977; Kreutzer, Leonard, & Flavell, 1975). It focuses on children's knowledge and use of strategies, such as rehearsal or categorization, to aid their performance in traditional memory tasks such as recalling a list of

words. In contrast to the early metacognitive achievements described earlier, no marked achievements appear during the preschool years. Unless they are prompted to do so, children tend not to apply strategies spontaneously in contexts where they would be useful. Such findings led to the conclusion that children have poor metastrategic awareness and understanding of their memory processes (Brown, Bransford, Ferrara, & Campione, 1983; Flavell & Wellman, 1977; Schneider, 1985). Studies that have directly assessed children's knowledge about memory support this conclusion (Kreutzer et al., 1975). Not before middle childhood do children understand, for example, that a memory strategy such as categorization aids recall (Moynahan, 1978).

Other research points to a more wide-ranging metastrategic deficit not confined to memory skills. Children show little evidence of engaging in metastrategic monitoring of their comprehension of what they read to judge whether it has been successful (Flavell, Speer, Green, & August, 1981; Markman, 1979). Such monitoring is a first step toward the use of metastrategic understanding as a means to regulate and improve cognitive performance. Although early studies did not indicate strong relations between metastrategic knowledge and strategic performance, more recent work suggests a bidirectional relationship in which metastrategic knowledge both directs and, in turn, is enhanced by strategy use (Kuhn & Pearsall, 1998a; Schneider & Bjorklund, 1998; Sophian, 1997).

What makes the weaknesses in early metastrategic and metacognitive skills that have been described here especially significant is the fact that, with development, we see improvement but by no means mastery, even by adulthood. Developmentalists characteristically probe children's early years in search of the origins of later-appearing competencies. In this case, we appear to be observing the early origins of a later lack of competence, one that has profound implications for critical thinking. These basic forms of second-order cognition—knowing what one knows and how one knows it and effectively managing and deploying one's cognitive resources—are the foundation of the critical thinking skills that we hope to impart to students during the remainder of their school years. Next, we examine the progress children make in these respects as they proceed into and through adolescence.

Life-Span Development of Meta-Knowing

Research involving older children, adolescents, and adults suggests that meta-knowing competencies—in contrast to most of the competencies that developmental psychologists study—remain incompletely developed. My own microgenetic studies of these age groups have involved two kinds of cognitive skills—those of analysis (of cause-and-effect relationships operating in multivariable systems; Kuhn & Phelps, 1982; Kuhn et al., 1992, 1995) and of argument (in a framework of alternative assertions, each associated with supporting and discrepant evidence; Kuhn, Shaw, & Felton, 1997; Kuhn, Weinstock, & Flaton, 1994). The studies involving analysis skills provide a rich window on the acquisition of new knowledge as a process of theory-evidence coordination, invoking the potential for cognitive control and, hence, critical thinking. For example, participants are asked to examine a database on children's ratings of TV programs to determine which features of the programs influence their popularity (Kuhn et al., 1995). The method allows us to follow over time both their evolving knowledge base and changes in the strategies by which they acquire that knowledge.

Because the method is a microgenetic one in which change over time is observed, the data address fundamental issues regarding the nature of the change process. Findings of other investigators who have used a microgenetic method to examine change converge with our own in showing that individuals approach a task with a repertory of strategies that they apply variably over time, even when the task environment remains constant (Kuhn, 1995; Siegler, 1996). Such findings lead to a revised conception of developmental change. In contrast to the traditional conception of a single transition in which a new strategy replaces an old one, with the focus on the challenge of mastering the new strategy, the newer portrayal of change features continuing shifts in the frequencies of usage of multiple strategies, with the diminished usage and eventual relinquishment of less adequate strategies a developmental challenge at least equal to that of mastering new, more adequate ones. This newer model of developmental change has major implications regarding the role of metastrategic factors. Rather than the traditional focus on metastrategic understanding of a particular strategy (such as categorization in meta-memory research) as a factor influencing performance, the major metastrategic task becomes *strategy selection* from the repertory of strategies an individual has available. Strategy selection is a metastrategic—not a strategic—function. Hence, the burden of explanation shifts to the metastrategic level.

At the same time as it calls on metastrategic skill in the selection and monitoring of strategies, coordinating theories and evidence requires metacognitive skill in justifying knowledge claims. It is here that we see in adolescents and adults metacognitive weaknesses that parallel those observed among preschoolers in the studies described earlier. Like preschoolers, many older individuals blur the distinction between theory-based and evidence-based sources of their beliefs. Rather than seeing their theories as belief states subject to disconfirmation and representing theory and evidence as distinct entities to be reconciled with one another, they merge the two into a single representation of "the way things are" with little apparent awareness of the sources of their belief. Evidence serves merely to *illustrate* what one knows to be true, with evidence-based and theory-based justifications functioning as interchangeable supports for a claim. Theories may eventually change in response to discrepant evidence, but often with the individual manifesting little awareness or control of the process. Like young children in the theory-of-mind research described earlier, older participants in our studies are likely to deny that they ever held a belief different from the one they are now professing.

In the strategic domain, investigative strategies are often driven by belief, with features believed irrelevant never examined. Although the strategies of adults we found on average superior to those of adolescents (Kuhn et al., 1995), a common pattern at both ages is the use of an adequate strategy to interpret theory-compatible evidence regarding one feature and an inadequate strategy to interpret theory-discrepant evidence regarding another feature, even though the evidence with respect to the two features is identical. Weak metacognitive awareness of the basis for one's beliefs and metastrategic inconsistency in the application of inference strategies thus reinforce one another. A third form of

meta-knowing also has a role to play—the epistemological, to which we now turn.

Epistemological Meta-Knowing

Research on the development of epistemological understanding, originating with the pioneering work of Perry (1970), has remained curiously isolated from other meta-knowing research, especially the theory-of-mind work to which it is most directly related. A possible explanation is that theory-of-mind research has been largely confined to children only up to the age of about 6, whereas work on the development of epistemological thinking has focused on adolescents and adults. The conceptual connection between the two bodies of work is nonetheless evident.

With the understanding of assertions as belief states, assertions are recognized as emanating from—and therefore connected to—the human activity of knowing. Nonetheless, the initial *absolutist* epistemological stance—the norm in childhood and into adolescence and even adulthood (Chandler, Boyes, & Ball, 1990; Hofer & Pintrich, 1997; King & Kitchener, 1994; Kuhn, 1991; Perry, 1970)—does not accord a pivotal role to the knower as a constructor of knowledge. Rather, the locus of knowledge remains in the external world, where it awaits discovery by human knowledge seekers. A child by 4 or 5 appreciates knowing as connected to and generated by a knowing agent to a sufficient extent to understand that beliefs may deviate from a single, true reality. Yet much slower to be achieved—if, indeed, it is achieved at all—is a truly constructivist theory of mind that recognizes the primacy of humans as knowledge constructors capable of generating a multiplicity of valid representations of reality.

The transition from a realist pre-epistemological unawareness of belief states to the initial epistemological stance of absolutism is nonetheless a profound one. It is a transition from simply knowing that something is true to evaluating whether it might be. To carry out such evaluation, absolutists rely on the concept of a certain truth, one that is known or potentially knowable through either direct apprehension or the authority of experts. Belief states can be judged as correct or incorrect in relation to this truth.

Most salient in the present context is the fact that the absolutist stance allows the acquisition of elementary critical thinking skills that serve as a foundation for more advanced forms of critical thinking that may develop later. Assertions are not taken at face value as simple descriptions of an external reality. Rather, they must be evaluated against some external standard by means of cognitive operations that are thereby exercised and strengthened.

Although an absolutist epistemological understanding is adequate to allow development of elementary critical thinking skills, it does not follow that it provides the strongest possible support for their development and use. In fact, an absolutist epistemology is more likely to function as a significant constraint on the development of critical thinking. Within the absolutist epistemological framework, claims under dispute can be resolved by seeking and obtaining information found to be lacking, either first hand from direct observation or second hand from an appropriate authority figure. Finding it may be difficult, but once the necessary information is available, questions of the truth or falsity of assertions should be answerable more or less directly. To the extent, then, that individuals confine themselves to an absolutist epistemology, the demand for critical thinking skills—and, hence, the impetus to exercise and further develop them—is slight.

People can spend entire lifetimes within the protective wraps of either a pre-absolutist stance in which assertions are equated with reality or, more commonly, the absolutist stance in which assertions can conflict but disagreements are resolvable by appeal to direct observation or authority. In the modern world, however, it is hard to avoid exposure to conflicting assertions not readily reconcilable by observation or appeal to authority. As a result, most people progress beyond absolutism, venturing onto the slippery slope that will carry them to a *multiplist* epistemological stance, which becomes prevalent at adolescence. A critical event leading to the first step down the slope toward multiplism is likely to be exposure to the fact that experts disagree about important issues. If even experts cannot be counted on to provide certain answers, one resolution is to relinquish the idea of certainty itself, and this is exactly the path the multiplist takes. As the next inductive leap along this path, if experts with all of their knowledge and authority disagree with one another, why should their views be accepted as any more valid than anyone else's? A better assumption is that anyone's opinion has the same status and deserves the same treatment as anyone else's. Beliefs or opinions are the possessions of their owners, freely chosen according to the owner's tastes and wishes and, accordingly, not subject to criticism. In the words of one of the adolescents in our research on argument (Kuhn, 1991, p. 182), "You can't prove an opinion to be wrong because an opinion is something somebody holds for themselves." Hence, in a conceptual sleight of hand that represents the final step down the slippery slope, because all people have a right to their opinions, all opinions are equally right.

In contrast to the absolutist stance, which is difficult to maintain in pure form, people often remain multiplists for life. Only a minority progress to an *evaluative* epistemology, in which all opinions are not equal and knowing is understood as a process that entails judgment, evaluation, and argument. Evaluative epistemologists have reconciled the idea that people have a right to their views with the understanding that some views can nonetheless be more right than others. They see the weighing of alternative claims in a process of reasoned debate as the path to informed opinion, and they understand that arguments can be evaluated and compared based on their merit (Kuhn, 1991). Those who remain at the multiplist level of epistemological understanding, in contrast, conceive of no basis for judging the strength of an argument, except possibly its power to persuade. As a result, their critical thinking skills are taxed to an even lesser extent than those of the absolutist, who stands ready to evaluate assertions against a criterion of truth.

The core dimension underlying and driving the progression in epistemological understanding is the coordination of the subjective and objective components of knowing. The absolutist sees knowledge in largely objective terms, as located in the external world and knowable with certainty. The multiplist becomes aware of the subjective component of knowing, but to such an extent that it overpowers and obliterates any objective standard that would provide a basis for comparison or evaluation of opinions. Only the evaluativist is successful in integrating and coordinating the two, by acknowledging uncertainty without forsaking

evaluation. (See Table 1 for summary.) This conception is compatible with that proposed by Hofer and Pintrich (1997) in a recent summary and review of the literature on the development of epistemological thinking.

Although often overlooked, the evolution of epistemological understanding is a fundamental part of meta-knowing and of cognitive development more broadly. Indeed, as I argue next, epistemological understanding may have a pivotal role to play when we turn to the concerns of educators concerned with critical thinking.

Critical Thinking As a Developmental Phenomenon

Developing competence in meta-knowing, I have suggested, warrants attention as a major component of cognitive development. A unifying dimension of this development is that of thought becoming increasingly aware of itself and under the individual's control. To be competent and motivated to "know how you know" puts one in charge of one's own knowing, of deciding what to believe and why and of updating and revising those beliefs as one deems warranted. To achieve this control of their own thinking is arguably the most important way in which people both individually and collectively take control of their lives.

How does critical thinking connect to this achievement? Each of the three kinds of meta-knowing that have been examined here—the metacognitive, metastrategic, and epistemological—is central to critical thinking. The development of metacognitive understanding is essential to critical thinking because critical thinking by definition involves reflecting on what is known and how that knowledge is justified. Individuals with well-developed metacognitive skills are in control of their own beliefs in the sense of exercising conscious control over their evolution in the face of external influences. They know what they think and can justify why. Their skills in the conscious coordination of theory and evidence also put them in a position to evaluate the assertions of others.

Metastrategic skill is also essential to critical thinking. Those who have developed strong metastrategic skills apply consistent standards of evaluation across time and situations. They do not succumb to a view of a favored assertion as more probable than its alternatives because of its favored status and, therefore, subject to different standards of evolution. They also resist the temptation of "local interpretation" (Klahr, Fay, & Dunbar, 1993) of an isolated piece of evidence as supportive because it is considered out of the context of a broader pattern of which it is a part.

The development of epistemological understanding may be the most fundamental underpinning of critical thinking. If knowledge is entirely objective, certain, and simply accumulates, unconnected to the human minds that do this knowing—as the absolutist conceives—or if knowledge is entirely subjective, subject only to the tastes and wishes of the knower—as the multiplist conceives—critical thinking and judgment are superfluous. People must see the point of thinking if they are to engage in it. Put simply by one of the multiplists in our studies, "I feel it's not worth it to argue because everyone has their opinion." In such cases, educators can undertake to teach intellectual skills, but the reasons to apply them will be missing.

Situating these attainments within a developmental framework makes it possible to investigate ways in which earlier attainments prepare the way for later ones. In contrast to most of the achievements studied by developmental psychologists, the course of development sketched out here is one that most individuals never complete. It is here, then, that we find the intersection of the concerns of researchers seeking to understand cognitive development

Table 1
Levels of Epistemological Understanding

Level	Assertions	Reality	Knowledge	Critical thinking
Realist	Assertions are **copies** that represent an external reality.	Reality is directly knowable.	Knowledge comes from an external source and is certain.	Critical thinking is unnecessary.
Absolutist	Assertions are **facts** that are correct or incorrect in their representation of reality (possibility of false belief).	Reality is directly knowable.	Knowledge comes from an external source and is certain.	Critical thinking is a vehicle for comparing assertions to reality and determining their truth or falsehood.
Multiplist	Assertions are **opinions** freely chosen by and accountable only to their owners.	Reality is not directly knowable.	Knowledge is generated by human minds and is uncertain.	Critical thinking is irrelevant.
Evaluative	Assertions are **judgments** that can be evaluated and compared according to criteria of argument and evidence.	Reality is not directly knowable.	Knowledge is generated by human minds and is uncertain.	Critical thinking is valued as a vehicle that promotes sound assertions and enhances understanding.

and the concerns of educators seeking to maximize the realization of intellectual potential. Educators who wish to foster critical thinking, I have suggested, stand to gain from conceptualizing students' potential for critical thinking in a developmental framework of what has preceded and what is likely to follow. Let us turn, then, to efforts to teach critical thinking as they exist today and ask how the developmental picture that has been sketched here might enrich this undertaking.

Teaching Critical Thinking As Cognitive (and Metacognitive) Development

For a number of years, the major debate among those concerned with teaching critical thinking has been the one noted earlier between teaching critical thinking skills as general entities or in the context of subject matter instruction (Perkins & Salomon, 1989). Today, that debate has been eclipsed by another that goes directly to the heart of what we have been concerned with here—identifying exactly what critical thinking is. On one side of the debate, traditionalists see it as a set of mental competencies that reside inside individual heads. On the other, advocates of a newer, situated-cognition perspective regard intellectual skills as social practices exercised and shared within a community (Cole, 1996; Resnick & Nelson-LeGall, 1997; Rogoff, 1998).

Although I have not undertaken to review the evidence here, the first debate, as noted earlier, has largely come down on the side of instruction embedded in rich subject matter. However, the successful wedding of thinking-skill development to subject matter instruction—identified by Perkins and Salomon (1989) as the major challenge facing educators—depends on the explicit definitions of thinking skills argued for here, making them readily identifiable within varied subject matter. Even if it is the best or only way to teach them, embedding them in rich content makes them harder—not easier—to identify. Furthermore, in addition to needing clear definitions of the skills they are seeking to instill, I have argued, educators benefit from seeing these skills in the developmental context of where they have come from and where they are headed, as guideposts for instructional efforts.

The second, more recent debate between cognitive-competency and social-practice conceptions might also be enriched by the developmental framework advocated here. Transfer has been a major focus of this debate. Although proponents dispute the charge (Greeno, 1997), critics of the situated cognition perspective (Anderson, Reder, & Simon, 1996) claim that it has little to tell us about occasions and respects in which behavior does generalize across contexts, as it often does. People draw on past experience as a powerful organizer of new encounters. They use analogy as a cognitive tool. Indeed, to apply this critique to the topic of this essay, critical thinking only makes sense as a construct if we believe humans have some ability to bring established modes or methods of thought to bear in approaching new situations.

One attempt to explain transfer has been to add a "dispositional" component to the traditional skill conception of critical thinking (Perkins, Jay, & Tishman, 1993): Critical thinking entails the disposition, as well as the skill, to think well. A problem with the disposition construct, however, is that it leaves much of the variance unaccounted for. What determines whether someone has a disposition to behave in a particular way? If disposition is interpreted in the sense of habit, as it often is, someone might get used to thinking well in the same way they are in the habit of exercising high standards of personal hygiene. Humans, however, are not simply creatures of habit; their beliefs and values regarding what is important help to shape their behavior. In the end, people think carefully and reflectively not out of habit, because such thinking is not an effortless habit to maintain, but because they are convinced of the value of doing so.

This conception invokes meta-knowing functions as a key factor in disposition (and, hence, performance). As a major and influential part of what develops cognitively during the childhood and adolescent years, they can help to bridge the contrasting conceptions of intellectual skills as individual abilities versus situated practices. Tied to the practices that identify groups and cultures are beliefs and values that represent how these practices are understood by members of the community. These are an essential—even if less visible—aspect of what is practiced and valued in the community and thereby appropriated by its younger members (Resnick & Nelson-LeGall, 1997). Hence, the power of social practice as a shaper of human behavior can be recognized without ignoring the knowing and meta-knowing powers that enable people to attribute meaning to what they do and, in the course of so doing, to shape their individual and collective behavior.

Where and how, then, might educators intervene to support the developmental process that has been described here, a process that the majority of students may never complete? Regular practice of the skills we would like to see develop is essential, we know, but practice does not make perfect in the absence of understanding. The best approach, then, may be to work from both ends at once—from a bottom-up anchoring in regular practice of what is being preached so that skills are exercised, strengthened, and consolidated as well as from a top-down fostering of understanding and intellectual values that play a major role in whether these skills will be used. The developmental goal is to put people in metacognitive and metastrategic control of their own knowing.

The essential contribution that modern cognitive development research can make to this challenge is a growing knowledge base regarding what is developing and, hence, what needs to change. Skills are only one part of a more complex structure that develops, with second-order meta-knowing components both arising from and feeding back to support the use of first-order cognitive skills. In building a knowledge base that describes this structure in concrete enough detail to be useful to educators, researchers can help define educational objectives rather than only advise on how to implement objectives determined by others, their more traditional role as educational consultants. A number of cognitive development researchers have begun to concern themselves in a serious way with building a bridge from their research findings to educational practice. This essay, I hope, will prove a useful starting point to educators seeking a bridge in the opposite direction, one enabling them to draw on empirical data on how children's intellects develop, as a means of enriching their visions of good practice.

References

Anderson, J., Reder, L., & Simon, H. (1996). Situated learning and education. *Educational Researcher, 25*(4), 5–22.

Brown, A. (1975). The development of memory: Knowing, knowing about knowing, and knowing how to know. In H. Reese (Ed.), *Advances in child development and behavior* (Vol. 10, pp. 103–152). New York: Academic Press.

Brown, A. (1978). Knowing when, where, and how to remember: A problem of metacognition. In R. Glaser (Ed.), *Advances in instructional psychology* (Vol. 1, pp. 77–165). Hillsdale, NJ: Erlbaum.

Brown, A. (1997). Transforming schools into communities of thinking and learning about serious matters. *American Psychologist, 52,* 399–413.

Brown, A., Bransford, J., Ferrara, R., & Campione, J. (1983). Learning, remembering, and understanding. In P. Mussen (Series Ed.), J. Flavell, & E. Markman (Vol. Eds.), *Handbook of child psychology: Vol. 3. Cognitive development* (4th ed., pp. 77–166). New York: Wiley.

Cahan, E. (1994). John Dewey and human development. In R. Parke, P. Ornstein, J. Rieser, & C. Zahn-Waxler (Eds.), *A century of developmental psychology* (pp. 145–167). Washington, DC: American Psychological Association.

Carpendale, J., & Chandler, M. (1996). On the distinction between false belief understanding and subscribing to an interpretive theory of mind. *Child Development, 67,* 1686–1706.

Chandler, M., Boyes, M., & Ball, L. (1990). Relativism and stations of epistemic doubt. *Journal of Experimental Child Psychology, 50,* 370–395.

Cole, M. (1996). *Cultural psychology: A once and future discipline.* Cambridge, MA: Harvard University Press.

Dewey, J. (1916). Democracy and education: An introduction to the philosophy of education. In J. Boydston (Ed.), *The middle works of John Dewey* (Vol. 9). Carbondale: Southern Illinois University Press.

Dewey, J. (1933). The process and product of reflective activity: Psychological process and logical forms. In J. Boydston (Ed.), *The later works of John Dewey* (Vol. 8, pp. 171–186). Carbondale: Southern Illinois University Press.

Ennis, R. (1987). A taxonomy of critical thinking dispositions and abilities. In J. Baron & R. Sternberg (Eds.), *Teaching thinking skills: Theory and practice* (pp. 9–26). New York: Freeman.

Estes, D., Wellman, H., & Woolley, J. (1989). Children's understanding of mental phenomena. In H. Reese (Ed.), *Advances in child development and behavior* (pp. 41–87). New York: Academic Press.

Ferrari, M., & Sternberg, R. (1998). The development of mental abilities and styles. In W. Damon (Series Ed.), D. Kuhn, & R. Siegler (Vol. Eds.), *Handbook of child psychology: Vol 2. Cognition, language, and perception.* (5th ed., pp. 899–946). New York: Wiley.

Flavell, J., Green, F., & Flavell, E. (1995). Young children's knowledge about thinking. *Society for Research in Child Development Monographs, 60*(Serial No. 243).

Flavell, J., Speer, J., Green, F., & August, D. (1981). The development of comprehension monitoring and knowledge about communication. *Society for Research in Child Development Monographs, 46*(Serial No. 192).

Flavell, J., & Wellman, H. (1977). Metamemory. In R. Kail & J. Hagen (Eds.), *Perspectives on the development of memory and cognition* (pp. 3–33). Hillsdale, NJ: Erlbaum.

Gelman, R., & Williams, E. (1998). Constraints on cognitive development and learning. In W. Damon (Series Ed.), D. Kuhn, & R. Siegler (Vol. Eds.), *Handbook of child psychology: Vol. 2. Cognition, language, and perception* (5th ed., pp. 575–630). New York: Wiley.

Gopnik, A., & Graf, P. (1988). Knowing how you know: Young children's ability to identify and remember the sources of their beliefs. *Child Development, 59,* 1366–1371.

Greeno, J. (1997). On claims that answer the wrong questions. *Educational Researcher, 26*(1), 5–17.

Haith, M., & Benson, J. (1998). Infant cognition. In W. Damon (Series Ed.), D. Kuhn, & R. Siegler (Vol. Eds.), *Handbook of child psychology: Vol. 2. Cognition, language, and perception* (5th ed., pp. 199–254). New York: Wiley.

Hofer, B., & Pintrich, P. (1997). The development of epistemological theories: Beliefs about knowledge and knowing and their relation to learning. *Review of Educational Research, 67*(1), 88–140.

Inhelder, B., & Piaget, J. (1958). *The growth of logical thinking from childhood to adolescence.* New York: Basic Books.

King, P., & Kitchener, K. (1994). *Developing reflective judgment: Understanding and promoting intellectual growth and critical thinking in adolescents and adults.* San Francisco: Jossey-Bass.

Klahr, D., Fay, A., & Dunbar, K. (1993). Heuristics for scientific experimentation: A developmental study. *Cognitive Psychology, 25,* 111–146.

Kreutzer, M., Leonard, C., & Flavell, J. (1975). An interview study of children's knowledge about memory. *Society for Research in Child Development Monographs, 40*(Serial No. 159).

Kuhn, D. (1989). Children and adults as intuitive scientists. *Psychological Review, 96,* 674–689.

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

Kuhn, D. (1995). Microgenetic study of change: What has it told us? *Psychological Science, 6,* 133–139.

Kuhn, D. (in press). Metacognitive development. In C. Tamis-Le-Monda (Ed.), *Child psychology: A handbook of contemporary issues.* New York: Garland.

Kuhn, D., Garcia-Mila, M., Zohar, A., & Andersen, C. (1995). Strategies of knowledge acquisition. *Society for Research in Child Development Monographs, 60*(Serial No. 245).

Kuhn, D., & Pearsall, S. (1998a). Relations between metastrategic knowledge and strategic performance. *Cognitive Development, 13,* 227–247.

Kuhn, D., & Pearsall, S. (1998b). *Metacognitive dimensions of knowledge acquisition: Awareness of theory and evidence as sources of one's knowledge.* Unpublished manuscript, Teachers College, Columbia University, New York.

Kuhn, D., & Phelps, E. (1982). The development of problem-solving strategies. In H. Reese (Ed.), *Advances in child development and behavior* (Vol. 17, pp. 1–44). New York: Academic Press.

Kuhn, D., Schauble, L., & Garcia-Mila, M. (1992). Cross-domain development of scientific reasoning. *Cognition and Instruction, 9,* 285–332.

Kuhn, D., Shaw, V., & Felton, M. (1997). Effects of dyadic interaction on argumentive reasoning. *Cognition and Instruction, 15,* 287–315.

Kuhn, D., Weinstock, M., & Flaton, R. (1994). Historical reasoning as theory-evidence coordination. In M. Carretero & J. Voss (Eds.), *Cognitive and instructional processes in history and the social sciences* (pp. 377–401). Hillsdale, NJ: Erlbaum.

Lipman, M. (1991). *Thinking in education.* New York: Cambridge University Press.

Markman, E. (1979). Realizing that you don't understand: Elementary school children's awareness of inconsistencies. *Child Development, 50,* 643–655.

McPeck, J. (1981). *Critical thinking and education.* New York: St. Martin's Press.

Moshman, D. (1998). Cognitive development beyond childhood: Constraints on cognitive development and learning. In W. Damon (Series Ed.), D. Kuhn, & R. Siegler (Vol. Eds.), *Handbook of child psychology: Vol. 2. Cognition, language, and perception* (5th ed., pp. 947–978). New York: Wiley.

Moynahan, E. (1978). Assessment and selection of paired associate strategies: A developmental study. *Journal of Experimental Child Psychology, 26,* 257–266.

Norris, S., & Ennis, R. (1989). *Evaluating critical thinking.* Pacific Grove, CA: Critical Thinking Press and Software.

Olson, D., & Astington, J. (1993). Thinking about thinking: Learning how to take statements and hold beliefs. *Educational Psychologist, 28*(1), 7–23.

Paul, R. (1990). *Critical thinking.* Rohnert Park, CA: Center for Critical Thinking and Moral Critique, Sonoma State University.

Perkins, D., Jay, E., & Tishman, S. (1993). Beyond abilities: A dispositional theory of thinking. *Merrill-Palmer Quarterly, 39*(1), 1–21. (Special Issue on "The Development of Rationality and Critical Thinking")

Perkins, D., & Salomon, G. (1989). Are cognitive skills context-bound? *Educational Researcher, 18*(1), 16–25.

Perner, J. (1991). *Understanding the representational mind.* Cambridge, MA: MIT Press.

Perry, W. (1970). *Forms of intellectual and ethical development in the college years.* New York: Holt, Rinehart & Winston.

Pillow, B., & Henrichon, A. (1996). There's more to the picture than meets the eye: Young children's difficulty understanding biased interpretation. *Child Development, 67,* 803–819.

Resnick, L., & Nelson-LeGall, S. (1997). Socializing intelligence. In L. Smith, J. Dockrell, & P. Tomlinson (Eds.), *Piaget, Vygotsky, and beyond* (pp. 145–158). London: Routledge.

Rogoff, B. (1998). Cognition as a collaborative process. In W. Damon (Series Ed.), D. Kuhn, & R. Siegler (Vol. Eds.), *Handbook of child psychology: Vol. 2. Cognition, language, and perception* (5th ed., pp. 679–744). New York: Wiley.

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Ruffman, T., Perner, J., Olson, D., & Doherty, M. (1993). Reflecting on scientific thinking: Children's understanding of the hypothesis-evidence relation. *Child Development, 64,* 1617–1636.
Schauble, L. (1996). The development of scientific reasoning in knowledge-rich contexts. *Developmental Psychology, 32,* 102–119.
Schneider, W. (1985). Developmental trends in the metamemory-memory behavior relationship: An integrative review. In D. Forrest-Pressley, G. MacKinnon, & T. Waller (Eds.), *Cognition, metacognition, and human performance* (Vol. 1, pp. 57–109). Orlando, FL: Academic Press.
Schneider, W., & Bjorklund, D. (1998). Memory. In W. Damon (Series Ed.), D. Kuhn, & R. Siegler (Vol. Eds.), *Handbook of child psychology: Vol. 2. Cognition, language, and perception* (5th ed., pp. 467–522). New York: Wiley.
Shultz, T., & Mendelson, R. (1975). The use of covariation as a principle of causal analysis. *Child Development, 46,* 394–399.
Siegel, H. (1988). *Educating reason: Rationality, critical thinking, and education.* New York: Routledge.
Siegler, R. (1996). *Emerging minds: The process of change in children's thinking.* New York: Oxford University Press.
Sophian, C. (1997). Beyond competence: The significance of performance for conceptual development. *Cognitive Development, 12,* 281–303.
Spelke, E., & Newport, E. (1998). Nativism, empiricism, and the development of knowledge. In W. Damon (Series Ed.) & R. Lerner (Vol. Ed.), *Handbook of child psychology: Vol. 1. Theoretical models of human development* (5th ed., pp. 275–340). New York: Wiley.
Taylor, M., Esbensen, B., & Bennett, R. (1994). Children's understanding of knowledge acquisition: The tendency for children to report they have always known what they have just learned. *Child Development, 65,* 1581–1604.
Wellman, H. (1990). *The child's theory of mind.* Cambridge, MA: MIT Press.
Wellman, H., & Gelman, S. (1998). Knowledge acquisition in foundational domains. In W. Damon (Series Ed.), D. Kuhn, & R. Siegler (Vol. Eds.), *Handbook of child psychology: Vol. 2. Cognition, language, and perception* (5th ed., pp. 523–574). New York: Wiley.
Wimmer, H., & Perner, J. (1983). Beliefs about beliefs: Representation and constraining function of wrong beliefs in young children's understanding of deception. *Cognition, 13,* 103–128.

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Publications-Related Events at the 1999 Annual Meeting

The Publications Committee is pleased to announce that this year's Annual Meeting includes several events, described below, which should be of interest to participants who would like to discuss publishing.

Open Meeting of the Publications Committee: The Future of the AERA Publications Program, Wednesday, April 21, 12:25–1:55

The Publications Committee will discuss how AERA publications are striving to respond to the interests and commitments of the educational research community.

Journal Talk I and Journal Talk II: Contributing to Educational Journals Thursday, April 22, 12:25–1:05; and Tuesday, April 20, 10:35–11:15

These roundtable sessions will give those interested in contributing to journals a chance to speak with editors of AERA journals and other education journals.

Welcoming New Voices Into the AERA Publications Program: An Open House and Reception, Thursday, April 22, 6:15–7:45