Cognition, Metacognition, and Epistemic Cognition: A Three-Level Model of Cognitive Processing

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Cognition, Metacognition, and Epistemic Cognition

A Three-Level Model of Cognitive Processing[1]

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Abstract. A three-level model of cognitive processing to account for complex monitoring when individuals are faced with ill-structured problems, i.e., problems on which opposing or contradictory evidence and opinion exists, is proposed. At the first level, cognition, individuals compute, memorize, read, perceive, solve problems, etc. At the second, metacognitive level, individuals monitor their own progress when they are engaged in these first-order tasks. At the third level, epistemic cognition, individuals reflect on the limits of knowing, the certainty of knowing, and criteria of knowing. Epistemic assumptions influence how individuals understand the nature of problems and decide what kinds of strategies are appropriate for solving them. While cognitive and metacognitive processes appear to develop in childhood and are used throughout the life span, current research on adult reasoning suggests that epistemic cognitive monitoring develops in the late adolescent and adult years.

The concept of metacognition has had a major influence on the study of cognitive development in the last decade [*Masters,* 1980]. Despite its impact, it has been defined in a vague and general way [*Kuhn,* 1983]. For example, it has been variously referred to as 'cognitive monitoring' [*Flavell,* 1979], 'executive processes' [*Brown,* 1977], 'self-communication' [*Meichenbaum and Asarnow,* 1979], and 'knowledge about knowledge' [*Brown,* 1977]. The definition of metacognition as 'knowledge and cognition about cognitive phenomenon' [*Flavell,* 1979, p. 906] seems to include any kind of monitoring of the cognitive enterprise and, hence, is extremely broad in scope. However, in most cases metacognition refers more narrowly to self-monitoring of one's own cognitive processes and influences on them when they are focused on a specific task or goal [*Flavell,* 1976], e.g., the monitoring of memory or comprehension tasks. Such monitoring is usually thought to include three parts: (a) knowledge about self and others as cogni-

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tive processors when they are engaged in a task or goal, (b) knowledge about specific cognitive tasks or problems themselves and (c) metacognitive experiences, i.e., feelings of wonder or puzzlement which lead to the re-evaluation of strategies. Frequently, the empirical study of metacognition has focused even more narrowly on what used to be called 'study skills' [*Brown,* 1979], particularly on what individuals know about memory processes and tasks [*Flavell and Wellman,* 1977].

Because the definition of metacognition has been broad and vague, while in reality it has referred to self-monitoring on specific cognitive tasks, important distinctions have been overlooked. *Kuhn* [1983] has noted that it blurs the distinction between what she calls 'executive 1' strategies, i.e., knowledge about the task or problem itself, and 'executive 2' strategies, i.e., knowledge of whether a particular strategy is appropriate to apply in a problem-solving situation. Moreover, the important distinction between two kinds of 'knowing about knowing' is obscured. In particular, the distinction between knowing about one's own individual cognitive processes and when to apply them and knowing about knowledge and the validity of truth claims in general has been lost. For example, a critical difference exists between knowing that a particular memory strategy is recommended under certain circumstances and knowing that for some problems we can never know a solution is absolutely true. It is this second kind of knowing about knowing in the epistemic sense on which this article will focus.

Although *Flavell* [1979] has suggested that the concept of metacognition might lead us to understand how adults make wise and thoughtful decisions about difficult problems, metacognition as it is most commonly understood (i.e., self-monitoring on simple cognitive tasks) will not be sufficient to achieve the goal. Only when we introduce a higher level of monitoring, a meta-metacognitive level of monitoring, can we understand how adults monitor their problem solving when they are engaged in the complex decision making of everyday life. This meta-meta level of cognitive monitoring, which has to do with knowing about knowing in the epistemic sense, will be referred to in this article as epistemic cognition.

Before proceeding with a more precise definition and description of metacognition and epistemic cognition, it is necessary to distinguish between puzzles, i.e., problems for which there are absolutely correct and knowable solutions, and 'ill-structured' problems [*Churchman,* 1971; *Mitroff and Sagasti,* 1973], i.e., problems for which there are conflicting assumptions, evidence, and opinion which may lead to different solutions. Metacognitive processes are sufficient to account for the type of monitoring that occurs in puzzle solving, but epistemic cognitive processes must also be involved when individuals are faced with ill-structured problems.

Puzzles versus Ill-Structured Problems

Puzzles and ill-structured problems differ both in their epistemic nature (i.e., in the ways they are knowable) and in the decision-making procedure required to solve them. This distinction has been made most precisely by *Churchman* [1971] and elaborated by *Mitroff and Sagasti* [1973]. *Churchman's* concern was with analyzing different models of inquiry, the structure of the problems each might address, and under what conditions

each might be solved. In his attempt to capture the epistemological assumptions underlying problem types, he used figures from the history of Western philosophy as a heuristic device to represent their essential differences. (Since the focus of this article is not on analyzing *Churchman's* model, but rather on using it to characterize problem types, the reader is referred to other sources for a more complete account of the model and its implications [*Freedle,* 1974; *Mitroff and Sagasti,* 1973; *Wood,* 1983].)

A puzzle is a well-structured problem. All the elements necessary for a solution are knowable and known, and there is an effective procedure for solving it. *Churchman* suggests that puzzles, the solution to which may be reduced to a deductive algorithm, are characteristic of what he calls the Leibnizian inquiring system (IS). Problems for which single solutions may be inductively agreed upon via a set of empirical observations and a group of preestablished rules distinguish the Lockean IS. Although the procedures differ, both assume that all problems are reducible to puzzles which can be solved by the correct application of an algorithm.

In other words, puzzles have a single, right or wrong answer which is available to the individual. The task, therefore, is to apply a particular, mechanical decision-making procedure to find, compute, or remember the answer. Puzzles may be simple or complex deductive ones (e.g., 2 + 2 = 4 in base 10; *Simon's* [1976] tower of Hanoi puzzle) or inductive ones whose solution is guaranteed by convention (e.g., a problem in a statistics textbook for which the inference is determined by scientific rules). In both cases, puzzles have two distinguishing characteristics: (a) there is only one correct, final solution, and (b) the solution is guaranteed by using a specific procedure (e.g., following a mathematical formula; moving the smallest ring to peg 1, then moving the next smallest ring to peg 2 ...; following an agreed upon set of rules for drawing a conclusion about a problem in statistical text). In *Churchman's* [1971, p. 143] words puzzles are 'mental exercises concocted so that one model or way of thinking, is the appropriate pathway to a solution'. Puzzles do not require considering alternative arguments, seeking out new evidence, or evaluating the reliability of data and sources of information. The puzzle solver does not find out anything in the process that might have been otherwise [*Neisser,* 1976]. Puzzles are of a limited scope and interest in the daily decision making of adults.

> In the richer problems of everyday life, one rarely finds that the problem can be constructed as a puzzle, and one of the most difficult aspects of realistic problem-solving is the determination of whether or not a solution has occurred... Another way of saying the same thing is that in social problems like pollution and poverty, there is no authorized source for terminating the inquiry [*Churchman,* 1971, p. 144].

The problems most often encountered in the real world, therefore, are of the ill-structured variety.

In ill-structured problems there is not a single, unequivocal solution which can be effectively determined at the present moment by employing a particular decision-making procedure. Such problems are typical of the Kantian IS and dialectical IS. The problems characteristic of a Kantian IS are those for which there are two or more complementary conceptualizations or potentially valid solutions. The dilemma is to decide which set of theoretical assumptions best fit the problem and the evidence at hand or how to integrate them into a single solution. *Wood* [1983] uses

the case of alcoholism as an example. One may offer a sociological answer or a psychological one or combine them in a single solution.

Churchman defines problems for which solutions are basically antithetical as 'dialectical'. Different and opposing assumptions underlie each side. Individuals on opposing sides define the problem in different ways and marshall the same evidence in support of their perspective. A solution or synthesis lies in reframing both or several perspectives into a more general model of the problem or redefining the problem as one that can be handled by a Kantian or Lockean IS. *Wood* [1983] uses the case of nuclear disarmament as typical of such problems, since each side uses the same data to support widely divergent solutions.

In other words, in both types of ill-structured problems evidence, expert opinion, reason, and argument can be brought to bear on the issues, but no effective procedure is available which can guarantee a correct or absolute solution. A solution must be constructed by integrating or synthesizing diverse data and opinion. The processes involved are not mechanical or reducible to an algorithm. They include making judgments about arguments and evidence on what may be opposing sides of the issue [*Toulmin,* 1958], evaluating information from inconsistent and imperfect data sources [*Rescher,* 1976], and developing and arguing for a reasonable solution [Toulmin et al., 1979; *Rescher,* 1976]. For ill-structured problems a reasonable solution is often the one which creates the best fit with the rest of our current knowledge of the issue [*Rescher,* 1976], or that redefines a problem in such a way that opposing perspectives are synthesized into a new framework.

A Three-Level Model of Cognitive Processing

The ability of individuals to monitor their own problem solving when engaged in ill-structured problems can be explained by postulating a three-level model of cognitive processing. Each level provides a foundation for the next one but is not subsumed by it. In other words, while the first tier may operate independently of the other two tiers, the reverse is not the case. The second tier operates in conjunction with the first tier and the third tier acts in conjunction with the first two.

At the first level of cognition (level 1), individuals enter into cognitive tasks such as computing, memorizing, reading, perceiving, acquiring language, etc. These are the premonitored cognitive processes on which knowledge of the world is built.

The second level (level 2), metacognition, is defined as the processes which are invoked to monitor cognitive progress when an individual is engaged in level 1 cognitive tasks or goals such as those listed above. Metacognitive processes include knowledge about cognitive tasks (e.g., how to memorize a list of words), about particular strategies that may be invoked to solve the task (e.g., saying the word out loud), of when and how the strategy should be applied (e.g., when one is required to remember the state capitals in school), and about the success or failure of any of these processes.

The third level (level 3), epistemic cognition, is characterized as the processes an individual invokes to monitor the epistemic nature of problems and the truth value of alternative solutions. It includes the individual's knowledge about the limits of knowing (e.g., some things can be known and others cannot), the certainty of knowing (e.g., some

things can only be known probabilistically), and the criteria for knowing (e.g., one knows the answer to a question if it can be conclusively verified scientifically). It also includes the strategies used to identify and choose between the form of solution required for different problem types.

While metacognition leads one to use different level-1 and level-2 cognitive strategies and to redefine a specific cognitive task, epistemic cognition leads one to interpret the nature of a problem and to define the limits of any strategy to solving it. It operates at a meta-meta level because its concern is not on 'what' cognitive strategy is available to solve a problem, but instead on 'whether' it is solvable under any conditions. The knowledge involved is not knowledge of one's self or others, nor is it knowledge about what level-1 cognitive strategy should be employed or is effective. Rather, it is knowledge of whether our cognitive strategies are sometimes limited, in what ways solutions can be true, and whether reasoning correctly about a problem necessarily leads to an absolutely correct solution.

Epistemic cognition may take several forms based on underlying epistemic assumptions. (See the section of this article on epistemic cognition and adult development.) For example, one set of assumptions may be that there is an objective reality that is absolutely knowable and known. Another may be that the objective knowledge does not exist in any sense. A third may take the form that knowledge is the outcome of ongoing critical inquiry [*Kitchener and King,* 1981]. Each different set of assumptions would lead the individual to assess the nature of problems and solutions available for them in different ways.

Differences in epistemic assumptions are particularly critical when individuals are engaged in monitoring the epistemic nature of ill-structured problems and identifying appropriate solutions for them. If, for example, individuals believe that there is an objective reality which is absolutely knowable and known by someone, they will be unable to distinguish between the type of solution necessary for puzzles and ill-structured problems. If knowledge is absolute and known by someone, they will assume that their task with respect to both types of problems is to apply *the* correct procedure (read a book, ask a teacher, compute the answer) to insure a valid and true solution. As long as individuals assume that a single, correct answer exists for all problems, they cannot consider the possibility that no answer may ever be recognized as universally correct for some problems.

By contrast, an individual may understand that problems do not always have an absolutely correct solution, only better or worse ones, that in some cases knowing is influenced by one's frame of reference, and that reason and data are fallible. Individuals holding such assumptions can allow for the existence of both puzzles and ill-structured problems and differentiate between the kinds of solutions available for each. As long as individuals assume that there may be several potentially valid perspectives on a problem, they can consider the possibility that different solutions may be constructed. As *Toulmin* [1958, p. 18] noted, once it is admitted that a number of potential solutions are available for a problem, an individual must also concede that these solutions have the 'right to be considered'. The concession precludes the mechanical application of a particular strategy and suggests the individual must develop a strategy to construct a solution.

On the other hand epistemic cognitive processes do not operate in isolation. Metacognitive processes may be sufficient to explain the monitoring necessary to solve puzzles; however, epistemic cognitive processes in combination with metacognitive processes are necessary to account for the kind of monitoring in which individuals must and do engage if they are to consider and solve ill-structured problems. If one individual assumes all problems are reducible to algorithms and another believes that some problems are reducible to algorithms and some are not, similar monitoring will occur when both are faced with evaluating their progress in a puzzle-solving situation, e.g., am I using the correct procedure, what can I do to improve my recall of the elements involved, should I try a different strategy, etc. These are metacognitive issues.

When faced with an ill-structured problem, however, individuals must first ask if the problem is solvable and if so, how it is solvable and whether there are strategies available to solve it. These are epistemic questions. As already noted, if they do not ask these questions they will proceed as if they are in a puzzle-solving situation. However, once the epistemic nature of the problem and strategies available to solve it are identified, individuals must still monitor their own progress on specific aspects of the task, e.g., understanding various elements of the issue. Thus, both level-3 and level-2 cognitive processes are used to monitor progress in ill-structured problems.

Because the broadest definition of metacognition includes the monitoring of all cognitive phenomena, it might conceivably be thought to subsume the epistemic sense of knowing about knowing. However, as already noted, knowledge about the epistemological assumptions underlying problem types has not been included in discussions of or research on metacognition [*Brown,* 1977, 1979; *Flavell,* 1979]. Since metacognition is typically understood to include only the individual's beliefs and knowledge about a specific cognitive task, the variables that influence it, and how that performance is monitored, it does not cover the processes involved in epistemic cognition. Both processes are critical, but they are not identical.

Levels of Cognitive Processing: An Illustration

As already noted, each level of cognitive processing is necessary for the next. To illustrate how they operate in conjunction with each other, consider the ill-structured problem of how to solve the intertwined issues of inflation and unemployment. To tackle the problem one must first acquire knowledge about both unemployment and inflation (such as how many people are out of work and what potential solutions are available). The acquisition of this knowledge requires level-1 cognitive processes such as reading, remembering, learning a new vocabulary, etc.

In acquiring the above knowledge the individual may become aware of not understanding a particular piece of information. This metacognitive experience may lead to monitoring reading material more closely, questioning experts more thoroughly, etc. This monitoring is at the second, metacognitive level, since it concerns strategies for deciding one's effectiveness with a particular cognitive task (e.g., learning a set of information), whether one has effectively learned it, and whether to invoke a different cognitive strategy for understanding it.

Suppose experts, as they often do, propose different (e.g. complementary or antithetical) solutions to the problem. If the individual is limited to cognitive and metacognitive processes, he or she would be at a loss either to understand why alternative solutions were being offered or how to choose between them. The individual would be limited to understanding the problem as a puzzle and would seek absolute solutions such as consulting an even higher authority.

The individual must have epistemic knowledge that each solution may have some validity and contain some error but that there may be no absolutely correct choice between them. Second, developing a strategy to pick a solution, integrate several solutions, or develop a more general synthesis involves assessing the relative validity, fruitfulness, or truth value of solutions. The level of cognitive enterprise moves beyond cognitive knowledge (e.g., knowing that a certain percentage of people are out of work and understanding the advice of several experts) (level 1). It also goes beyond the metacognitive knowledge that one does not understand certain information and how to go about correcting this situation (level 2). It involves epistemic knowledge (e.g., knowing that no one strategy is absolutely certain and that there are limits to each solution) (level 3). It may lead to developing models of when or where each strategy is effective and when to change strategies.

Epistemic Cognition and Adult Development

Although some discrepant data have been reported [*Cavanaugh and Borkowski,* 1980], most prior research [*Brown,* 1977, 1979; *Flavell,* 1979; *Flavell and Wellman,* 1977; *Masters,* 1980] supports the assertion that cognitive and metacognitive processes develop in young children and are common by early adolescence. Others [*Lachman,* et al., 1979] have shown that these processes remain active throughout the life span.

During the last 10 years, evidence and argument [*Basseches,* 1980; *Broughton,* 1977, 1978; *Diamond and Royce,* 1980; *Gibbs,* 1977; *King* et al., 1983; *Kitchener and King,* 1981; *Labouvie-Vief,* 1982; *Moshman,* 1979; *Perry,* 1970] have converged to support the claim that what we have been calling epistemic cognitive processes play a critical role in the reasoning of older adolescents and adults. These investigators argue that changes in assumptions about knowledge in the epistemic sense underlie the ability of adults to deal with conflicting ideas and systems in considering issues of logic, ethical choice, and reality.

Some investigators have begun to document specific shifts in epistemic assumptions [*Basseches,* 1980; *Broughton,* 1977, 1978; *Kitchener and King,* 1981; *Murphy and Gilligan,* 1980; *Perry,* 1970] and the relationship between epistemic assumptions and problem solving in adolescents and adults. Although the investigators differ in their conceptualization of the underlying processes and of the exact nature and number of shifts which occur, they agree that adolescents begin to explicitly formulate epistemic assumptions and that these assumptions develop and shift in the young adult years. While it is not the purpose of this article to review the data on these models nor to resolve the discrepancies between them in order to relate epistemic cognition to adult reasoning, it is important to review some general conclusions.

Most authors [*Basseches,* 1980; *Fischer* et al., in press; *Kramer,* 1983; *Kitchener and*

Kitchener, 1981; *Labouvie-Vief,* 1982; *Murphy and Gilligan,* 1980; *Perry,* 1970] recognize at least two developmental shifts in epistemic assumptions in the late adolescent or early adult years. The epistemic framework of early adolescents assumes knowledge is absolute and truth is effectively computable [*Labouvie-Vief,* 1982]. Such a framework can handle puzzle-type problems and would be characterized by *Churchman's* Leibnizian or Lockean IS. These writers concur that a developmental shift occurs in the late adolescent years which allows knowledge to be understood in relationship to the system or context in which it is embedded. This has been most frequently referred to as contextual relativism, a term coined by *Perry* [1970]. Such an epistemic framework would underlie *Churchman's* Kantian IS. Others have noted the importance of the shift to relativism for moral judgment [*Gibbs,* 1977; *Edelstein and Noam,* 1982; *Murphy and Gilligan,* 1980], for logic [*Labouvie-Vief,* 1982; *Moshman,* 1979] and for understanding life-span development in general [*Sinnott,* 1981].

A second shift occurs when adults begin to understand knowledge as encompassing antithetical perspectives while allowing for the progress of knowledge via integration and synthesis. This would correspond to the epistemic framework underlying *Churchman's* dialectical IS. Knowledge from this perspective is not seen as something that may be acquired for all time, but as the 'outcome of the ongoing process of reasonable inquiry' [*Kitchener and King,* 1981, p. 100].

Others [*Broughton,* 1978; *Kitchener and King,* 1981; *Murphy and Gilligan,* 1980; *Perry,* 1970] have offered a more fine-grained analysis of the epistemic shifts which occur between adolescence and the adult years. In particular they note that an abject skepticism concerning all forms of knowing is an intermediate step between the absolute epistemologies of adolescents and the relativism of young adults.

What these models of adult reasoning suggest is that the way in which people actually construct solutions to the dual problem of inflation and unemployment, as in the prior example, depends on the form of epistemic assumptions they have developed. In other words, not only is metacognition insufficient to describe the monitoring in which individuals engage, a complete model of cognitive monitoring must recognize that individuals hold different epistemic assumptions, these assumptions develop, and the differences that ensue lead individuals to use different epistemic cognitive processes when faced with ill-structured problems.

The development of epistemic cognition and the critical role it plays in ill-structured problems have implications for our theoretical understanding and conceptualization of adult development as well as for how research is done on it. While all of the implications cannot be explored in this paper, a few examples will suggest the scope of its importance.

First (as already noted), *Kuhn* [1983] points to the importance of executive-1 and executive-2 strategies when individuals are engaged in monitoring their progress on a specific cognitive task. However, when an individual is engaged in an ill-structured problem, understanding when a particular strategy is appropriate to apply – an executive-2 strategy according to *Kuhn* – depends on the individual's epistemic cognition and the particular epistemic assumptions he or she has developed. In other words, executive-2 strategies, when they are applied to ill-structured problems, depend on the development of epistemic cognition.

Similarly, the concept of wisdom, which is becoming increasingly important in discussions of adult thinking, is also dependent on differentiating metacognition and epistemic cognition. *Meacham* [1983, p. 21] for example, suggests that metacognition is consistent with the concept of wisdom defined as a 'balance between increases in the amount one knows and simultaneous increases in the recognition that there is much that one does not know'. Wisdom, so defined, recognizes the contradictions of knowledge acquisition in light of uncertainty and doubt. However, such recognition cannot be accounted for by metacognitive processes alone, but must rely on the development of epistemic cognitive processes, since they involve knowledge in the epistemic sense.

Last, empirical research on adult reasoning must recognize the tie between ill-structured problems and epistemic cognition and must allow this recognition to guide research design. Although metacognition and cognitive processes may be studied in relationship to both puzzle-solving and ill-structured problem-solving tasks, the same is not true for epistemic cognition. To observe the monitoring characteristic of epistemic cognition individuals must be engaged in ill-structured problem solving. It may be that the failure to distinguish metacognition and epistemic cognition in the past is the outgrowth of the common practice of asking subjects to engage in puzzle-solving tasks. This cannot continue if we are to learn more about the role of epistemic cognition in adult problem solving.

Conclusion

In summary, three levels of cognitive processing must be distinguished to account for the complex monitoring in which adults engage when they are faced with ill-structured problems. At the first level, individuals compute, memorize, read and comprehend. At the second level, they monitor their own progress and products as they are engaged in first-order cognitive tasks. This is the level of cognition which *Flavell* [1979] and others have called metacognition. Metacognitive processes are critical to understanding how individuals monitor their own progress when solving puzzles.

The third level of cognition, which has been referred to in this paper as epistemic cognition, must be introduced to explain how humans monitor their problem solving when engaged in ill-structured problems, i.e., those which do not have an absolutely correct solution. Epistemic cognition has to do with reflections on the limits of knowledge, the certainty of knowledge, and the criteria for knowing. Current evidence suggests that while cognitive and metacognitive processes emerge in children and are used throughout the life span, epistemic cognition emerges in late adolescence, although its form may change in the adult years.

Understanding differences in assumptions underlying epistemic cognition via models of adult reasoning is critical to understanding the divergent forms of justification individuals use when faced with the uniquely human issues that adults encounter in everyday life. Epistemic assumptions provide a framework through which individuals understand the nature of such problems and define and choose acceptable strategies or solutions. The goal of understanding how adults monitor and thoughtfully choose or create solutions to ill-structured problems will not be achieved if we do not go beyond the current concept of metacognition and begin to study how individuals acquire knowledge about knowledge

in the epistemic sense and the way that knowledge leads individuals to formulate a problem and to understand the nature of solutions available for it.

Such assumptions have important implications for educational programs [*Kitchener,* in press). In fact, issues of jurisprudence, public policy, scientific inquiry, philosophy, and interpretation in the arts are all areas in which epistemic assumptions are critical because they all are concerned with ill-structured problems. In order to understand how wise and thoughtful decisions are made in these areas, the concept of epistemic cognition is essential.

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