Chapter 1

Our Oldest Unchallenged Folk Theory at Last Faces Its Day of Reckoning

Something is going on in elementary schools across North America that might strike the detached observer as insane. Millions of dollars are being poured into high-tech equipment that is used mainly to produce the kinds of 'projects' that in an earlier day were produced using scissors, old magazines, and library paste. At the same time, and in the same schools, a back-to-basics movement has teachers obsessively concerned with covering traditional content and preparing students for tests.

One very naive response to this situation discerns no inconsistency. The computerized cut-and-paste work is believed to be teaching students computer skills that will insure their futures in the 21st century. It is therefore just another kind of skill practice to take its place with the more traditional drill in arithmetic, reading, and spelling. Adults are predictably overimpressed when children can do something they cannot. For instance, the things that can be done with photo image processing software these days look like magic, and when adults who have never encountered it before walk into a classroom and find 11-year-olds morphing images, changing coloration, and taking a figure from one image and planting it in another, they are likely to echo the words of a superintendent who exclaimed, "I think I have just seen the 21st century!" What they have seen, impressive as it may be, is however something that can be learned in two or three hours.

More sophisticated educators recognize that there is a conflict and try to resolve it. But conceptual limitations put creative solutions beyond reach, leaving grudging compromise as the only choice. Computer activities are categorized as 'constructivist.' The other kind are labeled 'traditional,' 'transmission model,' 'teacher-centered,' or perhaps even 'rote learning.' Such a categorization brings with it a baggage of false and stultifying beliefs which, however, remain hidden from view within the categorization and are therefore unlikely to be questioned. Constructivism is taken to mean independent hands-on activities, ignoring the outstanding examples of constructivist education that depend on teacher-led, highly focused inquiry (e.g., Hunt & Minstrell, 1994; Lampert, 1988). The possibility of finding a 'constructivist' way of meeting back-to-

basics demands for accountability is therefore virtually eliminated. Categorizing instruction of the 'nonconstructivist' kind as if it were something old and familiar wrongly implies that teachers already know how to do it and that it is an effective way to meet the demands for mastery of basic skills. That is usually far from the truth. Teachers are likely to have little knowledge of how to improve reading comprehension or how to overcome errors students make with fractions and decimals, two of the key requirements for improving achievement test scores.

Many different things are happening in education, some demonstrably good, some demonstrably bad, and many others of uncertain value. Yet in very fundamental ways, education is stuck. It doesn't know where to move and it doesn't have tools to move with. The dialogue, both within and outside the education profession, does not advance. The same blunt statements (including this one) are made over and over. The tools education needs are, of course, conceptual tools. In this so-called Knowledge Age, that is the first requirement in order for any human enterprise to advance. The argument I shall develop throughout this book is that education's conceptual tools are woefully inadequate. They are not even up to old tasks, such as the tasks of understanding a textbook or solving an algebra problem, let alone the new order of tasks that education must face in this era of global competition. Better tools are coming available, but it takes conceptual tools to understand and use them. The most basic of tools are our conceptions of knowledge and mind. That, I shall argue, is where change has to start if education is to become unstuck.

Knowledge is Everybody's Business

Knowledge used to be the sole province of philosophers; that is, philosophers were the only ones who studied and talked about knowledge as such. The rest of us might acquire, use, and perhaps even create knowledge, but we did not have to think about what any of that meant. In time social scientists began studying knowledge from the standpoint of the people who create and use it. The real territorial shift began, however, with the advent of cognitive science and it became decisive once the business world discovered knowledge and acquired a fascination with intellectual property, or

'IP' as it is familiarly called.[1] The barbarians are now within the gates. Perhaps philosophy's final loss of proprietorship over knowledge will be dated from 1997, when the Xerox Distinguished Professorship in Knowledge was established at the University of California, Berkeley—in the school of management, with the first occupant being a sociologist who made his name studying what he called 'knowledge-creating companies' (Nonaka, 1991).

In western philosophy, knowledge has typically meant something like true or warranted belief, usually in the form of propositions. When cognitive scientists began constructing computer models of human intelligence, knowledge in the form of propositions and rules played a central role. That is what made the models cognitive as opposed to behaviorist. But whether the propositions were true or not was irrelevant as far as understanding cognition was concerned. No one would imagine that the mind functions differently depending on whether it is operating on true propositions or false ones. Knowledge, accordingly, became whatever functions as knowledge in mental processes. Knowledge came to include beliefs of any sort and also to include rules that constitute know-how or skill (Anderson, 1983).

Cognitive science spawned practical applications in artificial intelligence and expert systems, and with the latter came a new occupation: knowledge engineering. In designing an artificial system to provide expert guidance in medical diagnosis, for instance, the best model will often be a human expert. But human experts, it was soon found, had limited ability to articulate the knowledge that seemed to be guiding their actions, and so it became the job of knowledge engineers to observe experts at work and, using a combination of detailed observation and probing questions, dig out the expert's covert knowledge and formulate it as rules and propositions that a machine could process. For business managers eager to capitalize on the new information technologies, this

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[1] The emergence of a sociology of knowledge has also been important, but not in quite the same way. Sociological ideas have directly influenced some philosophers, especially through the influence of Thomas Kuhn (1970), and thus have become assimilated into philosophy, whereas cognitive science and the commercialization of knowledge have appropriated knowledge and bent its meaning to their purposes.

development had a dual effect: It dramatized the importance and the vastness of knowledge that figures in expert performance. At the same time, it entrenched and gave an apparent scientific license for a simplistic conception of knowledge as items in individual minds.

Growing recognition of the economic importance of knowledge has brought all kinds of players into the knowledge arena who have no particular theoretical perspective on knowledge at all. Unhampered by philosophical or psychological strictures, they can shift indiscriminately between treating knowledge as stuff in people's heads and treating knowledge as stuff out in the world, to be found in books, patent applications, and the like. They do not distinguish between companies that strive to become better at what they are doing and companies whose work is to produce knowledge. Both are called learning organizations. They do not distinguish between knowledge that inheres in competence and knowledge that becomes negotiable property. Both are called intellectual capital (Stewart, 1997). As a result, there is no incisive way to talk about what is the main challenge for many organizations: How to get progressively more competent at producing advances in knowledge.

Despite these conceptual weaknesses, modern businesses are far in advance of the schools in understanding and appreciating the importance of knowledge. The Knowledge Age has not yet come to the schoolhouse. To many school people, knowledge is old fashioned, the stuff of pedants and test makers. Knowledge is what reactionary parents keep trying to force schools to go back to. Ever since the publication of Bloom's *Taxonomy of Educational Objectives* in 1956, educators in North America have been wedded to a hierarchical view of learning outcomes, with knowledge occupying the bottom rung. (More about this in Chapter 4). The upper rungs are occupied by 'higher-order thinking skills' or other elevated mental traits such as creativity. Business pundits, unhampered by requirements of consistency, buy all of this 'higher-order' talk as well. But they also value knowledge in a way that is foreign to the school world. They recognize knowledge as stuff to be produced and worked with.

I should make it clear from the beginning that I am to be counted among the barbarians. My interest in knowledge is practical, concerned especially with the improvement of education. But I have seen enough of the world outside education to be convinced that the muddles educators get into about knowledge are only a more acute form of the muddles people in the society at large are getting into.

They all have their source in conceptions of mind and knowledge that we acquire as children and never think to examine—because they seem to be given directly by experience and because no alternatives have ever been presented.

To put my present effort in perspective, it is at one remove from books on how to reform education or to reinvent businesses for the Knowledge Age. Instead, it develops a way to *think about* knowledge and mind when going about these innovative efforts. I do not believe managers and educators can get along indefinitely with a theory of knowledge acquired at their mother's knee. It is not that the theory is wrong. Better to say that it is obsolete. It is obsolete in much the same way as a five-year-old personal computer. It is still serviceable and for many ordinary uses it is perfectly adequate. It may even offer advantages over later models in simplicity and freedom from glitches. But there are new tasks—in multimedia and in communication, for instance—that the old machine either cannot handle or can handle only with considerable effort and ingenuity on the part of the user.

Folk Psychology and Epistemology

There is a commonsense psychology that we all develop in early childhood and that we use in making our way in a world whose most significant objects (for us) are other human beings. The central tenet of this psychology, as it develops among children in the Western world, is that people's behavior is determined by their beliefs and desires. It is well understood by six-year-olds, although not by three-year-olds, that other people's beliefs may differ from their own, but they also understand that they can, albeit imperfectly , infer other people's beliefs from their words and actions and from the facts of a situation (Astington, 1993).

Along with commonsense psychology comes a commonsense epistemology. Commonsense psychology posits a *mind*, which contains immaterial objects such as ideas, memories, facts, plans, goals, and principles. Commonsense epistemology posits a relationship between these things in the mind and an external world of observable things and actions. When this relationship is a correct one, the mental objects constitute *knowledge*. When the relationship is incorrect, we have false beliefs.

Together, the commonsense psychology and the commonsense epistemology make up what contemporary scholars refer to as "folk theory of mind." There is some dispute about calling it a theory, and I

do so only because it is a common and handy usage. But regardless of what scholars may decide to call it, it seems clear that to ordinary people what I described in the preceding two paragraphs is not a theory—not, that is, a set of propositions vulnerable to counterevidence. It is just the way things are.

Folk theories, however, generally have this aura of certainty rooted in direct experience. That the sun rises in the east and moves across the sky once seemed to be given directly by experience, to involve no conjecture or interpretation whatever, whereas what happens to the sun between the time it disappears in the west and reappears in the east is conjectural (and folk theories accordingly differ widely in what they say about it). To the modern mind, however, it is evident that the daytime cycle is also a matter of interpretation, even if not in quite the same way as what happens to the sun at night, and that interpreting it the way folk astronomy does gets one off on a wrong path for understanding the cosmos. Similarly, folk mechanics is based on the unquestioned observation that objects set in motion gradually lose their initial impetus and come to rest. From the standpoint of Newtonian mechanics, we can now recognize that loss of impetus, far from being an uncontaminated observation, is an inference that must be questioned in order for physics to progress.

The mind is popularly regarded as mysterious. There are all kinds of questions for which folk theory of mind provides no answers: why we remember some things and forget others, how ideas come about, the nature of dreaming, and so on. What seems to be given directly by experience is the existence of the mind itself and its contents: beliefs, desires, memories, ideas, dreams—the whole carload of mental luggage. This is what, to the folk way of thinking, seems to be beyond question, the solid rock on which conjectures and theories must rest. There is this about folk theory of mind, however, which sets it apart from other folk theories and may explain why it has survived while other folk theories have fallen before the march of science: Although it may be difficult, we can begin to conjure up doubts about almost anything that we perceive in the external world. In fact, playing with the idea that there is no world out there, that it is all a dream, is a favorite amusement of young people just awakening to the possibilities of philosophy. But to doubt our experience of the mind seems self-contradictory; for isn't the doubt itself an experience of the very kind we are supposing might be denied? That is the line of

reasoning Descartes pursued, in trying to find a foothold of certainty, something on which a sure understanding of the world could be based. But might it not be that what we think we experience so directly as mental events is already heavily interpreted in ways we fail to imagine?

When Folk Theories Give Way to Science

The term "folk theory" is used in several different ways. According to one usage, folk theories are what people believe in the absence of scientific theories. In ancient times folk theories were all there were. Then along came science, and by now most educated people have adopted scientific theories. According to this usage, folk theories are to be found mainly among primitive peoples and among children who have not yet been instructed in science.

According to the usage I will adopt here, however, folk theories are whatever theories or conceptual frameworks people pick up from popular culture and use in their daily efforts to make sense of events and plan their actions. We all acquire folk theories, and are apt to go on using them except when we get far enough into some endeavor that we need specialized knowledge. Folk theories, thus conceived, are not necessarily rigid things, insensitive to evidence and closed to novelty. They change as new facts and ideas are absorbed into popular culture. The kind of folk theory of disease that children grow up with in modern nations is radically different from the folk theory of a few hundred years ago. Germs now play a central role. Although folk theory offers little explanation of how germs cause disease, the notion of evil, fast-breeding little creatures invisibly pervading the environment provides a basis for hygenic practices that would have been meaningless to people of an earlier age.

Shouldn't we say, then, that modern people hold a scientific theory of disease—even if it is a limited and distorted one—rather than a folk theory? This is a definitional issue that could be decided either way, but I think we will get farther in our inquiry into the educational implications of theories of mind if we follow the definitional course I have proposed: Ordinary people in the modern world hold and generally function according to folk theories of disease, but these are theories that have been significantly influenced by medical science. One reason for treating the matter this way is that it allows us to consider reverse influences: how medical science might be influenced by folk theory—not folk theories of remote times

and places but the folk theories today's doctors acquired as children, growing up in middle-class suburbs, watching the Saturday morning television cartoons, being lectured to by their parents about what they should and shouldn't put into their mouths. Folk notions, being largely unarticulated and unexamined, can influence the way people interpret and apply scientific information. While these influences might be subtle in the case of medicine, the influence of folk theory of mind on scientific psychology and philosophy turns out, as will become evident later, to be obvious and profound.

Although higher learning may turn some of us into behaviorists who reject the notion of mind, idealists who deny there is a reality to which beliefs correspond, or antifoundationalists who deny there is a basis for comparing one belief to another, in our daily lives we continue to function according to the psychology and epistemology that we acquired in early childhood. There seems to be no practical alternative.That is probably true, as far as everyday life is concerned. Folk theory of mind is so intricately woven into the social fabric that there is no telling what would be left if we tried to remove it. Consider such socially important concepts as lying, pretending, promising, knowing, and joking. Everything from a criminal court decision to the fate of a friendship can turn upon whether one of these concepts is thought to apply. But each of these concepts distinguishes a relation between something overt and something in a person's mind. Joking is saying something untrue but without the intent that others will believe it; lying is the same thing, but with the intent to be believed. The capacity to hold a theory of mind seems to be an evolved capacity, with evidences of it in other primates (Premack, 1996). As humans evolved talents for cheating, lying, pretending, promising, making truth claims, and joking, the ability to detect and distinguish among these would become important survival skills (Barkow, Cosmides, & Tooby, 1992). A complementary notion, however, is that only having a theory of mind enables us to do such things. Chimpanzees, according to this reasoning, are not by nature less deceitful than we are, they are simply not as good at imagining themselves into one another's minds.

The fact that folk theory of mind serves us well in daily life does not mean, however, that it also serves well in all the more specialized activities of a modern society. There are other bodies of commonsense knowledge that serve us well in ordinary circumstances but that fail more severe challenges. I have already

referred to commonsense astronomy, according to which the sun rises each day and moves across the sky, and commonsense physics, according to which objects in motion slow down as they lose impetus. There is also a commonsense botany according to which plants draw food from the earth. These commonsense bodies of knowledge have proved sufficient not only for the unspecialized needs of daily life but also for practical arts, such as ocean navigation and farming. But they are completely inadequate for establishing a colony on the moon, for instance. For that we need sciences that do not merely extend commonsense knowledge but replace it by principles that hold more generally.

Teaching is a practical art, and it is safe to say that throughout its history it has relied on folk theory of mind.[2] It has served us up till now, but I do not want to concede that it has served us well. Such a judgment depends on what education might be if yoked to a different theory of mind. While I do not want to concede that folk theory of mind has served education well, I also do not want to attribute all of education's present ills to bad theory. Everything that goes on in education is bitterly contested by people who claim to have a better

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[2] American education is commonly said to have been dominated by behaviorism during a substantial portion of the twentieth century, which would imply that education during this period eschewed folk theory of mind in favor of a theory that recognized only overt behavior and regarded education as the shaping of a behavioral repertoire. There is no question that behaviorism had an influence. It was, and in many places still is, manifested in practices such as the following:

- breaking instruction down into small steps
- formulating "behavioral objectives," which generally amount to replacing traditional objectives with indicators used to assess them
- using frequent small rewards rather than punishment and reprimand
- paying less attention to issues of understanding and more to issues of performance and conduct

These could add up to significant changes in the conduct of schooling, but they are all easily accommodated by folk theory of mind. Furthermore, behaviorists in education have continued to rely on the traditional epistemology for much of what they do. Questions of what to teach and in what order, all the details and strategies of conveying content to the learner, are left to the wisdom and traditions of teaching. Often the creation of a behaviorist program of instruction starts by taking a conventional textbook or curriculum guide and breaking it down into separately teachable bits. Thus the epistemological assumptions frozen into textbooks and teaching practice are preserved. The same is true of assessment. Often the so-called 'behavioral objective' merely specifies test items the student must pass, the items themselves being grounded in folk theory that treats learning as the accumulation of items of mental content. The reason for behaviorism's limited impact on education is not subversiveness or cultural lag on the part of educators; the reason is that behaviorism was never able to provide an alternative conceptual framework for teaching subject matter—facts, concepts, and the like.

theory. In fact, that is about all theories are used for in education: to buttress arguments for or against some already existing position. Piaget produced a novel psychological theory, first taken up in education by Susan and Nathan Isaacs in the forerunner of the British infant school, but its main use was to support "activity" methods that had already been instituted (N. Isaacs, 1965).

It is legitimate, of course, to use theories as backing in policy discussions; for theories in some of the social sciences, that may be all the practical value we should ever expect of them. But that is not what theories are mostly good for in applied fields. They should help us create new possibilities and solve problems. In this regard, commonsense beliefs generally prove inadequate as soon as a field of practice begins to advance beyond a traditional craft.

Every craft develops specialized knowledge, but in a traditional craft this specialized knowledge rests on a base of commonsense knowledge that is taken for granted and remains largely unquestioned as one learns the craft. The peasant farmer acquires abundant knowledge of local plants and their ways, but it rests on a botany that has no notion of photosynthesis. One result is that, through trial and error over generations, practices evolve that work but for which there is no explanation. The limitations of traditional crafts show up when there is need to change. If the slash-and-burn practice, which returns necessary minerals to the soil, must be abandoned for economic or ecological reasons, commonsense botany offers no basis for discovering an alternative. If, because of population pressure, the land must be made to yield many times more food than before, traditional methods will fail. Without a better botany, there will be no Green Revolution.

The same story can be told in almost every field—in medicine and dentistry, navigation, engineering, metal work. Crafts based on commonsense understanding can often produce wondrous achievements, but when there is a need to adapt or innovate, commonsense knowledge falls short. We tend to think of science as having a life of its own, but in earlier times it was driven to a great extent by practial problems that were beyond the reach of commonsense knowledge. Even into the 19th century, most of physics was produced, not by university scholars, but by servants of industry. Then, as A. N. Whitehead has explained, the production of knowledge itself began to be professionalized (Whitehead, 1925/1948).

Now we are seeing commonsense knowledge being supplanted everywhere, not because it has proved inadequate to some task, but because a scientific discipline has made it its business to advance beyond it. Folk knowledge of practical value may even get lost in the process, as it has in medicine and agriculture. The offsetting advantage is that we have knowledge available for innovation; we do not always have to wait for the inadequacies of present knowledge to be revealed by practical difficulties. That is what seems to be happening with theory of mind as it relates to education.

The manifest difficulties that education is running into do not forthrightly suggest that anything is wrong with our commonsense theory of mind. I am referring to the difficulties that typically make news—drop-outs, violence, poor test performance, great inequalities of achievement, and so on. They may suggest that much is wrong with the culture, with our values, with the way schools are run; but it seems that all the relevant issues can be discussed fully and from all sides without straining against the limits of folk theory of mind. The inadequacies of folk theory of mind are showing up elsewhere, in philosophy and in artificial intelligence especially. That is also where an alternative theory of mind is starting to take shape. It does not look as if the new theory is going to lead straightaway to solving any of education's problems. Rather, what it promises to do is free our thinking from some of the restrictions of the folk theory and give us a way to deploy knowledge of the mind in more powerfully innovative ways.

Teaching is a traditional craft, or at least it aspires to be. It is learned through experience and example. Depending on how you conceive of a theoretical basis, teaching either has none or it has one but teachers don't know about it and it would have little relevance to practice if they did. Modern efforts to improve teaching focus on master teachers mentoring less accomplished ones and on teachers joining together to upgrade their craft. Consequently, you cannot expect what goes on in classrooms or in teacher development workshops to reveal inadequacies of the underlying folk theory. To see that, you would have to look at efforts to get outside the orbit of existing practices—outside the numerous variations on didactic instruction and child-centered or activity-centered methods.

Such efforts are going on, and I believe they are already stretching the limits of what folk theory of mind can handle. Interestingly, it is not the more spectacular sorts of high technology

that are having this effect in education. Intelligent tutoring systems and virtual reality, whatever their value, fit comfortably within the folk theory. Intelligent tutoring systems develop hypotheses about what is in the student's mind and try to alter it. Virtual reality may allow students to walk around inside a molecule, but the reason for thinking this might be a good thing for them to do comes right out of the folk psychological belief in the primacy of direct experience.

Mind as Container

Most of the time, when we explain or predict behavior on the basis of peoples beliefs, desires, plans, knowledge, and the like, we give no thought at all to how the mind works. If we have a theory of mind, it is dormant much of the time. A better way to put this was suggested by Ludwig Wittgenstein. He suggested that certain ideas do not enter actively into our deliberations but instead provide the *scaffolding* for our thoughts (Wittgenstein, 1969). Thus, there is a certain structure to the way we typically think about mental attributes, and this may be as close as people who are not cognitive scientists come to having an actual theory of mind.

This structure or scaffolding is what I believe we must struggle to replace, if education is to make headway in the knowledge age. As is often the case with everyday thinking, the scaffolding is provided by a metaphor (Lakoff & Johnson, 1980; Lakoff, 1987). In this case it is the metaphor of mind-as-container. Metaphors, as Lakoff argues, are basic to human thought, extremely productive, but also dangerous. The danger arises from the fact that, unlike explicit beliefs, they go unnoticed and uncriticized. Thus they can limit or bias our thought, often in fundamental ways, without our awareness.

In everyday use, the mind-as-container metaphor is handy and probably harmless. It is well suited to social interactions in which we are dealing with other people as individuals. In these cases it is important to keep beliefs, desires, and so on connected with the people who hold them. It is not the general proposition that hospitals are dangerous places that concerns us, it is Uncle Roscoe's belief that hospitals are dangerous places, with all the quirks, colorations, prior associations, and implications that his particular belief may have. Roscoe's children, who are trying to get him to enter hospital for an operation, hold other beliefs, which are also not to be considered in isolation but in relation to their other personal beliefs, goals, strategies, and so on. Such situations can become quite complicated, but the container metaphor helps us sort things out. Each of the

people involved is credited with a mind, and all of the relevant cognitive and emotional stuff is thought of as residing in one or another of these minds. There are other ways of sorting things out, as I shall suggest later, but this way unquestionably serves its purpose very well.

The mind-as-container metaphor gives rise to a number of vexing philosophical problems, although these are usually of little concern in everyday applications. There is, for instance, the problem of how to ascertain that two people hold the same belief—or, indeed, how to compare their beliefs at all. In everyday life this is addressed as a problem of communication. Presumably, if people could be perfectly clear in expressing their beliefs, it could always be determined whether their beliefs were the same. Such a presumption will not stand up under critical analysis, but its practical import is all to the good: When in doubt, talk things out. Another vexing problem of long standing is known as the mind-body problem. How can mental objects, located in an immaterial mind, cause material things to happen? For our present purpose, the thing to note about these and other philsophical conundrums is that they arise from regarding the mind as literally a container. If mind-as-container is just a metaphor, we have to expect that it will fail on certain points. “All the world is a stage” is a nice metaphor, but you cannot stretch it very far before it becomes ridiculous. We all recognize that the world is only metaphorically a stage, that the kindergarten teacher is only metaphorically a gardener. But by not recognizing that the mind is only metaphorically a container, by perhaps not even being aware that we are thinking of it as a container, we are susceptible to false dilemmas and often much worse.

The Container Metaphor in Educational Thought and Practice

Education necessarily goes beyond the face-to-face negotiations for which the mind-as-container metaphor has proved so helpful. It is true that school teachers deal with individual students and that for this purpose the container metaphor serves them well. The textbook may contain a rule for adding fractions, but teachers cannot be concerned only with this rule. Here is Alfred, who in adding 1/2 and 1/3 gets 2/5, Francine, who gets 1/5, and Blair, who gets 2/6. The insightful teacher will infer that Alfred is following a rule that calls for adding numerators to numerators and adding denominators to denominators. Other idiosyncratic rules may be inferred to account

for the behavior of Francine and Blair. These rules will be thought of as residing in the respective minds of these students, and the teacher will deal with them accordingly—perhaps by encouraging the students to formulate their rules explicitly, so that they can be examined, or perhaps simply by reiterating the textbook rule, with examples, and hoping that it displaces the faulty rules in the students' minds.

That is one level of educational enterprise, and at that level the container metaphor can go without challenge. But there are other levels to the enterprise. Staying with our example, there is a level at which teachers, curriculum writers, and others must try to figure out what is wrong with mathematics education, such that a substantial proportion of children, after having undergone weeks of instruction in adding fractions, respond with a number that is less than 1/2 when they are asked to add 1/2 and 1/3. One of the concepts likely to be brought in at this level is *number sense.* The children in question will be said to lack number sense, and the educational program will be faulted for failing to develop it. But what is number sense, and how might it be promoted? Here the container metaphor fails; but if no one notices this, the discussion is likely to lose its way.

Number sense is clearly something attributable to individual minds. But it is not any specifiable set of facts or rules or skills. It is an attribute of the whole system, not a lot of items in a mental container. All the mathematics curriculum guides I have seen demonstrate that educators do not know what to make of something like number sense. They either leave it completely unspecified, relegating it to the status of an item of wishful thinking (along with love of learning and respect for cultural differences), or else they reduce it to specifics and make it indistinguishable from teaching standard mathematics content. One of the most influential guidelines avoided defining number sense, but confidently stated that it must be taught through practical experiences. A few years later, after some crushing test results, the state's policy makers decided that, on the contrary, the way to teach number sense was through lots of exercises on carefully designed worksheets. But they still had not come clean about what number sense is and how either method was supposed to produce it. From what is known about number sense, I conclude that both approaches are wrong (Greeno, 1991; Griffin, Case, & Siegler, 1994), but the point I want to make here is that folk theory of mind makes the issue virtually undiscussable. The

container metaphor fails miserably when we try to deal with sorts of knowledge and skill that cannot be defined as items in the container but that instead characterize the whole container.

There are still higher levels to which the adding fractions example may take us, and where other weaknesses of folk theory of mind are revealed. A mathematics educator may suggest that the student who offers 2/5 as the sum of 1/2 and 1/3 probably doesn't recognize 2/5 as a number but only as a quotient or, worse, simply as two whole numbers with a line in between. This sounds plausible and enlightening, but what are we to make of it? What does it mean to "recognize 2/5 as a number"? Surely it means more than having a statement to that effect stored away in memory. Educators will say that it implies *understanding* that fractions are numbers. But what kind of object or set of objects in the mind constitutes understanding?

It turns out that understanding, one of the main objectives of education, is very hard to reconcile with the mind-as-container metaphor. In order to do so, cognitive scientists have had to posit some very large objects in the mental container. The most popular have been schemas (Rumelhart , 1980) and concept nets (Novak & Gowan, 1984). A student's *fraction* schema would contstitute in one organized whole everything the student knows about fractions; and it would control all the student's behavior related to fractions, ranging from recognizing something as a fraction to performing arithmetic involving fractions and responding to questions such as, "Is a fraction a number?" *Understanding* may then be regarded as a characteristic of the whole schema. It could be thought of as a matter of how closely the schema in the mind of the student resembles the schema in the mind of a mathematician.

These megaobjects constitute a neat solution to the problem of how to deal with understanding and other large cognitive issues while preserving the metaphor of mind as container.[3] They make

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[3] Essentially the same commentary applies to concept nets. A schema may be thought of as a form, like the lost luggage forms air travelers must occasionally fill out. It contains blanks to fill in or alternatives to select in accordance with the present instance. However, unlike the lost luggage form, which may oblige you to choose from among drawings, none of which very much resembles your own luggage or indeed any other luggage manufactured in the last 25 years, the luggage schema in your own mind will nicely encapsulate descriptions of the luggage that has actually figured in your experience. A concept net looks entirely different, but captures much the same information. It is usually depicted as a lot of circles connected by lines. Each circle represents a concept (in the case of fractions, things like *fraction, numerator, denominator, ratio, least common denominator, addition,* and *multiplication.* The connecting lines are labeled to indicate relationships and these

room for the intuition that understanding is a property of a whole system and not an item of mental content in itself. For the educator, however, schemas and concept nets raise more problems than they solve. How do such things get into the mind? You can't *teach* them in any straightforward sense, so what do you do to ensure that they get created and that they are good schemas or concept nets and not bad ones? How do you change a faulty schema into a more adequate one? (This is an important question, because one of the premises of schema theory is that students already have fraction schemas, physics of motion schemas, and the like, which it is the formidable job of education to alter.) When we ponder these questions, two things become apparent: (1) These problems apply to a very large part of what formal education is concerned with; and (2) folk theory of mind has little to offer toward their solution.

There is a final level to which our fractions example may take us. I will only touch on it here, because it will be taken up at length in a later chapter. What are numbers, anyway? What are we teaching when we teach that 2/5 is a number? In the ordinary business of the world, these are questions of mathematics. They have nothing to do with the mind. But, under the influence of postpostivism and other 'post-isms,' educators are likely to bring the mind in as a party to such issues. Having learned that there are no objective truths, they will conclude that number systems and propositions about numbers are ideas and beliefs in the minds of mathematicians. Accordingly, they will have qualms about ordaining that these mere opinions are to be forced upon students. Shouldn't the students' own opinions be given equal weight? There are important issues here, but folk theory tends to muddy them. Folk theory of mind tends to recognize only two sorts of things: real, palpable things that exist out there in the material world, and immaterial things that exist as objects in people's minds. Thus, 2/5 of a quart of whisky is something real, to be found in abundance on the shelves of cheap liquor stores, whereas 2/5, the pure number, is found only in people's minds. Under the influence of such a theory, it is not surprising that many educators should decide to avoid dealing with pure numbers and concentrate mathematics instruction only on quantities of material things. From this it follows naturally that, when testers come out of the blue with a question about the sum of 1/2 and 1/3, students will be liable to

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relationships, together with the concepts they link, constitute propositions: *fraction* has *numberator*; *addition* needs *least common denominator*; *fration* isa *number*; etc.

produce answers that make no sense either mathematically or in relation to quantities they might encounter in the physical world.

It is perhaps unfair to blame this last anomaly on folk epistemology. To young children, numbers are perfectly real things (Cobb, Gravmeijer, Yackel, McClain, & Whitenack, 1997). Educators who honor (and often share) this intuition find that mathematics can be made quite a meaningful field of inquiry for students (Lampert, Rittenhouse, & Crumbaugh, 1996). The insistence on treating numbers as objects in people's minds comes about from trying to promote the mind-as-container metaphor into a genuine theory, with defensible premises and empirical implications. It therefore behooves us to look, as we shall do in the next chapter, at the efforts of cognitivists to build scientific theories embodying the container metaphor.

Do We Really Need A Theory of Mind?

Developmental psychologists are always posing problems to young children: Which side of the balance will go down? Are there more candies in that row or this row? How much is one less than five? A dog undergoes cosmetic surgery so that it looks just like a cat: Is it now a cat? Frequently such questions are followed up by asking the child, "How do you know?" A not uncommon answer is, "My brain told me." What the children seem to be saying is something an adult would express as "It's obvious" or "I figured it out." But the children have already begun positing an agent that does this perceiving of the obvious and figuring things out. That agent will later come to be called the mind.

I don't think there is much to be gained by starting out with positing a mind and then trying to define what it is and how it relates to the brain. A more promising starting point is with the idea of a mentalistic level of description. A great deal of people's talk about themselves and each other takes place at this level. It is talk referring to what people know, believe, feel, experience, remember or forget, desire, like or dislike. Such mentalistic talk is what behaviorists have tried to eliminate from scientific discourse. Once that is done, the question of whether there is a mind distinct from the brain becomes moot. Except for the uncommonly clever Dr. Skinner, however, most behaviorists have found it necessary to use mental terms in their everyday speech. That a mentalistic level of description is necessary for education seems to me so obvious that I am not going to waste words arguing the point. I will simply leave it as a challenge to the

doubter to figure out a way to deal with an issue such as *teaching for deeper understanding* without using mental terms.

A mentalistic level of description does not necessarily imply a mind as the agent, however. Much of the time in our mentalistic talk the implied agent is the whole person—*I* remember; *you* believe; *Gustav* wants; et cetera—with no mention of a mind at all. The notion of mind comes in at a more systemic level. A person's beliefs, feelings, desires, and so on are not just so many bits and pieces. They hang together in some way—or, if they do not, that is a matter of concern. When we talk about the mind we are talking about this whole interconnected system of mental attributes. Thus the concept of *mind* is rather like the concept of *economy*. There is an economic level of description, at which terms such as production, consumption, accumulation, and exchange are applied to people's activities. The notion of an economy enters in at a systemic level, when we consider all these activities as they interrelate and have joint effects. An economy as a whole may be characterized as healthy or sick, stagnant or expanding, complex or simple—terms that are also sometimes applied to minds.

A major difference between *economy* and *mind* is that no one ever gets the economy confused with a physical object (it may get confused with objective indicators, such as gross domestic product, but that is a different problem). There is endless dithering, however, about distinguishing the mind from the brain (cf. Taylor, 1979; Popper & Eccles, 1977).[4] I suppose if a nation's economy were based on a single machine that was the source of all the goods produced in that country, a similar confusion might arise. Conversely, if cognition were fully distributed throughout the body, the mind-body problem might vanish. As it is, however, cognition is largely concentrated in the brain. But that does not localize cognition very much. The brain contains more neurons than there are people in the world and is about as complex in its functioning as the functioning of the world economy. From this viewpoint, to say, as some cognitivists are prone to do, that the mind and the brain are one is about as illuminating as saying that the economy and the human population are one and the same.

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[4] The Cartesian dualism seems to keep coming back to life after repeated total destruction, like Chucky, the evil doll in the movie *Child's Play* and its sequels. See, for instance, Popper & Eccles (1977), and the commentaries following Dennett & Kinsbourne (1992).

We—and by this I mean practically everyone, not just behavioral scientists and philosophers—need a concept of mind because we continually deal with mental phenomena at a systemic level. We do not simply record in list fashion what we take to be one another's beliefs and dispositions, but we try to make sense of them. This is important for practical as well as intellectual purposes. To succeed at it, we need some notion of an organized whole. It seems natural to treat that organized whole as a thing and to assign processes and attributes to it. Hence, the mind. Although objections can be raised against such reification, I do not think we should fight it. At least, we should not abandon the mind until a better alternative is offered, and as I shall try to show in the next three chapters the alternatives do not quite make the grade.

Why Education, Especially, Needs a NewTheory of Mind

The main motivation for the present inquiry is my belief that education must advance beyond the state of a traditional craft if it is to do the job required of it in the post-industrial age. Folk theory of mind stands in the way of such advancement. The fault is not with the idea of mind itself, as behaviorists and some contemporary cognitivists claim, but with the root metaphor on which folk theory of mind is based. It is the *mind-as-container* metaphor. This metaphor leads to the positing of an array of mental objects contained in the mind—such old-fashioned objects as beliefs, desires, goals, and plans, or such new-fangled objects as schemata, production systems, and conceptual networks. Education is viewed as a matter of introducing new objects into the mind or modifying ones already there. According to an older view, learning consists of taking objects in from outside. According to the more fashionable constructivist view, the mind constructs the objects it contains. The container metaphor remains, however, and that is where the trouble starts.

Generally, folk theory of mind has great trouble dealing with any sort of knowledge that cannot be understood as an object in an individual mind. Thus contemporary talk about a "learning society," "knowledge-based industries," "corporate memory," "team expertise," and the like has an unreal air about it for many people and for others it is degraded into more comfortable notions of mental or physical objects. Those of a sociocultural turn of mind may have no difficulty with the idea of knowledge existing at a suprapersonal level, but they have trouble linking this up to

children's learning their times tables. A viable theory of mind for 21st century education, it seems to me, must be able to negotiate effectively between individual learning on one hand and knowledge conceived of as a product or as a cultural good on the other. Folk theory of mind, constrained by its container metaphor, simply can't do the job.

The most promising new developments in education involve restructuring school activities and discourse so that they resemble in some fashion the workings of research groups—where real questions are being investigated and students are trying to contribute to progress on those questions. Within the conceptual framework of folk theory of mind, however, this kind of collaborative knowledge-building activity degenerates into "cooperative learning." It becomes students helping each other learn. There is nothing wrong with that, but it is not the same as collaborative knowledge-building. Folk theory of mind cannot support the distinction.

Even at the individual level there is an important distinction that folk theory of mind obscures. The individual scientist occasionally takes time out from research to learn something—to master a new piece of computer software, for instance. But to folk theory of mind, research *is* learning. It is obtaining knowledge, adding to the contents of the mental container. Folk theory of mind is unable to make anything significant of the fact that research and theorizing are meant to advance the world's knowledge (or that of some group, at any rate) whereas learning is only meant to advance one's own.

This inability to distinguish between knowledge building and learning produces a dilemma that several generations of educators have agonized over. On one hand is the official wisdom promoted by virtually all the education journals and professional associations and embodied in virtually all the publicized innovations. This is a wisdom identified with such phrases as "inquiry," "meaning-making," "sciencing," and "constructivism." On the other hand is the unofficial wisdom of the workplace and of the teacher's lounge, which holds that there are a great many important things that people tend not to learn, or at least not to learn very thoroughly or efficiently, unless they are taught. Typically the dilemma is handled by compromise, but it is an uneasy, sometimes guilt-ridden compromise. I have heard education professors express dismay when they find that a teacher who was doing a marvellous job of following their precepts for inquiry-based mathematics teaching also devoted time to mental

arithmetic drill. That this should be perceived as an inconsistency testifies to the conceptual impoverishment of presentday educational thought. As I will try to show in Chapter 8, there is reason to believe that this conceptual impoverishment is leading to an impoverishment of practice as well.

The mind-as-container metaphor is handy for talking about the acquisition of knowledge, but not for talking about what the knowledge is good for once it is in the container. A perennial educational concern is what Alfred North Whitehead called "inert knowledge." This is knowledge that just sits in the container until its name is called and does not participate actively in the conduct of life. But what else could we expect of immaterial lumps of mental content? If one ignores the mind for the time being, it is legitimate and illuminating to discuss such questions as, "What is the value of the concept of gravity?" Having obtained some positive answers ("It helps to explain such-and-such," "It makes it possible to predict thus-and-so"), one can then go on to plan ways of enabling students to avail themselves of these uses of the concept. Turn the concept of gravity into an object in the mind, however, and this straightforward pragmatic approach to knowledge suddenly becomes difficult to manage. In order to get these static objects in the mind to doing anything, one has to conjure up a process. Educators will speak of a process called "transfer"—a term properly applied to skills, where it means something quite unmysterious, whereas transfer becomes a *deus ex machina* when applied to conceptual knowledge.

On all of the counts I have mentioned, educational thinkers have managed to make progress despite holding to a folk theory of mind. Human thinkers, when in good form, can be quite agile and get past all sorts of impediments, including not only those created by an archaic theory of mind but also those that come from having to use a language that may be said to embody that theory. But as the demands put upon educational thought become more exacting, the impediments become increasingly detrimental. When you are not expecting to do anything about it, when you are just trying to provide a succinct description, it is perfectly all right to talk about students having models in their minds of biological systems, number lines, and so on. But when practice gets serious, to the point that educators are talking about changing the student's mental model of plant nutrition so that it more nearly resembles the botanist's mental model, then it is time to stop and ask, "Do we really mean what

we're saying? Are we really prepared to assert that there are describable things in students' minds that can be compared to things in the minds of scientists and that we can get hold of the first kind of thing and make it over into something like the second kind of thing—or is this all just a manner of speaking?"

A more familiar line of questioning has to do with whether it is possible to base a successful science on folk theory of mind. Behaviorists have been vehemently negative on this point, although for reasons that no longer seem very compelling. More recently, a number of people within cognitive science have begun to offer negative answers as well, based on computational possibilities and what is known about the brain. Although I will be drawing, in the next chapter, on the objections raised by these people, their arguments are not central to the case I shall be trying to make. My interest is in education. It is quite possible that cognitive science could be reconstructed on a new basis—on a neurological basis, for instance—without its making any difference to educational thought and practice. Most of the contemporary critics of folk theory of mind would probably agree. They think the folk theory is fine for conducting the practical affairs of the world, they just want it driven out of laboratories and philosophers' seminar rooms. They are called "eliminativists," because what they are pursuing is not a new theory of mind but rather a behavioral and brain science that gets along without a mental level of description.

Back to Aquinas?

When I said in the Preface that our folk theory of mind is older than the wheel, that was more an attention-grabber than a calculated estimate of antiquity. In some respects—the respects in which theory of mind is innate—it is probably much older than the wheel (Barkow, Cosmides, & Tooby, 1992). But Julian Jaynes (1986) has argued, mainly on the basis of the way human action was portrayed in ancient myths, that early human beings did not have the subjective experience of thought, that what we perceive as mental events were perceived by them as voices from the beyond. However that may be, it is clear that by the time of Plato something very like contemporary folk theory had taken shape (Dreyfus, 1988). But there may yet have been an important difference. In an essay titled "How Old is the Mind?" Hilary Putnam (1986) offered evidence which suggests that the mind-as-container metaphor may not have taken hold among European philosphers until the Renaissance. In ancient and medieval thought the closest

thing to the present-day concept of mind, the *nous*, was more like what we would call consciousness or active attention. Mental content was just what we are aware of or, in contemporary jargon, 'processing' at the moment. The idea of the mind as a repository of unattended beliefs and memories was absent. Instead, these were conceived of as a sort of bodily material out of which the active mind formed, in Aquinas's words, "intellectual species." Putnam commented,

> The contemporary "common-sense" view is that it is obvious that memories are in the mind; what is still regarded as a difficult question is whether they are *identical* with brain traces or only *correlated* with brain traces. The view I have been attributing to Aquinas is that it is obvious that memories are in the body (the brain); when they are not actively being recalled, they are not "mental" at all. The *nous*/body distinction that Aquinas would have drawn is not at all the same as the modern mind/body distinction. Yet, when I think about it, it doesn't sound worse than the modern one. *Is it* obvious that there is something called the mind whose contents include all of my memories, whether I am actively recalling them or not, but whose functions do not include digestion or reproduction? Or are we in the grip of a picture, a picture whose origins are somewhat accidental and whose logic, once examined, is not compelling? (p. 34).

Like Putnam, I find this antique view of the mind intuitively appealing. Unlike behaviorism, it fully accepts the introspective evidence of mind—the experiences of thinking, remembering, understanding, and intending. What it excludes is the part we never experience directly but only infer: the vast archive of beliefs and memories that are not part of our immediate consciousness but that we assume to be stored away somewhere to be retrieved on occasion. That exclusion, of course, would pose what I can only think to call a 'mind-boggling' question for education. What could education be if it is not in large part concerned with the contents of students' mental archives? But that is a question educators have been wrestling with in various ill-defined ways throughout the past century, and it is just possible that the antique view might render the question more tractable.

Curiously, the pre-Renaissance view, when translated into current language as Putnam has done, has a more modern ring to it

than the contemporary folk theory with which it competes. At about the same time that Putnam's essay was published, a monumental two-volume work also appeared which has had a profound influence on cognitive science in all its many branches. I refer to *Parallel Distributed Processing*(McClelland, Rumelhart, and the PDP Group, 1986; Rumelhart, McClelland, and the PDP Group, 1986). Connectionism, as it is now generally called, demonstrates how a brain could be knowledgeable—that is, could retain and take advantage of the results of experience—without anything that might properly be called mental content. *Parallel Distributed Processing* did not offer a theory of mind, but it cleared a workspace for developing one.

Conclusion

The idea of knowledge as the contents of a mental filing cabinet is, I believe, the most stultifying conception in educational thought. But it has been shared by all the major combatants in the educational debates of this century. There are traditionalists who want to make sure the filing cabinet is filled and with the right things; there are child-centered and 'constructivist' educators who insist that the contents of the filing cabinet should be the result of the child's own inquiries; and there are the thinking skills enthusiasts who want to ignore the mental filing cabinet (whose contents they believe to be rapidly obsolescent) and to focus on developing skills in accessing various external filing cabinets and applying their contents. There is merit in all these positions, but they appear unreconcilable. Moreover, they all *undervalue* knowledge as it figures in a knowledge-based economy and in the careers of experts.

It is too much to expect that a reconstituted theory of mind would lead to consensus where we now have people at loggerheads over educational policies, although there might be a bit less talking past one another. I should hope, rather, that a new theory of mind would result in constructive disagreements where there is now superficial consensus. There is at this time widespread agreement on a number of educational ideas. These include higher-order skills, teaching for understanding, constructivism (understood as the opposite of passive reception of information), authentic problem solving, and lifelong learning. The consensus, though far from complete, includes not only a broad spectrum of professional educators but also business people and politicians. There is seldom, however, any investigation of the possibility that people understand these terms quite

differently; for if it turned out that they did, there would be noplace for the discussion to go. It would be as if pirates met only to discover that they held pieces of different treasure maps. We lack concepts for advancing beyond the stage educational enlightenment has currently reached. My hope in this book is to show that by adopting a new way of thinking about knowledge and mind, educational thought can be freed to do the job it must do if education is to earn its place in the Knowledge Age.

References

Anderson, J. R. (1983). The architecture of cognition. Cambridge, MA: Harvard University Press.

Astington, J. R. (1993). The child's discovery of the mind. Cambridge, MA: Harvard University Press.

Barkow, J. H., Cosmides, L., & Tooby, J. (1992). The adapted mind: Evolutionary psychology and the generation of culture. Oxford: Oxford University Press.

Bloom, B. S. (Ed.). (1956). Taxonomy of educational objectives: Handbook 1. Cognitive domain. New York: David McKay Company, Inc.

Cobb, P., Gravmeijer, K., Yackel, E., McClain, K., & Whitenack, J. (1997). Mathematizing and symbolizing: The emergence of chains of significance in one first-grade classroom. In D. Kirshner & J. A. Whitson (Eds.), Situated cognition: Social, semiotic, and psychological perspectives (pp. 151-233). Mahwah, NJ: Erlbaum.

Dennett, D. C., & Kinsbourne, M. (1992). Time and the observer: The where and when of consciousness in the brain. Behavioral and Brain Sciences, 15(2), 183-247.

Dreyfus, H. L. (1988). The Socratic and Platonic basis of cognitivism. AI and Society, 2, 99-112.

Greeno, J. G. (1991). Number sense as situated knowing in a conceptual domain. Journal for Research in Mathematics Education, 22, 170-218.

Griffin, S. A., Case, R., & Siegler, R. S. (1994). Rightstart: Providing the central conceptual prerequisites for first formal learning of arithmetic to students at risk for school failure. In K. McGilly (Eds.), Classroom lessons: Integrating cognitive theory and classroom practice (pp. 25-49). Cambridge, MA: MIT Press.

Hunt, E., & Minstrell, J. (1994). A cognitive approach to the teaching of physics. In K. McGilley (Eds.), Classroom lessons: Integrating cognitive theory and classroom practice. (pp. 51-74). Cambridge, MA: MIT Press.

Isaacs, N. (1965). Piaget: Some answers to teachers' questions. London: National Froebel Foundation.

Jaynes, J. (1986). How old is consciousness? In R. M. Caplan (Eds.), Exploring the concept of mind (pp. 51-72). Iowa City: University of Iowa Press.

Kuhn, T. (1970). The structure of scientific revolutions. Chicago: University of Chicago Press.

Lakoff, G. & Johnson, (1980). Lakoff, G., & Johnson, M. (1980). Metaphors we live by. Chicago, IL: University of Chicago Press.

Lakoff, G. (1987). Women, fire, and dangerous things: What categories reveal about the mind. Chicago, IL: University of Chicago Press.

Lampert, M. (1988). Connecting mathematical teaching and learning. In E. Fennema, T. P. Carpenter, & S. J. Lamon (Eds.), Integrating research on teaching and learning mathematics: Papers from the first Wisconsin Symposium for Research on Teaching and Learning Mathematics (pp. 132-165). Madison, WI: University oF Wisconsin, Wisconsin Center for Education Research.

Lampert, M., Rittenhouse, P., & Crumbaugh, C. (1996). Agreeing to disagree: Developing sociable mathematical discourse. In D. O. &. N. Torrance (Eds.), Handbook of education and human development: New models of learning, teaching and schooling (pp. 731-764). Cambridge, MA: Basil Blackwell.

McClelland, J. L., Rumelhart, D. E., & the PDP Research Group (Eds.). (1986). Parallel distributed processing: Explorations in the

microstructure of cognition: Vol. 2. Psychological and biological models. Cambridge, MA: MIT/Bradford.

Nonaka, I. (1991). The knowledge-creating company. Harvard Business Review, 69(6), 96-104.

Novak, J. D., & Gowin, D. B. (1984). Learning how to learn. Cambridge: Cambridge University Press.

Popper, K. R., & Eccles, J. C. (1977). The self and its brain. Berlin: Springer-Verlag.

Premack D. & Premack, A. J. (1996). Why animals lack pedagogy and some culture have more of it than others. In D. Olson &. N. Torrance (Eds.), Handbook of education and human development: New models of learning, teaching and schooling (pp. 302-323). Cambridge, MA: Basil Blackwell.

Putnam, H. (1986). How old is the mind? In R. M. Caplan (Ed.), Exploring the concept of mind (pp. 31-50). Iowa City: University of Iowa Press.

Rumelhart, D. E. (1980). Schemata: The building blocks of cognition. In R. J. Spiro, B. C. Bruce, & W. F. Brewer (Eds.), Theoretical issues in reading comprehension (pp. 33-58). Hillsdale, NJ: Lawrence Erlbaum Associates.

Rumelhart, D. E., McClelland, J. L., & the PDP Research Group (1986). Parallel distributed processing: Explorations in the microstructure of cognition: Vol. 1. Foundations. Cambridge, MA: MIT Press.

Stewart, T. A. (1997). Intellectual capital: The new wealth of nations. New York: Doubleday.

Taylor K. (1989) Narrow content functionalism and the mind-body problem. Nous,
23, 355-72.

Whitehead, A. N. (1925/1948). Science and the modern world (Mentor ed.). New York: New American Library.

Wittgenstein, L. (1969). On certainty. New York: Harper Torchbooks.

Notes

1 The emergence of a sociology of knowledge has also been important, but not in quite the same way. Sociological ideas have directly influenced some philosophers, especially through the influence of Thomas Kuhn (1970), and thus have become assimilated into philosophy, whereas cognitive science and the commercialization of knowledge have appropriated knowledge and bent its meaning to their purposes.

2 American education is commonly said to have been dominated by behaviorism during a substantial portion of the twentieth century, which would imply that education during this period eschewed folk theory of mind in favor of a theory that recognized only overt behavior and regarded education as the shaping of a behavioral repertoire. There is no question that behaviorism had an influence. It was, and in many places still is, manifested in practices such as the following:

breaking instruction down into small steps

formulating "behavioral objectives," which generally amount to replacing traditional objectives with indicators used to assess them

using frequent small rewards rather than punishment and reprimand

paying less attention to issues of understanding and more to issues of performance and conduct

These could add up to significant changes in the conduct of schooling, but they are all easily accommodated by folk theory of mind. Furthermore, behaviorists in education have continued to rely on the traditional epistemology for much of what they do. Questions of what to teach and in what order, all the details and strategies of conveying content to the learner, are left to the wisdom and traditions of teaching. Often the creation of a behaviorist program of instruction starts by taking a conventional textbook or curriculum guide and breaking it down into separately teachable bits. Thus the epistemological assumptions frozen into textbooks and teaching practice are preserved. The same is true of assessment. Often the so-called ‘behavioral objective’ merely specifies test items the student must pass, the items themselves being grounded in folk theory that treats learning as the accumulation of items of mental content. The reason for behaviorism’s limited impact on education is not subversiveness or cultural lag on the part of educators; the reason is that behaviorism was never able to provide an alternative

conceptual framework for teaching subject matter—facts, concepts, and the like.

3 Essentially the same commentary applies to concept nets. A schema may be thought of as a form, like the lost luggage forms air travelers must occasionally fill out. It contains blanks to fill in or alternatives to select in accordance with the present instance. However, unlike the lost luggage form, which may oblige you to choose from among drawings, none of which very much resembles your own luggage or indeed any other luggage manufactured in the last 25 years, the luggage schema in your own mind will nicely encapsulate descriptions of the luggage that has actually figured in your experience. A concept net looks entirely different, but captures much the same information. It is usually depicted as a lot of circles connected by lines. Each circle represents a concept (in the case of fractions, things like *fraction, numerator, denominator, ratio, least common denominator, addition,* and *multiplication*. The connecting lines are labeled to indicate relationships and these relationships, together with the concepts they link, constitute propositions: *fraction* has *numberator*; *addition* needs *least common denominator*; *fration* isa *number*; etc.

4 The Cartesian dualism seems to keep coming back to life after repeated total destruction, like Chucky, the evil doll in the movie *Child's Play* and its sequels. See, for instance, Popper & Eccles (1977) and the commentaries following Dennett & Kinsbourne (1992).