CHAPTER 32

Learning to Think: The Challenges of Teaching Thinking

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The idea that thinking can be taught, or at least productively nurtured along its way, is ancient. Beginning with the efforts of Plato and the introduction of Socratic dialog, we see attention to improving intelligence and promoting effective thinking as a recurring educational trend throughout the ages. Early in the twentieth century, Dewey (1933) again focused North American's attention on the importance of thinking as an educational aim. At the same time, Selz (1935) was advocating the idea of learnable intelligence in Europe. In the 1970s and 1980s, specific programs designed to teach thinking took shape, many of which continue in schools today. Efforts to teach thinking have proliferated in the new millennium, often becoming less programmatic in nature and more integrated within the fabric of schools.

Despite this long history of concern with thinking, one reasonably might ask: Why do we need to "teach" thinking anyway? After all, given reasonable access to a rich cultural surround, individuals readily engage in situated problem solving, observing, classifying, organizing, informal theory building and testing, and so on, without much prompting or even support. Indeed, neurological findings suggest that the brain is hard-wired for just such activities as a basic mechanism for facilitating language development, socialization, and general environmental survival. Furthermore, it might be assumed that these basic thinking skills are already enhanced through the regular processes of schooling, as students encounter the work of past thinkers, engage in some debate, write essays, and so on. Why, then, should we concern ourselves with the teaching and learning of thinking? Addressing these issues entails looking more closely at a fuller range of thinking, particularly what might be called high-end thinking, as well as examining the role education plays in promoting thinking.

Although it is true that the human mind comes readily equipped for a wide variety of thinking tasks, it is equally true that some kinds of thinking run against these natural tendencies. For example, probabilistic thinking is often counterintuitive in nature or doesn't fit well with our experience (Tversky & Kahneman,1993; also see Kahneman & Frederick, Chap. 12). We have a natural tendency toward favoring our own position and interests – my-side bias (Molden & Higgins, Chap. 13) – that can lead to poor conclusions in decision making and discernments of truth (Baron, et al. 1993). We frequently draw conclusions and inferences based on limited evidence (Perkins, 1989, 1995). The fundamental attribution error (Harvey, Town, & Yarkin, 1981) names the tendency, particularly in Westerners, to ascribe characterological traits to others based on limited but highly salient encounters.

Furthermore, sometimes our natural ways of making sense of the world actually stand in the way of more effective ways of thinking. For instance, our ability to focus attention can lead to narrowness of vision and insight. Our natural tendency to detect familiar patterns and classify the world can lock us into rigid patterns of action and trap us in the categories we invent (Langer, 1989). Relatedly, already developed understandings constitute systems of knowledge that are much more readily extended than displaced: We tend to dismiss or recast challenges rather than rethinking our understandings, a deep and general problem of learning (see Chi and Ohlsson, Chap. 16). Our emotional responses to situations can easily override more deliberative thinking (Goleman, 1995). The phenomenon of groupthink, in which the dominant views of the group are readily adopted by group members, can lead to limited processing and discernment of information (Janis, 1972). These are just a few thinking shortfalls suggesting that truly good thinking does not automatically develop in the natural course of events.

Even when our native tendencies do not lead us astray, they can usually benefit from development. The curiosity of the child for discovering and making sense of the world does not automatically evolve into an intellectual curiosity for ideas, knowledge, and problem solving (Dewey, 1933), for example. Our ability to see patterns and relationships forms the basis for inductive reasoning (see Sloman & Lagnado, Chap. 5) but the latter requires a level of precision and articulation that must be learned. Our natural ability to make inferences becomes much more sophisticated through systematized processes of reasoning with evidence, weighing evidentiary sources, and drawing justifiable conclusions. Indeed, for most thinking abilities that might be considered naturally occurring, one can usually identify a more sophisticated form that such thinking might take with some deliberate nurturing. This type of thinking is what is often referred to as high-end thinking or critical and creative thinking. Such thinking extends beyond a natural processing of the world into the realm of deliberative thinking acts aimed at solving problems, making decisions (see LeBoeuf & Shafir, Chap. 11), and forming conclusions.

The contribution of schooling to the development of thinking is a vexed matter (see Greenfield, Chap. 27, for a cross-cultural perspective on the impact of schooling). On the one hand, it is clear that schooling enhances performance of various kinds on formal tasks and IQ-like instruments (Grotzer & Perkins, 2000; Perkins, 1985; see Sternberg, Chap. 31, for a discussion of intelligence). For the most part, however, schools have addressed knowledge and skill acquisition. The narrowness of this focus and absence of strong efforts to nurture thinking were criticized by Dewey at the turn of the century. Such critiques have continued until today from a variety of sources. In a series of empirical investigations, Perkins and colleagues (Perkins, Allen, & Hafner, 1983; Perkins, Faraday & Busheq, 1991) investigated the impact of conventional education at the high school, university, and graduate school levels on informal reasoning about everyday issues. Cross-sectional studies examining the impact of three years of high school, college, and graduate school revealed only marginal gains (Perkins, 1985). Several national reports on schooling in the 1980s discussed how schools were dominated by rote work and involved very little thinking (Boyer, 1983; National Commission on Excellence in Education, 1983; Goodlad, 1983).

The problems of overcoming thinking shortfalls while enhancing native thinking

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processes through education therefore constitute an important rationale for the explicit teaching of thinking. Furthermore, as knowledge and information become at the same time more complex and more accessible, critics argue that teaching thinking should be considered even more of a priority (Resnick, 1987). In this setting, it is not enough to simply consume predigested knowledge, one must also become a knowledge builder (Scardamalia, Bereiter, & Lamon, 1994) and problem solver (Polya, 1957; Schoenfeld, 1982; Selz, 1935).

This need for thinking instruction has led to a rapid increase in efforts to teach thinking over the past thirty years. During this time, a few well-established thinking programs have taken hold in schools and sustained their development, while a plethora of new programs, often small interventions based on current cognitive theory, have flourished. In addition, an increasing array of subject-based programs and designed learning environments aimed at developing students' thinking also have emerged. These programs deal with many different aspects of thinking, including critical and creative thinking (for more on creative thinking, see Sternberg et al. Chap. 15), reflective and metacognitive thinking, self-regulation, decision-making, and problem solving, as well as disciplinary forms of thinking.

All of these programs – whether aimed at developing thinking as part of a stand-alone course, within the context of teaching a particular subject, or as part of a larger design of the instructional environment – confront at least five important challenges in their efforts to develop thinking. We use these as the basis for the present review. The first challenge relates to the bottom line: Can thinking be taught with some reasonable signs of success? The second challenge concerns what one means when one talks about good thinking. Programs and efforts to teach thinking are shaped largely by the answer to this question. The third challenge deals with the dispositional side of thinking, not just skills and processes but attitudes and intellectual character (Ritchhart 2002; Tishman 1994). The fourth challenge is that of transfer, a pivotal concern within the teaching of thinking. We conclude with a fifth challenge, that of creating cultures of thinking, in which we examine the social context and environment in which thinking is being promoted. Each of these challenges involves key philosophical and practical issues that all efforts to teach thinking, whether undertaken by a single teacher or a major research university, must confront. We review the ways in which various efforts to teach thinking address these challenges to clarify just what is involved in teaching thinking.

The Challenge of Attaining Results

As is the case with any class of educational interventions, one of the most fundamental questions to be asked is: Do they work – at least with some populations under some circumstances? This is especially important for an area like the teaching of thinking, which is haunted by skepticism on the part of lay people and some scholars.

It may seem premature to turn to findings without discussing details about background theories and issues in the field, but letting the question of impact hover for many pages while we deal with such matters also seems troublesome. After all, if there isn't at least some indication that thinking can be taught, then the remaining challenges become academic. Accordingly, we turn to this ultimate challenge first, asking whether, at least sometimes, coordinated efforts to teaching thinking work in a reasonable sense, also taking it as an opportunity to put quick profiles of several interventions on the table to give readers a feel for the range of approaches.

In looking for success, it is helpful to bear in mind three broad criteria – *magnitude, persistence,* and *transfer* (Grotzer & Perkins, 2000). An intervention appears successful to the extent that it shows some magnitude of impact on learners' thinking, with effects that persist well beyond the period of instruction, and with transfer to other contexts and occasions. Previous reviewers of thinking programs pointed out that the empirical evidence needed to assess program effectiveness is often hard to come by in the research literature (e.g., Adams, 1989; Nickerson, Perkins, & Smith, 1985; Sternberg, 1986), often because of the lack of funding for careful long-term program evaluation. We emphatically do not limit this article only to those programs receiving extensive evaluation, but we do focus this section on a few such programs. The good news is that the history of efforts to teach thinking provides proofs for achieving all three criteria, at least to some extent.

Programs designed to teach thinking come in many different styles. For instance, some programs are designed to develop discrete skills and processes such as classification and sequencing, as means of developing the building blocks for thinking. Paul (1984) refers to these programs as "micrological" in nature. They often find their theoretical justification in theories of intelligence (see next section for more on how various programs define good thinking), and they often use decontextualized and abstract materials similar to those one might find on standardized psychometric tests.

Perhaps the best-known program of this type is *Instrumental Enrichment* (IE) (Feuerstein, 1980). It uses very abstract, test-like activities to develop skills in areas such as comparisons, categorization, syllogisms, and numerical progressions, among others. Instructors are encouraged to "bridge" the abstract exercises by relating the skills to real-world problem solving. Instrumental enrichment was designed to bring students who show marked ability deficits into mainstream culture, although it can be used with other students as well.

In one study, matched samples of low functioning, low socio-economic status (SES) twelve to fifteen year olds participated in IE or general enrichment (GE) programs providing direct help, such as math or science tutoring. Instrumental enrichment subjects made greater pre- to posttest gains on tests of interpersonal conduct, self-sufficiency, and adaptation to work demands. Instrumental enrichment subjects scored slightly above normal, far better than would have been expected, and significantly better than GE subjects by about a third of a standard deviation on incidental follow-up testing on an Army Intelligence test (DAPAR) two years later (Feuerstein et al., 1981; Rand, Tannenbaum, & Feuerstein, 1979). These findings show both magnitude and persistence of effects, with some transfer. The program uses testlike activities, so the transfer to a nonverbal intelligence test might be considered a case of near transfer (Perkins & Salomon, 1988). Evidence of transfer to school tasks – far transfer – seems to depend on the individual teacher or instructor, who is responsible for providing the bridging (Savell, Twohig, & Rachford, 1986; Sternberg, 1986).

These findings have proved less easily replicated with students of average or above-average ability. What is consistent, however, is the change in behavior and attitude students experience, generally in terms of increased confidence in abilities and a more positive attitude toward school work (Blagg, 1991; Kriegler, 1993).

Another type of program to teach thinking tends to be more "macrological" in nature (Paul, 1984), being contextualized and real-world oriented, focusing on more broad-based skills such as considering multiple points of view, dealing with complex information, or creative problem solving. Philosophy for Children (Lipman, 1976), and CoRT (Cognitive Research Trust) (de Bono, 1973), are examples of this approach. The Philosophy for Children program engages students in philosophical discussions around a shared book to cultivate students' ability to draw inferences, make analogies, form hypotheses, and so forth. The CoRT program teaches a collection of thinking "operations" defined by acronyms for creative and critical thinking; operations that aim to broaden and organize thinking and facilitate dealing with information. Through a developed set of practice problems, for instance, students learn to apply the PMI operation (plus, minus, interesting), identifying the pluses, minuses, and interesting but otherwise neutral points about a matter at hand.

Both of these programs have been around long enough to develop a strong base and avid followers, resulting in a wealth of anecdotal evidence and reports of effectiveness. Indeed, observers of these programs tend to be impressed with the involvement of students and the level of thinking demonstrated (Adams, 1989). Furthermore, some evidence can be found to support both programs. Edwards (1994) reports that twelve-year-olds taught all sixty lessons of the *CoRT* program showed improved scores on quantitative as well as qualitative measures. Compared with other seventh grade students, scores of CoRT students ranged from forty-eight percent to sixty-two percent above the national mean on standardized tests whereas other seventh graders' scores ranged from twenty-five percent to forty-three percent (with a national norm of thirty-one percent), indicating a magnitude effect. Teachers reported improvements in student thinking and confidence. Although students reported using the skills in other areas of their lives, there was no formal measure of transfer on this evaluation. Other evaluations revealed mixed results on transfer (Edwards & Baldauf, 1983, 1987). The program produces an interesting finding with respect to persistence that should be noted. Although reviews of research on CoRT suggest that the effects were short-term (Edwards, 1991a, 1991b), it was found that a small amount of follow-up reinforcement given in the two years following the intervention resulted in increased persistence of effects with scores that were one-third better than controls three years after the intervention (Edwards, 1994).

With respect to Philosophy for Children, evaluations have shown that children in grades four to eight display significant gains in reading comprehension or logical thinking (Lipman, 1983). Transfer is built into the program because the discussions are text-based and consequently deepen comprehension while teaching and modeling thinking strategies within the real-world contexts of the stories. As Adams (1989, p. 37) points out, the texts give "Lipman the freedom to introduce, reintroduce, and elaborate each logical process across a diversity of real-world situations."

Another program worth mentioning is a unique hybrid. The Odyssey (Adams, 1986) program developed through a collaboration between Harvard Project Zero, Bolt Beranek and Newman, Inc., and the Venezuela Ministry of Education was specifically designed to systematically build macrological skills upon micrological skills. The first lessons of the program deal with micrological skills, or what the program developers call first-order processes of classification, hierarchical classification, sequencing, and analogical reasoning, to build the foundation for the macrological process of dimensional analysis. Processes often are introduced in the abstract, but then application is made to varied contexts. The program takes the form of a separate course with 100 lessons, but it seeks to connect directly to the scholastic activities of students and provide links to everyday life as well. The Odyssey program has been evaluated only in Venezuela. In a relatively large evaluation of the program involving roughly 900 students in control and experimental groups across twenty-two seventh grade classes, the group gains of the experimental group were 117 percent more than that of the control group on course-designed pre and post measurements, a strong indicator of magnitude of effects. A battery of tests were used to assess for transfer, including those of general ability, word problems, and nonverbal reasoning. All showed significant gains for the experimental group, indicating both magnitude and transfer of effects (Herrnstein, et al., 1986).

The abovementioned programs, whether focusing on micrological or macrological skills, were stand-alone interventions with perhaps a modest degree of integration. A number of programs are fully integrated and connected to the curriculum. A few of these are Intuitive Math (Burke, 1971) and *Problem Solving and Comprehension* (Whimbey and Lochhead, 1979), both focused on mathematics, and *Think* (Adams, 1971) and *Reciprocal Teaching* (Brown & Palincsar, 1982), focused on language arts and reading. All of these programs are designed to connect thinking processes to specific school content to enhance student understanding and

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thinking. Think and Intuitive Math focus on skills such as classification, structure analysis, and seeing analogies. Problem Solving and Comprehension uses a technique called "paired problem solving" to develop metacognitive awareness of one's thinking during problem solving. Reciprocal Teaching is not so much a program as an approach to teaching reading comprehension. Through a dialog with the teacher, students engage in cycles of summarizing, question generating, clarifying, and predicting. All of these interventions have been shown to produce impressive results for their target populations, generally low-achieving students, within the domains of their focus. In addition, transfer effects have been documented for Intuitive Math and Think (Worsham & Austin, 1983; Zenke & Alexander, 1984).

As promised, these examples – and others discussed later – offer a kind of existence proof regarding the challenge of attaining results (more reviews of these and other thinking programs can be found in Adams, 1989; Grotzer & Perkins, 2000; Hamers & Overtoom, 1997; Idol, 1991; McGuinness & Nisbet, 1991; Nickerson et al., 1985; Perkins, 1995; Sternberg, 1986). They give evidence that instruction designed to improve learners' thinking can advance it, with persistent impact, and with some degree of transfer to other contexts and occasions. Along the way, they also illustrate how rather different approaches can serve this purpose.

This is not to say that such results demonstrate overwhelming success. Impacts on learners' thinking are typically moderate rather than huge. The persistence of effects tapers off after a period of months or years, particularly when learners return to settings that do not support the kind of development in question. Transfer effects are often spotty rather than sweeping. These limitations are signs that the grandest ambitions regarding the teaching of thinking are yet to be realized. That said, enough evidence is at hand to show that the prospects of teaching thinking cannot simply be dismissed on theoretical or empirical grounds. This opens the way for a deeper consideration of the challenges of doing so in the upcoming sections.

The Challenge of Defining Good Thinking

Any program that aspires to teach thinking needs to face the challenge of defining good thinking, not necessarily in any ultimate and comprehensive sense but at least in some practical, operational sense. With the foregoing examples of programs in mind, it will come as no surprise that many different approaches have been taken to answer this challenge.

To begin, it is useful to examine some general notions about the nature of good thinking. There are a number of very broad characterizations. Folk notions of intelligence, in contrast with technical notions, boil down to good thinking. A number of years ago, Sternberg et al. (1981) reported research synthesizing the characteristics people envision when they think of someone as intelligent. Intelligent individuals reason systematically, solve problems well, think in a logical way, deploy a good vocabulary, make use of a rich stock of information, remain focused on their goals, and display intelligence in practical as well as academic ways. Perkins (1995) summed up a range of research on difficulties of thinking by noting the human tendency to think in ways that are *hasty* (impulsive, insufficient investment in deep processing and examining alternatives), *narrow* (failure to challenge assumptions, examine other points of view), *fuzzy* (careless, imprecise, full of conflations), and *sprawling* (general disorganization, failure to advance or conclude). Baron (1985) advanced a search-and-inference framework that emphasized effective search and inference around forming beliefs, making decisions, and choosing goals. Ennis (1986) offered a list of critical thinking abilities and dispositions, including traits such as seeking and offering reasons, seeking alternatives, and being open-minded. There are many others as well.

The overlap among such conceptions is apparent. They can be very useful for a broad overview and for the top level of program design, but they are not virtues of thinking that learners can straightforwardly learn or teachers teach. They do not constitute a good theory of action (e.g. Argyris, 1993; Argyris & Schön, 1996) that would guide and advise learners about how to improve their thinking, or guide and advise teachers and program designers about how to cultivate thinking. With this general challenge in mind, we turn to describing three approaches through which researchers and educators have constructed theories of action that characterize good thinking – by way of norms and heuristics, models of intelligence, and models of human development.

Norms and Heuristics

One common approach to defining good thinking is to characterize concepts, standards, and cognitive strategies that serve a particular kind of thinking well. These guide performance as norms and heuristics. When people know the norms and heuristics, they can strive to improve their practice accordingly. The result is a kind of "craft" conception: Good thinking is a matter of mastering knowledge, skills, and habits appropriate to the kind of thinking in question as guided by the norms and heuristics.

Norms provide criteria of adequacy for products of thinking such as arguments or grounded decisions. Examples of norms include suitable conditions for formal deduction or statistical adequacy, formal (e.g., affirming the consequent) or informal (e.g., ad hominem argument) fallacies to be avoided, or maximized payoffs in game theory (Hamblin, 1970; Nisbett, 1993; Voss, Perkins, & Segal, 1991). Heuristics guide the process of thinking, but without the guarantees of success that an algorithm provides. For instance, mathematical problem solvers often do well to examine specific cases before attempting a general proof or to solve a simpler related problem before tackling the principal problem (Polya, 1954, 1957).

The norms and heuristics approach figures widely in educational endeavors. Training in norms of argument goes back at least to the Greek rhetoriticians (Hamblin, 1970) and continues in numerous settings of formal education today, with many available texts. Heuristic analyses have been devised and taught for many generic thinking practices – everyday decision-making, problem solving, evaluation of claims, creative thinking, and so on.

Looking to programs mentioned earlier for examples, the CoRT program teaches "operations" such as PMI (consider plus, minus, and interesting factors in a situation) and OPV (consider other points of view) (de Bono, 1973). The Odyssey program teaches strategies for decision-making, problem solving, and creative design, among others, foregrounding familiar strategies such as looking for options beyond the obvious, trial and error, and articulation of purposes (Adams, 1986). Polya (1954, 1957) offered a well-known analysis of strategies for mathematical problem solving, including examining special cases, addressing a simplified form of the problem first, and many others. This led to a number of efforts to teach mathematical problem solving, with unimpressive results, until Schoenfeld (1982; Schoenfeld & Herrmann, 1982) demonstrated a very effective intervention that included the instructor working problems while commenting on strategies as they were deployed, plus emphasis on the students' self-management of the problem-solving process. Many simple reading strategies have been shown to improve student retention and understanding when systematically applied, including, for example, the previously mentioned "reciprocal teaching" framework, in which young readers interact conversationally in small groups around a text to question, clarify, summarize, and predict (Brown & Palincsar, 1982).

Nisbett (1993) reported a series of studies conducted by himself and colleagues about the effectiveness of teaching norms and heuristics of statistical, if-then, cost-benefit, and other sorts of reasoning, main to college students. Nisbett concluded that instruction in rules of reasoning was considerably more effective than critics of general, context-free rules for reasoning had claimed. To be sure, student performance displayed a range of lapses and could have been better. Nonetheless, students often applied the patterns of reasoning that they were studying quite widely, well beyond the content foregrounded in the instruction. Relatively abstract and concise formulations of principle alone led to some practical use of rules for reasoning, and this improved when instruction included rich exploration of examples. Nisbett emphasized that we could certainly teach rules for reasoning much better than we do. Nonetheless, the basic enterprise appeared to be sound.

To summarize, the characteristic pedagogy of the approach through norms and heuristics follows from its emphasis on thinkers' theories of action. Programs of this sort typically introduce norms and heuristics directly, demonstrate their application, and engage learners in practice with a range of problems, often with an emphasis on metacognitive awareness, self-management, and reflection on the strategies, general character, and challenges of thinking.

Readily grasped concepts and standards, strategies with three or four steps, and the like characterize the majority of norms and heuristics approaches. One objection to such simplicity is that it can seem simpleminded. "Everyone knows" that people should consider both sides of the case in reasoning or look for options beyond the obvious. However, as emphasized in the introduction to this article, such lapses are commonplace. Everyone does not know, and those who do know often fail to do. The point of norms and heuristics most often is not to reveal novel or startling secrets of a particular kind of thinking but to articulate some basics and help bridge from inert knowledge to active practice.

Models of Intelligence

The norms and heuristics approach to defining and cultivating good thinking may be the most common, but another avenue looks directly to models of intelligence (see Sternberg, Chap. 31). Not so often encountered in the teaching of thinking is good thinking defined through classic intelligence quotient (IQ) theory. On the one hand, many, although by no means all, scholars consider general intelligence in the sense of Spearman's *g* factor to be unmodifiable by direct instructional interventions (Brody, 1992; Jensen, 1980, 1998). On the other hand, a single factor does not afford much of a theory of action, because it does not break down the learning problem into components that can be addressed systematically.

Models of intelligence with components offer more toward a theory of action. J. P. Guilford's 1967; (Guilford & Hoepfner, 1971) *Structure of Intellect* (SOI) model, for example, proposes that intelligence involves no fewer than 150 different components, generated by a three-dimensional analysis involving several cognitive operations (cognition, memory, evaluation, convergent production, divergent production) crossed with several kinds of content (behavioral, visual figural, and more) and cognitive products (units, classes, relations, and more). An intervention developed by Meeker (1969) aims to enhance the functioning of a key subset of these components. Feuerstein (1980) argues that intelligence is modifiable through mediated learning (with a mediator scaffolding learners on the right kinds of tasks). His Instrumental Enrichment program offers a broad range of mediated activities organized around three broad categories of cognitive process – information input, elaboration, and output – to work against problems such as blurred and sweeping perception, impulsiveness, unsystematic hypothesis testing, and egocentric communication.

Sternberg (1985) developed the triarchic theory of intelligence over a number of years, featuring three dimensions of intelligence – analytic (as in typical IQ tests), practical (expert "streetwise" behavior in particular domains), and creative (invention, innovation). Sternberg, et al. (1996) report an intervention based on Sternberg's (1985) triarchic theory of intelligence: High school students taking an intensive summer college course were grouped by their strengths according to Sternberg's three dimensions and taught the same content in ways building on their strengths. The study included other groups not matched with their strengths. Matched students exhibited superior performance.

The typical pedagogy of interventions based on models of intelligence emphasizes not teaching norms and heuristics but rather providing abundant experience with the thinking processes in question in motivated contexts with strong emphasis on attention and self-regulation. Often, although by no means always – the Sternberg intervention is an exception here, for example – the tasks have a rather abstract character, on the theory that the learning activities are enhancing the functioning of fundamental cognitive operations and content is best selected for minimal dependence on background knowledge. That said, it is important to recognize that no matter what the underlying theory – norms and heuristics, intelligence-based, or developmental, as in the following section – interventions often pragmatically combine a variety of methods rather than proceeding in a purist manner.

Models of Human Development

Another approach to defining good thinking looks to models of human development that outline how cognitive development normally advances, often through some sequence of stages that represent plateaus in the complexity of cognition, as with the classic concrete and formal operational stages of Inhelder and Piaget (1958; see Halford, Chap. 22). For example, the program called Cognitive Acceleration through Science Education (CASE) (Adey & Shayer, 1993, 1994) teaches patterns of thinking in science – for instance the isolation and control of variables – based on Piagetian principles of uncovering students' prior conceptions and creating opportunities for them to reorganize their thinking. Lessons introduce cognitive dissonance around particular puzzles so students are led to examine their assumptions and rethink their prior conceptions. In addition to the thinking skills, the program focuses explicitly on fostering metacognition and transferring knowledge and strategies between contexts. A formal evaluation compared CASE students with control students on school science achievement tests with delayed post-testing. For some groups, substantial and statistically significant differences emerged for science, mathematics, and English performance two years after participation in CASE, demonstrating magnitude, persistence, and transfer of impact, the criteria used in the foregoing results section (Adey & Shayer, 1994, p. 92).

Although this example takes a stage-like view of human development, another tradition looks to the work of Vygotsky and his followers, seeing development more as a process of internalization from social situations that scaffold for the thinking of the participant (1978). In addition to its Piagetian emphasis, the work of Adey and Shayer draws upon social scaffolding. Scardamalia and colleagues developed an initiative initially called C*SILE* (Computer Supported Intentional Learning Environments) and now Knowledge Forum, that engages students in the collaborative construction of knowledge through an online environment that permits building complex knowledge structures and labels for many important epistemic elements such as hypotheses and evidence (Scardamalia, et al., 1989). The social character of the enterprise and the forms of discourse it externalizes through the online environment create conditions for Vygotskian internalization of patterns of thinking. Studies of impact have shown gains in students' depth of explanation and knowledge representation, capability in dealing with difficult texts, recall of more information from texts, and deeper conceptions of the nature of learning, with more of a mastery emphasis (Scardamalia, Bereiter, & Lamon, 1994).

Of course, developmental psychology has evolved greatly since the days of Vygotsky and Piaget. For example, the past half century has seen development explained in terms of expansion in, and more efficient use of, working memory (e.g., Case, 1985; Fischer, 1980; Pascual-Leone, 1978); semi-independent courses of development traced in different domains (e.g., Case, 1992; Fischer, 1980; Carey, 1985); strands of

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development attributed to the modularity of mind, with innate mental structures anticipating certain kinds of knowledge (e.g., Detterman, 1992; Hirschfeld & Gelman, 1994), and so on.

It is not the role of the present article to review the complexities of contemporary developmental psychology, especially because as far as we know, few approaches to the teaching of thinking have based themselves on recent developmental theory. Quite likely, there are substantial opportunities that have not been taken. To give a sense of the promise, Case (1992) advanced the idea of *central conceptual structures*, core structures in broad domains such as quantity, narrative, and intentionality that lie at the foundations of development in these domains and enable further learning. Working from this notion, Griffin, Case, and Capodilupo (1995) designed and assessed an intervention called Rightstart to develop the central conceptual structure for number and advance kindergarteners' preparation for learning basic arithmetic operations through formal instruction. Testing demonstrated that the children in the treatment group indeed acquired a more fully developed central conceptual structure for number, displayed greater understanding of number in content areas not included in the training, and responded with substantially greater gains to later formal instruction in the basics of arithmetic as well as showing far transfer to sight reading in music and to the notion of distributive justice, areas related to the central conceptual structure for number.

As these examples illustrate, the general pedagogical style of the developmental approach is to harness "natural" footholds and mechanisms of development to accelerate development and perhaps reach levels that the learner otherwise would not attain. As theories of action, models of human development, like models of intelligence, do not so much offer strategic advice to learners as they address teachers and especially designers, suggesting how they might arrange activities and experiences that will push development forward. Indeed, a common, although questionable, tenet of much developmental theory is that you cannot teach directly the underlying logical structures. Learners must attain them by wrestling with the right kinds of problems under appropriately reflective and supportive conditions.

What Effect Does a Theory of Good Thinking Have?

With approaches to defining good thinking through heuristic analysis, intelligence, and human development on the table, perhaps the most natural question to ask is which approach is "right" and therefore would lead to the most powerful interventions. Unfortunately, the matter is far too complex to declare a winner. One complication is that all programs, despite their theoretical differences, share key features. All programs engage learners in challenging thinking tasks that stretch beyond what they normally undertake. All programs place some emphasis on focused attention and metacognitive self-regulation. It may that these demand characteristics are the factors that influence an intervention's success more than the underlying theory. Furthermore, as underscored earlier, programs are often eclectic in their means: Their methods overlap more than their philosophies.

To further complicate declaring a winner, different programs speak to the distinctive needs of different audiences – children of marked disabilities with unsystematic and impulsive ways of thinking, students of elementary science conceptually confused about themes such as control of variables, math students in college struggling with strategies of proof.

Another confounding factor is that a technically well-grounded theory may not be that helpful as a theory of action. As noted earlier, this is a problem with classic *g* theory. Finally, and somewhat paradoxically, a theory in some ways suspect may lead to an intervention that proves quite effective. For example, Piagetian theory has been challenged in a number of compelling ways (e.g., Brainerd, 1983; Case, 1984, 1985), yet applying certain key aspects of it appears to serve very well the demonstrably effective

CASE program (Adey & Shayer, 1993, 1994), perhaps because the kinds of thinking it foregrounds are important to complex cognition of the sort targeted, putting aside the standing of Piagetian theory as a whole.

In summary, although approaches based on norms and heuristics, theories of intelligence, and models of development can be identified, it is difficult at present to dismiss any of them as misguided. As with much of human enterprise, the devil is in the details – here, the details of particular programs' agendas, the learners they mean to serve, and the extent to which their conceptions of good thinking provide helpful theories of action.

That said, there is a general limitation to all three approaches: They all concern what it is to think well *when you are thinking*. Such criteria are certainly important, but this leaves room to ask: What if you don't feel moved to think about the matter at hand, or what if you don't even notice that the circumstances invite thinking? This brings us to the next fundamental challenge of teaching thinking – the role of dispositions.

The Challenge of Attending to Thinking Dispositions

We discussed earlier how approaches to teaching thinking needed to address the question, "what is good thinking?" In a sense, that question was incomplete. Good thinkers, after all, are more than people who simply think well when they think: They also think at the right times with the right commitments – to truth and evidence, creativity and perspective taking, sound decisions, and apt solutions. Views of thinking that bring this to the fore are often called *dispositional* because they look not just to how well people think when trying hard but what kinds of thinking they are *disposed* to undertake.

Most views of thinking are abilities-centered, but several scholars have developed dispositional perspectives – for instance Dewey (1922), who wrote of habits of mind; Baron (1985) as part of his search-inference framework; Ennis (1986) and Norris (1995), as part of analyses of critical thinking; Langer (1989, p. 44), with the notion of mindfulness, which she defined as "an open, creative, and probabilistic state of mind"; and Facione et al. (1995). Models of self - regulation have emphasized volitional aspects of thinking and individuals' motivation to engage thoughtfully (Schunk & Zimmerman, 1994). We and our colleagues have done extensive work in this area, referring to intellectual character as a particular perspective on dispositions (Ritchhart, 2002; Tishman, 1994, 1995) and to dispositions themselves (Perkins, Jay, & Tishman, 1993; Perkins et al., 2000; Perkins & Tishman, 2001; Perkins & Ritchhart, 2004).

Accordingly, it is important to examine the dispositional side of the story and appraise its importance in the teaching of thinking.

The Logical Case for Dispositions

One line of argument for the importance of dispositions looks to logic and common experience. There is a natural tendency to associate thinking with blatant occasions – the test item, the crossword puzzle, the choice of colleges, the investment decision. Plainly, however, many situations call for thinking with a softer voice all too easily unheard – the politician's subtle neglect of an alternative viewpoint, your own and others' reasoning from ethnic stereotypes, the comfort of "good enough" solutions that are not all that good. Even when we sense opportunities for deeper thinking in principle, there are many reasons why we often shun them – blinding confidence in one's own view, obliviousness to the possibilities for seeing things differently, aversion to complexities and ambiguities, and the like. Such lapses seem all too common, which is why, for example, Dewey (1922) emphasizes the importance of good *habits of mind* that can carry people past moments of distraction and reluctance. Scheffler (1991, p. 4), writing about cognitive emotions, put the point eloquently in stating that "emotion without cognition is

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blind, and . . . cognition without emotion is vacuous."

It also is notable that the everyday language of thinking includes a range of terms for positive and negative dispositional traits considered to be important: A person may be open-minded or closed-minded, curious or indifferent, judicious or impulsive, systematic or careless, rational or irrational, gullible or skeptical. Such contrasts have more to do with how well people actually use their minds than how well their minds work.

The Empirical Case for Dispositions

The foregoing arguments from logic and common sense give some reason to view the dispositional side of thinking as important. Beyond that, a number of researchers have investigated a range of dispositional constructs and provided empirical evidence of their influence on thinking, their trait-like character, and their distinctness from abilities.

Research on dispositional constructs such as the need for cognitive closure (Kruglanski, 1990) and the need for cognition (describing an individual's tendency to seek, engage in, and enjoy cognitively effortful activity, Cacioppo & Petty, 1982) has shown that they influence when and to what extent individuals engage in thinking, and has demonstrated test–retest reliability (Kruglanski, 1990; Cacioppo et al., 1996). Measures of an individual's need for cognition developed by Cacioppo and colleagues show that it is a construct distinguishable from ability (Cacioppo et al., 1996).

Dweck and colleagues investigated another dispositional construct for a number of years – the contrast between entity learners and incremental learners (Dweck, 1975, 2000). Broadly speaking, learners with an entity mindset believe that "you either get it or you don't," and if you don't, you probably are not smart enough. As a result, they tend to quit in the face of intellectual challenges. In contrast, learners with an incremental mindset believe their abilities can be extended through step-by-step effort, so they persist. An extended program of research has shown that these traits are independent of cognitive abilities, but often affect cognitive performance greatly. Also, teaching style and classroom culture can shape the extent to which students adopt entity versus incremental mindsets.

Using self-report measures of dogmatism, categorical thinking, openness, counterfactual thinking, superstitious thinking, and actively open-minded thinking, Stanovich and West (1997) found these measures predicted performance on tests of argument evaluation even after controlling for cognitive capacities.

These studies support the notion that dispositional constructs do influence behavior and can be useful in predicting performance, although perhaps not in any absolute sense. One can be curious in one situation and not in another, for instance. Likewise with dispositions such as friendliness or skepticism. Although there is evidence for cross-situational stability for some dispositional constructs (Webster & Kruglanski, 1994), the value of the dispositional perspective does not rest on an assumed cross-situational character. Indeed, rather than acting in a top-down, trait-like fashion, dispositions offer a more bottom-up explanation of patterns of behavior consistent with emerging social-cognitive theories of personality (Cervone, 1999; Cervone & Shoda, 1999). A dispositional perspective takes into account both the situational context and individual motivational factors, positing that patterns of behavior are emergent and not merely automatic. To better understand how such behavior emerges and how dispositions differ from traits, it is necessary to break apart dispositional behavior into its distinct components.

For a number of years, the authors and their colleagues have sustained a line of research on the nature of dispositions, as cited earlier. Although most scholars view dispositions as motivating thinking, we have analyzed the dispositional side of thinking into two components – sensitivity and inclination. Sensitivity does not motivate thinking as such but concerns whether a person notices occasions in the ongoing flow of events that might call for thinking, such as noticing a hasty causal inference, a sweeping generalization, a limiting assumption to be challenged, or a provocative problem to be solved. Inclination concerns whether a person is inclined to invest effort in thinking the matter through, because of curiosity, personal relevance, and so on.

Our empirical research argues that sensitivity is supremely important. We used stories that portrayed people thinking through various problems and decisions, with embedded shortfalls in their thinking, such as not going beyond the obvious options or not examining the other side of the case (Perkins et al., 2000; Perkins & Tishman, 2001). In multiple studies, we found that subjects detected only about 10% of the thinking problems, although, when prompted, they showed good ability, readily brainstorming further options or generating arguments on the other side of the case. Inclinations played an intermediate role in their engagement in thinking.

In one study, we examined test–retest correlations on sensitivity scores for detecting thinking shortfalls and found correlations of about 0.8 for a ninth grade sample and 0.6 for a fifth grade sample. The findings provide evidence that sensitivity to the sorts of shortfalls examined is a somewhat stable characteristic of the person. In several studies, we examined correlations between our dispositional measures and various measures of cognitive ability, with results ranging from no to moderate correlation but lower than correlations within ability measures (Perkins et al., 2000; Perkins & Tishman, 2001). The findings suggest that sensitivity and inclination are not simply reflections of cognitive ability as usually conceived: Dispositions are truly another side of the story of thinking.

Cultivating Thinking Dispositions

These lines of evidence support the fundamental importance of dispositions in understanding what it is to be a good thinker. The question remains what role attention to dispositions does – and should – play in the teaching of thinking. Most programs do not attend directly and systematically to dispositional aspects of thinking, although they may foster dispositions as a side-effect. Indeed, it is inconvenient to address dispositions through programs that focus on direct instruction and regimens of practice. The dispositional side of thinking concerns noticing when to engage thinking seriously, which inherently does not come up in abilities-centered instruction that point-blank directs students to think about this or that problem using this or that strategy.

One solution to this suggests that culture is the best teacher of dispositions (cf. Dewey, 1922, 1933; Ritchhart, 2002; Tishman, Jay, & Perkins, 1993; Tishman, Perkins, & Jay, 1995; Vygotsky, 1978). A culture in the classroom, the family, or the workplace that foregrounds values of thinking and encourages attention to thinking would plausibly instill the attitudes and patterns of alertness called for.

Interventions that wrap learners in a culture include the *Philosophy for Children* program developed by Lipman and colleagues (Lipman, 1988; Lipman, Sharp, & Oscanyon, 1980), which foregrounds Socratic discussion, and the online collaborative knowledge-building environment CSILE (Scardamalia & Bereiter, 1996; Scardamalia et al., 1989, 1994), both of which were discussed earlier. Instrumental Enrichment (Feuerstein, 1980) involves a strong culture support between mediator and learners. We have also worked on programs with a cultural emphasis, including *Keys to Thinking* (Perkins, Tishman, & Goodrich, 1994; Cilliers et al., 1994) and one now under development (Perkins & Ritchhart, 2004), and have published a book for teachers with this emphasis – *The Thinking Classroom* (Tishman, Perkins, & Jay, 1995). The theme of cultures of thinking is important in other ways as well, so, rather than elaborating further, we will return to it in a later section.

It is reasonable to ask whether such interventions have been shown to enhance learners' thinking dispositions. Unfortunately, evidence on this question is sparse. Although most of these programs have been formally evaluated, the assessments by and large are abilities-oriented. Their performance-on-demand character does not estimate what students are disposed to do in the absence of explicit demands, which is what dispositions are all about. That acknowledged, it is worth recalling from earlier that CSILE students revealed deeper conceptions of the nature of learning, a tendency to make mastery-oriented choices in their learning, and an avowed valuing of deep thinking (Scardamalia, Bereiter, & Lamon, 1994). Low-ability students responding to IE show marked increases in self-confidence (Feuerstein et al., 1981; Rand, Tannenbaum, & Feuerstein, 1979). The authors think it likely that many programs have at least some impact on learners' dispositions, but an extensive empirical case remains to be made.

In summary, both folk psychology and a good deal of academic psychology give abilities center stage in explaining good and not-so-good thinking and thinkers. Along with this abilities-centered view of thinking comes a concomitant view of what it is to teach thinking: To get people to think better and improve their abilities, teach problem-solving skills, learning skills, self-management skills, and so on. All this certainly has value as far as it goes. However, the arguments advanced here question the completeness of the storyline. They challenge whether performance-on-demand tasks are a good model of how thinking works in everyday life and urge that well-rounded efforts to teach thinking attend to dispositional development as well as the development of abilities.

As is the case with abilities development, dispositions need to be considered from the standpoint of transfer of learning. Not only skills, but dispositions need to be generalized broadly from their initial contexts of learning for them to develop a robust nature. This brings us to our next challenge, that of teaching transfer.

The Challenge of Transfer

Like education in general, efforts to teach thinking do not simply target the here and now: They mean to serve the there and then. What learners acquire today in the way of thinking skills, strategies, cognitive schemata, underlying cognitive operations, dispositions, metacognitive capabilities, and the like aims to help them there and then make a difficult personal decision or study quantum physics or manage a business or draft and deliver a compelling political statement. In other words, the teaching of thinking reaches for transfer of learning. Sometimes the ambition for transfer is modest – experiences with reading for understanding or mathematical problem solving here and now should improve performance for the same activities later in other contexts. Not uncommonly, however, the ambition is far more grand – fundamental and far-reaching transformation of the person as a thinker.

Some have charged that such ambitions are overwrought. Although thinking may be cultivated in particular contexts for particular purposes, far-reaching transformation may be impossible. Relatedly, some have argued that it may be impossible to teach thinking in an abstract way – say, with puzzle-like problems and through stepwise strategies – with gains that will spread far and wide.

Empirical research shows us that the prospects of transfer cannot be utterly bleak. In the second section of this article, we offered a number of existence proofs for magnitude, persistence, and transfer of impact, and more appeared in the subsequent section. Before looking further at such results, let us hear the case for meager transfer. At least three lines of scholarship pose a challenge to transfer – research on transfer itself, research on expertise and the role of knowledge in cognition, and research on situated cognition. We will look briefly at each in turn.

Transfer of learning has a vexed history, particularly with respect to far transfer, a somewhat informal term for transfer to contexts very different from that of the initial learning (see Holyoak, Chap. 6, for a review of work on transfer by use of analogies). We can touch only briefly on this complex literature. The classic studies are Thorndike's (1923, Thorndike & Woodworth, 1901) demonstrations that the intellectual rigor of studying Latin did not lead to improved performance on other fronts. Since that time, numerous reviews and compilations have shown that far transfer is hard to come by (e.g., Detterman, 1992; Detterman & Sternberg, 1992; Salomon & Perkins, 1989). For an interesting echo of Thorndike's era, a number of efforts in the 1980s to teach various versions of computer programming as, it might be said, "the new Latin," generally showed no cognitive gains beyond the programming skills themselves (Salomon & Perkins, 1987). Thorndike's view that transfer depended on "identical elements" and is less likely to apply to domains far removed from one another remains a tempting explanation of the difficulties.

A more recent view in a somewhat similar spirit, Transfer Appropriate Processing, holds that the prospects of transfer depend on a match between the features foregrounded during initial encoding and the kinds of features called for in the target context. Initial encoding may tie the learning to extraneous or unnecessarily narrow features of the situation, limiting the prospects of transfer to other situations that happen to share the same profile (Morris, Bransford, & Franks, 1977). Another rather different barrier reflects the position held by many IQ theorists that there is nothing to train and transfer: Very general cognitive capabilities simply are not subject to improvement by direct training, although genetics, nutrition, long-term enculturation by schooling, and other factors may influence general cognitive capability.

Research directly on transfer aside, more damage to the prospects comes from studies of expertise and the importance of domain-specific knowledge. Although it might be thought that skilled cognition reflects general cognitive capabilities, an extensive body of research has shown the fundamental importance of familiarity with the knowledge, strategies, values, challenges, and other features of particular disciplines and endeavors (e.g., Bereiter & Scardamalia, 1993; Ericsson & Smith, 1991; Ericsson, 1996). For a classic example, de Groot (1965) and, building on his work, Chase and Simon (1973) demonstrated that skillful chess play depends on a large repertoire of strategic patterns about chess specifically, accessed in a perception-like way (see Novick & Bassok, Chap. 14).

Evidence from a range of professions argues that naturalistic decision-making depends on quick typing of situations to link them to prototypical solutions that can be adjusted to the immediate circumstances (Klein, 1999). In the same spirit, path analyses of performance in practical job contexts has shown specific knowledge to be a much more direct predictor of performance than general intelligence (Hunter, 1986). Several scholars have argued that intelligent behavior is deeply context bound (e.g. Ceci, 1990; Detterman, 1992b; Glaser, 1984; Lave, 1988). Effective thinking depends so much on a large repertoire of reflexively activated context-specific schemata that substantial transfer of expert thinking from one domain to another is impossible. Everyday support for this comes from the informal observation that people rarely manage to display high-level thinking in more than one field.

Interventions consistent with this view include programs in mathematics and science education that focus on a particular domain and try to advance learners' expertise. For example, Schoenfeld and Herrmann (1982) documented how subjects in a previously mentioned experimental intervention based on heuristics became more expert-like in their mathematical problem solving, coding problems more in terms of their deep structure than surface features.

Further skepticism about the prospects for far transfer derives from studies of the situated character of cognition and learning (Brown, Collins, & Duguid, 1989; Kishner & Whitson, 1997; Lave, 1988; Lave & Wenger, 1991). The general point here is that skilled activity is socially and physically situated in particular contexts, depending for its fluency and depth on a web of interactions with peers, mentors, physical and symbolic tools, and so on. Skill and knowledge do not so much sit in the heads of individuals as they are distributed through the social and physical setting (Salomon, 1993) and constituted through that setting. Individuals off-load certain thinking tasks onto the environment by use of note-taking, organizational mechanisms, fellow collaborators, and other technological tools, to free up mental space for more complex forms of thinking (Pea, 1993).

Accordingly, complex cognition is more likely to develop through "cognitive apprenticeship" (Collins, Brown, & Newman, 1989) in the context of rich social and physical support than through instruction that attempts to teach abstract schemas. Within such environments, individuals may first participate on the periphery of the group or with high-levels of support and gradually transition to more independent and central forms of operation as their expertise and comfort level increases (Lave & Wenger, 1991). Because cognition is so situated, the story goes, it is hard to uproot patterns of cognition and transplant them into very different contexts where they can still thrive. Interventions consistent with this view include, for example, the CSILE collaborative online knowledge building environment mentioned earlier (Scardamalia, Bereiter, & Lamon, 1994), and the Jasper Woodbury program, which helps youngsters build mathematical skills and insights through situating problem solving within compelling narratives and by making it a social endeavor (Van Haneghan et al., 1992).

This triple challenge to the prospects of transfer seems daunting indeed. However, it is important to emphasize that these critiques by and large address the prospects of *far* transfer. They allow ample room for CSILE, the Jasper Woodbury program, writers' workshops, design studios, philosophy classes and the like, where the aim is to get better at a particular kind of thinking.

Second, the positions on transfer, expertise, and situated cognition just outlined have their critics as well as their proponents. Many moderate positions take the most severe implications of these views with a large grain of salt. For example, Salomon and Perkins (1989) outlined a two-channel model of transfer specifying conditions for transfer by way of reflective abstraction and by way of automatization of routines, pointing out that there certainly were some successes reported in the transfer literature, and explaining a range of failures by the absence of conditions that would support transfer along one channel or the other. In similar spirit, Gick and Holyoak (1980, 1983) (see Holyoak, Chap. 6) demonstrated effective transfer between quite different problem-solving contexts when subjects spontaneously or upon prompting reflectively abstracted underlying principles. Bassok and Holyoak (1993) summarize experiments by making the case that superficial content context was not as limiting as some had argued. In many cases, learners bridged quite effectively from one content context to another quite different, although mismatches in the character of key variables in source and target sometimes induced considerable interference. Bransford and Schwartz (1999) urged reframing the problem of transfer in terms of readier learning in the future, not of direct gains in performance, arguing that this afforded ample opportunity for far transfer.

Turning to the theme of expertise, it can be acknowledged that a rich collection of schemata constitutes an essential engine for high-level thinking in a domain. Although necessary, however, this engine is not sufficient. Expert status does not protect a person from blind spots such as failure to examine the other side of the case (Perkins, Farady, & Bushey, 1991). Indeed, people who "ought to know better" can behave with remarkable obtuseness (Sternberg, 2002). In keeping with this, many norms and heuristics for good thinking address not the complex knowledge characteristic of domain mastery but broad patterns of processing, such as engaging anomalies seriously, examining other perspectives, or questioning assumptions, the neglect of which commonly entraps even those with well-developed knowledge in a domain (see Chi and Ohlsson, Chap. 16).

Moreover, expert thinking is misleading as a gold standard. Producing expert thinking by no means is the sole aim of the teaching of thinking. In many contexts, good thinking needs to be understood not as good-for-an-expert but good-for-a-learner or good-for-an-amateur. Some scholars have observed that there seems to be such a thing as "expert novices," and "expert learners" who bring to learning situations a range of attitudes and strategies highly conducive to developing expertise more quickly (Bereiter & Scardamalia, 1993; Brown, Ferrera, & Campione, 1983; Bruer, 1993). Moreover, in many facets of complex modern life – consider filing income taxes, functioning as responsible citizens, purchasing a new car or home – most of us operate as perpetual amateurs. We do not engage in such activities enough to build deep expertise. The question is less whether good general thinking enables us to behave like an expert – it does not – and more whether good general thinking enables us to perform better than we otherwise would by leveraging more effectively what knowledge we do have and helping us to acquire more as we go.

Turning to the related theme of situated knowledge, Anderson, Reder, and Simon (1996) identified four core claims characteristic of the situated position – that action is grounded in concrete situations, knowledge does not transfer between tasks, training by abstraction is of little use, and instruction must be done in complex social environments – and proceeded to summarize empirical evidence contrary to all of them as universal generalizations. Bereiter (1997) and Salomon and Perkins (1998) underscored how learners productively learn under many degrees and kinds of social relations and situatedness. Greeno, Smith, and Moore (1992) offered an account of transfer from the perspective of situated cognition, explaining how people sometimes export systems of activity to other superficially quite different contexts. The point of all this is certainly not to argue the opposite – that transfer comes easily, expertise depends largely on general cognitive capabilities, and learning is not somewhat entangled in its particular contexts – but rather to point out that the most dire readings of the prospects of transfer do not seem to be warranted.

Although the foregoing treats the general debate, the evidence on transfer from efforts to teach thinking also warrants consideration. As cited earlier, Nisbett (1993) summarized a number of studies in which efforts to teach statistical, if–then, cost–benefit, and other sorts of reasoning had led to transfer across content domains. As emphasized under the first challenge we addressed, there is considerable evidence for persistent far transfer of improvements in thinking from a number of studies. The signs of such transfer include impact on general reading skills, IQ-like measures, thinking in various subject matters, the general cognitive competence of retarded people, and more. It will be recalled that the philosophies and methods of these programs are quite diverse, with some using rather abstract tasks well removed from any particular subject matter or natural community.

In summary, we suggest that the debate around transfer, expertise, and situated learning has been overly polarized and ideological, leading to sweeping declarations on both sides regarding what is possible or impossible that do not stand up to empirical examination. The relationship between general cognitive structures and particular situations perhaps needs to be understood as more complex and dynamic. Perkins and Salomon (1989) offer the analogy of the human hand gripping something. The human hand plainly is a very flexible general instrument, but it always functions in context, gripping different things in different ways. Moreover, we need to learn to grasp objects according to their affordances: You don't hold a baby the same way you hold a brick. Likewise, one can acknowledge a broad range of general strategies, cognitive operations, and schemata without naïvely holding that they operate in context-neutral ways. Adjustments are always made, sometimes easily, sometimes with difficulty. Skilled cognition involves complex interarticulations of the general and the specific.

So the prospects of transfer escape these skirmishes with skepticism – but not unscathed! Indeed, there are pointed lessons to be drawn. We can learn from research on the difficulties of transfer that transfer is nothing to take for granted. Well-designed efforts to cultivate thinking will face up to the challenge, for instance by incorporating episodes of reflective abstraction to help learners to decontextualize patterns of thinking and by providing practice across multiple distinct contexts. Well-designed efforts to cultivate thinking will look closely at the behavior of experts to construct their heuristic analyses, and will not expect general norms and heuristics to do the job of norms and heuristics tailored to particular endeavors such as writing or mathematical problem solving. Well-designed efforts to cultivate thinking will recognize the distributed nature of cognition, and take advantage of social and physical support systems to advance individual and collective thinking.

The Challenge of Creating Cultures of Thinking

Thus far, we've examined four challenges that efforts to teach thinking traditionally have faced. As teachers and program developers seek to meet those challenges, a host of additional concerns arise: For example: How do we provide enough time, context, and diverse applications so that new patterns of thinking actually take hold? How can we best take into account that school learning happens in a social context within a classroom among a group of individuals? Is the development of individual thinking best served and supported by the development of group learning practices? How do we uncover the thinking that is going on in individuals and within the group so we can respond to it and learn from it? These questions connect us to our last and final challenge, the challenge of creating cultures of thinking.

Culture has been mentioned briefly in previous sections, but one still might ask: What is it about culture, and cultures of thinking in particular, that demands attention (see Greenfield, Chap. 27, for further discussions on the role of culture)? Three important motives are worthy of attention: First, of the supporting structures of culture are needed to sustain gains and actualize intelligent behavior over time, as opposed to merely building short-term capacity (Brown & Campione, 1994; Scardamalia et al., 1994; Tishman, Perkins, & Jay, 1993). It is through the culture of the classroom that strategies and practices take on meaning and become connected to the work of learning. Second, culture helps to shape what we attend to, care about, and focus our energies upon (Bruner, Olver, & Greenfield, 1966; Dasen, 1977; Super, 1980). Thus, culture is integrally linked to the dispositional side of thinking and to the cultivation of inclination and sensitivity. Third, researchers and program developers increasingly have recognized that thinking programs are not merely implemented but are enacted, developed, and sustained in a social context. As a result, they have found it necessary to move away from teacher-proof materials, which view learning as an isolated individual process, and toward approaches that pay more attention to the underlying conditions of learning.

As a result of the awareness of the role culture plays in learning, the past two decades have seen efforts to teach thinking shift from programmed strategy instruction aimed at students as individuals to broad-based approaches aimed at building classroom cultures supportive of the active social construction of knowledge among groups. These approaches take a variety of forms, such as cognitive apprenticeship (Collins, Brown, & Newman, 1989), fostering a community of learners (Brown & Campione, 1994), group knowledge building (Bereiter & Scardamalia, 1996; Scardamalia & Bereiter, 1996), inquiry-based teaching (Lipman, 1983), and the development of patterns of thinking (Tishman, Perkins, & Jay, 1995) and habits of mind (Costa & Kallick, 2002). Several programs associated with these approaches were mentioned previously – CISLE/Knowledge Forum, Philosophy for Children, and Keys to Thinking among them. We'll examine a few additional ones subsequently. Before doing so, however, it may be useful to take a closer look at just what is meant by culture in the cultural approach.

Culture, construed broadly, refers to the context and general surround in which we operate. This doesn't tell us much about the what it means to become enculturated, however. To illuminate this issue it is helpful to look at particular intellectual subcultures or communities of practice, say of mathematicians or writers or even mechanics. What does it mean to be a part of these cultures? A frame that we have found useful is based on two top-level conceptions: *resources* and *practice* (Roth, 1995). Resources are the things upon which members of the culture of practice draw they do their work. Resources can be physical in nature: computers, books, instruments, tools, and the like. There are also social resources such as colleagues, coworkers, editors, peer-review boards, and so on. These types of resources help distribute cognition outside the individual thinker's mind (Salomon, 1993). In addition, there are conceptual resources, consisting of the conceptual, knowledge, and belief systems in which the subculture readily traffics. Also included in the conceptual resources are the symbol systems and notational structures evolved to support abstract thought (Gardner, 1983; Goodman, 1976; Olson, 1974).

Practice captures the constructive acts engaged in by the cultural group, what it is they do, the kind of work that is valued and rewarded, the methods they employ. This connects the group to the socio-historically valued ways of knowing and thinking, such as the epistemic forms of the disciplines that are part of the group's heritage (Collins & Ferguson, 1993; Perkins, 1994, 1997). Resources and practice interact dialectically in that individual and group practice transform resources that, in turn, have an effect on practice. At the same time, resources and practice provide supports for distributed intelligence, scaffolding intelligent behavior beyond that which can be displayed by an individual mind (Salomon, 1993).

This dialectical interplay between practice and resources informs our understanding of just what it is in which individuals become enculturated. But, how does this enculturation happen? How are a culture's practice and resources conveyed and learned by group members? In a study of thoughtful classrooms, Ritchhart (Ritchhart, 2002) identified seven cultural forces at work in classrooms that facilitated the process of enculturation in thinking: (1) messages from the physical environment about thinking, (2) teacher modeling of thinking and dispositions, (3) the use of language of thinking, (4) routines and structures for thinking, (5) opportunities created for thinking, (6) conveyance of expectations for thinking, and (7) interactions and relationships supportive of thinking.

These cultural forces act as direct and indirect vehicles for teaching. For example, the use of routines and structures for thinking, which connects to the idea of norms and heuristics mentioned previously, is a highly integrated but still direct form of teaching. By introducing "thinking routines" (Ritchhart, 2002), teachers provide students with highly transportable tools for thinking that they learn in one context and then transfer to other situations over time until the strategy has become a routine of the classroom. We and our colleagues are currently capitalizing on this approach in the design of a new thinking program. The use of the language of thinking (Tishman & Perkins, 1997) – which includes *process* (justifying, questioning, analyzing), *product* (theory, conjecture, summation), *stance* (challenge, agree, concur) and *state* (confused, puzzled, intrigued) words – is a much more indirect method of promoting thinking that gives students the vocabulary for talking about thinking. By combining the direct (routines and structures, and opportunities) and the indirect (modeling, language, relationships and interactions, environment, expectations), a culture of thinking is built and sustained.

One can see these cultural forces at play in the Community of Learners approach (Brown & Campione, 1994). In this approach, a premium is placed on research, knowledge-building, and critical thinking, communicating expectations for thinking to students through the types of opportunities provided. In this environment, individual responsibility is coupled with the communal sharing of expertise. Discourse (constructive discussion, questioning, and criticism) is the norm, making use of the language of thinking and interactions and relationships supportive of thinking. Ritual, familiar participant structures, and routines were introduced to help students navigate and work within the new culture. All of this was accomplished within an environment that made thinking visible for students.

Research suggests that, at least in this particular case, a broad-based cultural approach was superior to one based on teaching heuristics. Approximately ninety fifth and sixth graders in the Community of Learners (CL) group outperformed a group using only a reciprocal teaching technique in which students led the learning in reading discussions (and this result occurred even though the group was given twice as much practice as the CL group) on criterion-referenced tests of reading comprehension. There was no improvement in a reading-only control group. Scores on questions dealing with inference, gist, and analogy improved dramatically. The results show magnitude of effects but require further study to assess the generality and persistence of effects. Further research is needed to determine whether the effects are sustaining in the sense of ongoing repertoire, the ultimate goal of a cultural approach, or whether their impact is limited to behaviors in the immediate environment.

A common thread running through cultural approaches to teaching thinking is the effort to make thinking visible, often through the various cultural forces. This occurs as teachers model their thought processes before the class, students are asked to share their thinking and discuss the processes they went through in solving problems or coming to conclusions, group ideas and conjectures are recorded and reviewed, the artifacts of thinking are put on display in the classroom, and so on. At the heart of these efforts lies reflection on one's thinking and cognitive monitoring, the core processes of metacognition. Ultimately, teaching students to be more metacognitive and reflective, providing rich opportunities for thinking across various contexts, setting up an environment that values thinking, and making the thinking of group members visible contribute a great deal to the formation of a culture of thinking. The cultural forces can be leveraged toward this end. Within such a culture of thinking, other efforts to teach thinking, both formal and informal, have a greater likelihood of taking hold because they will be reinforced through the culture and opportunities for transfer and reflection will increase.

In summary, in some sense, a fully developed culture of thinking in the classroom or, indeed, in other settings such as the home or the workplace, represents the cohesive culmination of the separate challenges of achieving results, defining the thinking, attaining transfer, and attending to thinking dispositions. A thoroughgoing culture of thinking attends to all of these. Unfortunately, the converse is certainly not so. It is possible to attend assiduously to the first four – say, every Tuesday and Thursday from 11 to 12, or when we do math projects for a day at the end of each unit – and still fall far short of a pervasive culture of thinking. Results reviewed earlier in this article suggest that even limited treatments may well benefit students' thinking. However, one has to ask about the rest of their learning. In the end, the point of a culture of thinking is not just to serve the development of thinking but to serve the breadth and depth of students' learning on all fronts.

Conclusions and Future Directions

This review of the teaching of thinking has cast a wide net to look at programs for which adequate data exist for examination and discussion. These programs address a great variety of thinking – creative and critical thinking, problem solving, decision-making, and metacognition, as well as subject-specific types of thinking. Even so, we have only scratched the surface of the ongoing efforts to teach thinking. Why does the teaching of thinking continue to be such a central question in education? Why do we even need to teach thinking? As discussed earlier, efforts to teach thinking deal with both amplifying native tendencies and addressing problems of thinking shortfalls. In addition, a major goal of most thinking interventions is to enhance learning and promote deeper understanding. The idea that deep and lasting learning is a product of thinking provides a powerful case for the teaching of thinking. Indeed, we venture that the true promise of the teaching of thinking will not be realized until learning to think and thinking to learn merge seamlessly.

Toward this end, we singled out five challenges that must be dealt with along the way. The first addressed the question of whether or not thinking can be taught with some reasonable signs of success. We reviewed several programs as a kind of existence proof that, indeed, it is possible to produce impacts with substantial magnitude, persistence, and transfer. These programs spanned a variety of philosophical and methodological approaches, while sharing the common characteristics of increasing the demand for thinking, developing thinking processes, and paying attention to metacognitive self-regulation. These common demand characteristics appear to be key elements in the teaching of thinking.

The second challenge concerned what one means when one talks about good thinking. We showed how efforts to teach thinking are shaped largely by how they answer this question. Thus, the content, sequence, and methods of instruction for a particular intervention arise from a single or collective set of grounding theories, be they linked to norms and heuristics, intelligence, or human development. Interestingly, programs with quite different theories seem to have achieved substantial success. Why should this be? Does theory matter at all? As with the first challenge, the answer to effectiveness may lie more with certain demand characteristics of programs than with any single theoretical approach. Increased explicit involvement with thinking and systematic attention to managing one's thinking may be the most critical conditions. To untangle this issue empirically, one would need to compare the effectiveness of programs with different theoretical bases but with the same demands for thinking and reflection. Unfortunately, it is rare in the literature on the teaching of thinking to find pitted against one another alternative approaches addressing the same kinds of thinking and the same sorts of learners.

The third challenge dealt with the dispositional side of thinking. We showed how the effective teaching of thinking is more than just the development of ability, demanding the development of awareness and inclination as well. In particular, the lack of a sensitivity to occasions for thinking appears to be a major bottleneck when it comes to putting one's abilities into action. It is our belief that some programs accomplish this. Although most data focus on abilities, leaving impact on sensitivity and inclination unassessed, there are a few indications of impact on dispositions. Certainly, more work is needed in this area.

Transfer, a pivotal concern within the teaching of thinking, constituted our fourth challenge. Although some have argued that transfer cannot be obtained because all knowledge is bound to context, the empirical record of successful programs has shown clearly that some degree of transfer is possible across domains of content knowledge. This is by no means automatic, however. Transfer must be designed deliberately into interventions by highlighting key features of the situation that need attention, promoting reflective abstraction of underlying principles, and providing practice across multiple contexts. Even then, one is more likely to see near transfer of thinking to similar contexts than far transfer.

Our fifth challenge, that of creating cultures of thinking, examined the social context and environment in which thinking is fostered. Efforts to teach thinking cannot be removed from their social context. Context provides important avenues for the development of supporting inclinations toward thinking, learning from more accomplished peers, focusing attention, and access to the resources and practices of the group. In classrooms, a set of cultural forces directs and shapes students' learning experiences both directly and indirectly. These cultural forces convey to students how much and what kinds of thinking are valued, what methods the group uses to go about thinking, and what expectations there are regarding thinking. Furthermore, the thinking of individuals and groups is made visible through these forces.

Our review of these five challenges suggests several fronts for further investigation:

- The questions of transfer and sustained impact need to be better understood. In particular, little is known about the impact of extended interventions. One might expect that broad multi-year interventions would yield wide impact sustained for many years, but the empirical work has not been done to our knowledge. Relatedly, what would be the effect of a cross-subject thinking intervention in which students encounter the same practices concurrently in multiple disciplines?
- An exploration of the trade-offs among the norms and heuristics, models of intelligence, and developmental approaches is needed to better understand the role of theory in successful interventions. How and where does the underlying theory of thinking matter? When demands for thinking are held constant, does one theoretical approach work better than another? What is it that makes successful programs work? What characteristics and practices are most pivotal to success?
- Within the realm of thinking dispositions, there is much to be learned. How successful are existing programs at developing the dispositional side of thinking? What kinds of practices and interventions effectively foster students' inclination and sensitivity? Are dispositions bound to the social context in which they are developed or do they transfer to new settings? How does attention to the development of sensitivity to occasions affect transfer of thinking skills? Efforts to teaching thinking skills are sometimes done in a limited time frame, raising the question: What is the appropriate time frame for the development of dispositions?

Perhaps the biggest question about the teaching of thinking concerns how to integrate it with other practices, in school and out of school, in an effective way. We already know enough about the teaching of thinking to have a substantial impact, and yet the reality of collective practice falls short. We must ask ourselves: How can thinking initiatives be sustained and integrated with the many other agendas faced by schools, museums, clubs, corporate cultures, and other settings in which thinking might thrive? Only when we understand how to foster cultures of thinking not just within individual families or classrooms but across entire schools, communities, and, indeed, societies, will scholarly insights and the practical craft of teaching thinking achieve their mutual promise.

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