Educating for Insight

By using mental models, coaching for "understanding performances," and teaching for transfer, teachers can promote thoughtful learning in their classrooms.

D. N. PERKINS

Recently my 12-year-old son Tom asked, "Did you ever notice how statements can be questions?" I probed for an example, and Tom had one ready. "Well, maybe Mom says, 'I'm going down to the bank.' She's asking do I want to go with her to stop by the place nearby and rent a videogame?" So, of course, Tom got some praise for his insight into the form-doesn't-always-fit-function character of language.

Tom, a reflective fellow, has odd insights like that from time to time. So, I've found, do many other youngsters. But these *insights* do not so often concern school topics. Insight is alive and well . . . and living in Argentina.

The Opposite of Insight

Well, at least not living in school—its natural home—as often as we would like. We simply do not get enough insight into the subject matters. This reality has become especially conspicuous over the past several years as the spotlight has turned on youngsters' achievement in mathematics and science. Cognitive scientists investigating how children learn these subject matters have discovered almost the opposite of insight. If the word *insight* suggests particularly deep understanding, researchers have found that students often have a strikingly superficial understanding of what they have been taught (Gardner, in press; Perkins, in press; Perkins and Simmons 1988).

For example, even college students who have had formal instruction in physics commonly do not understand what Newton's laws really say about the way objects move in the world. They make mistaken predictions in simple qualitative situations, even though they may be able to wield the equations to solve technical problems (e.g., Clement 1982, 1983; McCloskey 1983). For another example, many youngsters have only the vaguest sense of the relative size of fractions: they have trouble placing fractions on a number line. They have difficulty recognizing that 3/12 is the same as 1/4 (Behr et al. 1983, Lesh et al. 1983).

While one might hope that students show more insight in the less technical subject matters—English and history, for example—realistically there are little data to encourage such a conclusion. For instance, reading scores on inference-making from passages that students read leave much to be desired (e.g., Mullis 1984). For another example, many students believe that good reasoning means building up the strongest possible case on one side, rather than looking at both sides—a misconception about the nature of reasoning not unlike some of the misconceptions about key concepts in science (Baron 1988). Any teacher who gives essay assignments has seen the lack of depth in many students' writing.

All this is a familiar tale. There is little need to document it in detail here. So my colleagues Howard Gardner, Vito Perrone, and I have launched a long-term inquiry, with support from the Spencer Foundation, into approaches to teaching for deep understanding (that is, insight), in partnership with other university- and school-based collaborators. One of the earliest points we discovered was heartening indeed. Virtually all teachers are concerned about understanding and strive to teach for understanding. There is no absence of will! Moreover, some teachers teach in ways that seem likely to help students learn with deeper understanding—such as helping students to relate school concepts to everyday life, or using hands-on examples. Even so, we are not getting as much insight, that is, deep understanding, as we would like. Why not? And what can be done about it?

The Enigma of Insight

There are reasons why educating for insight may be singularly challenging. One of the most central is the enigmatic character of the goal. What, after all, is it to understand something deeply? A contrast with knowing helps to make clear how poorly we understand understanding. We grasp pretty well what it is for someone to know something: he or she has information in storage and can retrieve it on call.

However, for someone to *understand* something—say Newton's laws or the principle of supply and demand—what must he or she be able to do? Certainly just knowing either one will not do. Whatever understanding is, it plainly goes beyond stored information.

In our early work on teaching for insight, we have evolved a useful clarification about the nature of understanding. Often, people speak of "having an understanding" of something. We believe that this is misleading. Understanding, we suggest, is more a matter

of what people can *do* than something they have. Understanding involves action more than possession (Gardner, in press; Perkins 1989, in press; Perkins et al., in press).

In particular, there are many actions of mind that might be called "understanding performances." When people show these actions, then, we see evidence that they understand something. Suppose, for example, that a learner can *explain* the law of supply and demand in his or her own words (not just reciting a canned definition), can *exemplify* its use in fresh contexts, can *make analogies* to novel situations (let us say to grades in school rather than to the cost of goods), can *generalize* the law, recognizing other laws or principles with the same form, and so on. We probably would be fairly impressed by such a learner's insight into the law of supply and demand.

In other words, we recognize understanding when someone can display such "understanding performances." There is no official list of understanding performances; anything in the same spirit will do. But one thing *not* on the list is mere remembering; another is rote execution of a plan, such as the long division algorithm. Indeed, a key requirement for an understanding performance is significant novelty: explanation has to be in your own words, analogies must be fresh, not canned, and so on.

Of course, what is novel to the learner may not be to the teacher. Understanding performances need not represent discoveries new to all of human civilization or even to the classroom in question. They just need to stretch the learner somewhat. To put it another way, a number of years ago Jerome Bruner (1973) wrote about the power of the human cognitive system at "going beyond the information given." When people go conspicuously beyond the information given (in reasonable ways), then we recognize that they understand.

At this point, someone might query, "But you are simply characterizing insightful behaviors—what people can do when they understand something deeply. What is insight on the *inside*, psychologically, in the mind?" A good question, but one with a complicated answer. In our view, no one thing "in the mind" equips a person for understanding performances. Rather, several factors contribute: knowledge, to be sure; "mental models"—informative images and other concise mental representations that enable reasoning; patterns of reasoning that allow one to extrapolate; and more.

I will not pursue the inner mechanisms of understanding here. For now, it is enough to emphasize that understanding goes beyond knowing through involving readiness for a wider range of characteristic performances—not just retrieving information but explaining, exemplifying, generalizing, analogizing, and so on in the same spirit, always with an emphasis on significant novelty.

John McNamara

Having students design their own experiments is one way teachers can provide classroom activities that lead to "understanding performances."

Shortchanging Insight

This brings us to a simple and compelling diagnosis of why we do not see as much understanding as we would like to in youngsters. The performance model of understanding plainly implies that developing insight into a topic requires developing a range of *understanding performances* around the topic. Yet when, in typical instruction, do students have a chance to build such performances? How often are they asked to explain the law of supply and demand? Or make an analogy with it? Or generalize from it? Or make up their own examples of it? And so on.

Instead, students are usually asked to apply curricular concepts to a few well-defined cases of limited range in a fairly rote manner, with little of the "going beyond the information given" that Bruner celebrated. No wonder students do not develop insight into many important concepts: they have little opportunity to practice and refine the kinds of understanding performances that would constitute insight.

Avenues to Insight

All this writes a rough prescription for teaching for insight: whatever else hap-

pens, youngsters must have ample opportunity to engage in and refine understanding performances, if they are to develop insight into subject-matter topics. This discloses a deep connection between educating for insight and another agenda that has been much on the mind of educators in recent years: the teaching of thinking (e.g., Baron and Sternberg 1986, Chipman et al. 1985, Nickerson et al. 1985, Segal et al. 1985).

Often, the teaching of thinking has been pursued as something for its own sake—and it is indeed a worthy educational agenda. However, psychologists, philosophers, and educators have emphasized a point supported by a wide range of research: effective learning means *thoughtful* learning. Learners do not achieve well-understood and actively used bodies of knowledge through rote learning. Rather, thoughtful learning rich with connection-making is needed for insight and for the lively and flexible use of knowledge (e.g., Bransford et al. 1989, Craik and Lockhart 1972, O'Neil 1978, O'Neil and Spielberger 1979).

How does one approach such thoughtful learning in the classroom? We look to three important elements: (1) constructing the curriculum out of *generative topics* that engage students deeply and encourage connection-making; (2) deploying *ways of teaching for understanding* that help students to build understanding performances; (3) emphasizing *assessment in context*, which, rather than treating testing as separate matter, includes in the instruction itself complex authentic tasks that gauge students' progress for their and the teacher's benefit..

In this article, I concentrate on the middle of this triad, ways of teaching for understanding. Inevitably there are many ways. Here we'll look at three: teaching with mental models, coaching understanding performances, and teaching for transfer. These three are certainly not unique to our work, but our university- and school-based collaborators are beginning to try them out with attention not only to pedagogical effectiveness but practical classroom viability.

Teaching with Mental Models

One approach we are pursuing highlights the role of "mental models" in enabling understanding performances. A number of psychologists have emphasized that concise mental representations of a topic, often but not always imagistic in character, play a key role in bad and good thinking about the topic. Sometimes misconceptions about important concepts reflect misleading mental models of the topic itself or the subject matter within which it sits (e.g., Clement 1983, diSessa 1983, Perkins and Simmons 1988). On the positive side, investigations by Richard Mayer and others have shown that introducing students to carefully crafted mental models of important concepts can boost their understanding considerably (Mayer 1989, White 1984, White and Horwitz 1987).

Understanding is more a matter of what people can do than something they have. Understanding involves action more than possession.

How does one use mental models in instruction? Christopher Unger, a research associate at the Harvard Graduate School of Education, has organized our work in this area. Very often, teachers can make a good beginning by asking students to disclose their own existing mental models of the topic in question—through discussion, picturing, analogy, and other means. This gives teachers something to build on, alerting them to knowledge gaps and to misconceptions that need adjustment during the instruction.

Then teachers may present a prefabricated mental model. Or they may engage the students in revising and refining their existing mental models. For instance, Mayer (1989) employed diagrammatic models of radar and of the structure of computers to help students to understand these topics better. Such models set the stage for engaging students in a series of understanding performances, where they apply, explain, generalize, and so on, exercising their understandings and amplifying their reach.

Coaching Understanding Performances

Peter Kugel, a member of our research team and professor at Boston College, has guided work on another complementary approach to teaching for deep understanding. He calls it the "coaching" approach, an apt term where performances are concerned (cf. Collins et al. 1989). The performances in question are, of course, not playing football or acting on the stage, but *understanding* performances.

The coaching approach starts from the premise that people learn fundamentally by doing more than receiving—by acting on information and making up their own information more than just soaking up information. Accordingly, the insight-oriented classroom should feature students actively engaged in understanding performances much more of the time, and simply listening much less of the time.

This can mean many things. It can include, for example, writing across the curriculum, where students maintain diaries, produce mini-essays, write col-

laboratively, and play out diverse other writing activities—so long as the writing activities are conspicuously understanding performances. The more the writing goes beyond straight description and narrative of known events toward interpretation, generalization, argument, analogy, transformation, and so on, the more this is the case. It can also include students designing their own experiments, engaging in debates, acting out short stories, making up their own mathematical theorems, and similar activities.

Whatever the case, "coaching" gives a name to the kind of supportive activities the teacher needs to provide to keep these understanding performances alive and thriving. The adroit teacher-coach hints, advises, cajoles, motivates, forms partnerships among students, creates time—all the while encouraging the students as much as is practical to find their own ways with the task and to be ambitious about it. Of course, coaching and mental models are not in conflict; they readily combine, with the teacher coaching students in their development or application of better mental models.

Teaching for Transfer

A third approach, one which again can be used in combination with the others, emphasizes transfer of knowledge within and across the subject matters and into everyday life. As has been discussed in *Educational Leadership* before, students commonly do not transfer concepts and skills broadly; however, there are many ways to teach for transfer (Perkins and Salomon 1988; see also Salomon and Perkins 1989). Moreover, the act of transfer is an understanding performance: to find a possible relationship between a notion from math class and a point on the six o'clock news requires creating a generalization, an application, an analogy—some form of thoughtful connection.

Accordingly, we can teach for understanding by teaching for transfer. The artful teacher for transfer creates the expectation in students that there are connections to be made—connections with upcoming ideas in the same course, with ideas in other courses, and with out-of-school settings. The artful teacher for transfer coaches students in looking for connections worth making. The artful teacher for transfer ponders how widely key curricular concepts might be usefully applied, and ensures that students encounter a broad range of examples that stimulate generalization- and analogy-making, rather than the more typical narrow range.

Betty Buchignani

When teachers provide opportunities for thoughtful learning in their classrooms, students will demonstrate the insight that results from deep understanding of subject matter.

Toward the Connected Curriculum

In *Knowledge as Design*, I wrote with some vehemence about the "disconnected curriculum" (Perkins 1986). All too often, we teach skills and concepts disconnected from the purposes, the models, and the arguments that make them meaningful, that weave them into a larger tapestry of flexible and functional knowledge. Educators often seem to adopt a kind of "chocolate box" model of learning; they attempt to put more isolated chocolates of diverse flavors into the expanding chocolate box of the mind. Unfortunately, that is not the way understanding works.

Basically, "understanding performances" make connections. They do not merely retrieve information but put information into new relationships, interpreting, generalizing, applying, analogizing, and so on. Connection-making can thrive not only within the subject matters, but across the subject matters, which are, in many ways, artificial partitions with historical roots of limited contemporary significance. A concern with connecting things up, with integrating ideas within and across the subject matters, and with elements of out-of-school life, inherently is a concern with understanding in a broader and a deeper sense. Accordingly there is a natural alliance between those making a special effort to teach for understanding and those making a special effort toward integrative education.

In the spirit and under the banner of both, one can imagine a new look in the curriculums that evolve in the years to come, a new connectedness. The "connected curriculum" would shun something pernicious and emphasize something crucial. It would shun education which shortchanges insight into subject matter, which takes knowing a lot as a substitute for understanding, which tolerates the chocolate box model of learning—because learning like that will go

stale the week after the test. It would emphasize connection-making performances within and across subject-matter knowledge, performances that both build and show understanding. It would help to bring insight home to the classroom. □

References

Baron, J. (1988). *Thinking and Deciding*. New York: Cambridge University Press.

Baron, J. B., and R. S. Sternberg, eds. (1986). *Teaching Thinking Skills: Theory and Practice*. New York: W. H. Freeman.

Behr, M., R. Lesh, T. Post, and E. Silver. (1983). "Rational-Number Concepts." In *Acquisition of Mathematics Concepts and Processes*, edited by R. Lesh and M. Landau, pp. 91-126. New York: Academic Press.

Bransford, J. D., J. J. Franks, N. J. Vye, and R. D. Sherwood. (1989). "New Approaches to Instruction: Because Wisdom Can't Be Told." In *Similarity and Analogical Reasoning*, edited by S. Vosniadou and A. Ortony. New York: Cambridge University Press.

Bruner, J. (1973). "Going Beyond the Information Given." In *Beyond the Information Given*, edited by J. Anglin, pp. 218-238. New York: Norton.

Chipman, S. F., J. W. Segal, and R. Glaser, eds. (1985). *Thinking and Learning Skills, Volume 2: Research and Open Questions*. Hillsdale, N.J.: Lawrence Erlbaum Associates.

Clement, J. (1982). "Students' Preconceptions in Introductory Mechanics." *American Journal of Physics* 50: 66-71.

Clement, J. (1983). "A Conceptual Model Discussed by Galileo and Used Intuitively by Physics Students." In *Mental Models*, edited by D. Gentner and A. L. Stevens. Hillsdale, N.J.: Lawrence Erlbaum Associates.

Collins, A., J. S. Brown, and S. F. Newman. (1989). "Cognitive Apprenticeship: Teaching the Craft of Reading, Writing, and Mathematics." In *Knowing, Learning, and Instruction: Essays in Honor of Robert Glaser*, edited by L. B. Resnick, pp. 453-494. Hillsdale, N.J.: Lawrence Erlbaum Associates.

Craik, F. I., and R. S. Lockhart. (1972). "Levels of Processing: A Framework for Memory Research." *Journal of Verbal Learning and Verbal Behavior* 11: 671-684.

diSessa, A. (1983). "Phenomenology and the Evolution of Intuition." In *Mental Models*, edited by D. Gentner and A. L. Stevens, pp. 267-298. Hillsdale, N.J.: Lawrence Erlbaum Associates.

Gardner, H. (In press). *The Unschooled Mind*. New York: Basic Books.

Lesh, R., M. Landau, and E. Hamilton. (1983). "Conceptual Models and Applied Mathematical Problem-Solving Research." In *Acquisition of Mathematics Concepts, Processes*, edited by R. Lesh and M. Landau, pp. 263-343. New York: Academic Press.

Mayer, R. E. (1989). "Models for Understanding." *Review of Educational Research* 59: 43-64.

McCloskey, M. (1983). "Naive Theories of Motion." In *Mental Models*, edited by D. Gentner and A. L. Stevens, pp. 299-324. Hillsdale, N.J.: Lawrence Erlbaum Associates.

Mullis, I. V. S. (May 1984). "What Do NAEP Results Tell Us About Students' Higher Order Thinking Abilities?" Paper prepared for the Wingspread Conference on Teaching Thinking Skills, Wingspread Conference Center, Racine, Wis.

Nickerson, R., D. N. Perkins, and E. Smith. (1985). *The Teaching of Thinking*. Hillsdale, N.J.: Lawrence Erlbaum Associates.

O'Neil, H. F., ed. (1978). *Learning Strategies*. New York: Academic Press.

O'Neil, H. F., and C. D. Spielberger, eds. (1979). *Cognitive and Affective Learning Strategies*. New York: Academic Press.

Perkins, D. N. (1986). *Knowledge as Design*. Hillsdale, N.J.: Lawrence Erlbaum Associates.

Perkins, D. N. (1989). "Art as Understanding." In *Art, Mind, and Education*, edited by H. Gardner and D. Perkins, pp. 111-131. Urbana-Champaign and Chicago: University of Illinois Press.

Perkins, D. N. (In press). *Schools of Thought: The Necessary Shape of Education*. New York: The Free Press.

Perkins, D. N., and G. Salomon. (1988). "Teaching for Transfer." *Educational Leadership* 46 1: 22-32.

Perkins, D. N., and R. Simmons. (1988). "Patterns of Misunderstanding: An Integrative Model of Misconceptions in Science, Mathematics, and Programming." *Review of Educational Research* 58, 3: 303-326.

Perkins, D. N., D. Crismond, R. Simmons, and C. Unger. (In press). "Inside Understanding." In *Teaching for Understanding in the Age of Technology*, volume in preparation, edited by D. N. Perkins, J. Schwartz, M. M. West, and M. S. Wiskes.

Salomon, G., and D. N. Perkins. (1989). "Rocky Roads to Transfer: Rethinking Mechanisms of a Neglected Phenomenon." *Educational Psychologist* 24, 2: 113-142.

Segal, J. W., S. F. Chipman, and R. Glaser, eds. (1985). *Thinking and Learning Skills, Volume 1: Relating Instruction to Research*. Hillsdale, N.J.: Lawrence Erlbaum Associates.

White, B. (1984). "Designing Computer Games to Help Physics Students Understand Newton's Laws of Motion." *Cognition and Instruction* 1: 69-108.

White, B., and P. Horwitz. (1987). *ThinkerTools: Enabling Children to Understand Physical Laws* (BBN Inc. Report No. 6470). Cambridge, Mass.: BBN Laboratories Inc.

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