

Chapter 9

Subject Matter That Matters

Only in education, never in the life of farmer, sailor, merchant, physician, or laboratory experimenter, does knowledge mean primarily a store of information aloof from doing.

Dewey (1916/1944, p. 185)

[E]ducation to be living and effective must be directed to informing pupils with those ideas, and to creating for them those capacities which will enable them to appreciate the current thought of their epoch.

Whitehead (1929, p. 83)

The traditional way of viewing the problem of school subject matter goes like this: There is a huge and growing mountain of things to know. Schools can teach only a small part. Therefore they must select what is most important and what will provide the best foundation for going on and learning more. Everything beyond that is pedagogy—the art of ensuring that students master and retain what has been presented. This is probably still how most of the public thinks about it. However, most of modern educational thought reflects an intuition that content and pedagogy are more closely intertwined than this. There is content *in* the pedagogy—the so-called ‘hidden curriculum,’ which is conveyed through the manner of teaching. Furthermore, thinking of subject matter as a mountain of things to be learned predisposes toward a certain kind of pedagogy, which most modern educators oppose. Thus the problem of what to teach has become thoroughly conmingled with the problem of how to teach, and there emerges a higher-level problem: How to think about what to teach.

That there is a serious problem here becomes evident whenever people start discussing what should be taught in school. Flat

assertions of wildly different kinds are made: More content. Less content. Multiple intelligences. Cognitive apprenticeship. Conceptual change. Process not product. Higher-order skills. Learner-centered curriculum. Appeals are made to various documents issued by professional associations as if these were the absolute authority on education in the established disciplines, but then these disciplines are accused of artificially partitioning the curriculum. There is no real discussion because there is no paradigm within which it may be conducted (and hence, of course, no possibility of a paradigm shift).

The virtual impossibility of productive discourse is dramatized in an anecdote reported by E. D. Hirsch, Jr. (1996, p. 55). Pursuant to the ideas set out in his book, *Cultural Literacy*, Hirsch had been editing resource books intended to encapsulate essential knowledge for elementary school children. At a meeting of school administrators, he was asked whether he had enjoyed this task.

I said, yes indeed, that I had learned a great deal. Next question: What had I learned that was most interesting? I pondered. Well, perhaps, the most exciting thing for me was at last to understand the relations between the earth and the sun during a year's orbit, and why, at the equator, spring and fall are the hottest seasons. Then, from another quarter, a dash of cold water was thrown on this momentary enthusiasm when an educator asked me if I thought that tidbit of information had made me a better person.

It is not recorded what Hirsch replied. But what could one have said that would have even the slightest chance of initiating a worthwhile discussion?

The learning that Hirsch described was much more than a "tidbit of information." It was an understanding that tied together and made sense out of many tidbits of information. It was the very kind of understanding that research reveals is most pathetically lacking in American students. Why could Hirsch's critic not see that? Perhaps if Hirsch had said, "I finally understood the implications of the Copernican model of the solar system," this would have sounded impressive enough to have averted the criticism. All educators surely recognize that there are big and important principles that are worth learning, but they may not be able to recognize them unless they are so labeled. If Hirsch had reported that he gained in understanding of energy and its importance, this too would probably have been

accepted as worthy. *Energy* is a concept that figures prominently in virtually every science curriculum guide. Yet so notable a scientist as Richard Feynman (19xx) has declared it unsuitable for elementary education. At the level that children can understand it, he said, *energy* explains nothing.

The suggestion that learning, to be worthwhile, should make one a better person may sound fatuous, and in the reported context it certainly was. But behind it is a legitimate concern that knowledge acquired in school should do something for the learner. If it does not improve character and has no obvious practical application either, however, then what could it do for the learner? Satisfy curiosity, perhaps; but if that is the purpose, it suggests an altogether different approach to content selection than the one Hirsch advocates, which is based on considerations of what members of a society need to possess as shared knowledge.

Early in the twentieth century, two important philosophers turned their attention to problems of school subject matter—John Dewey in America, Alfred North Whitehead (although he was later to move to America) in England. Looking at rather different school systems, they saw essentially the same thing: students' heads being crammed with information that was supposed to represent the accumulated riches of a great civilization but that in effect amounted to little more than mental stuffing. Both Dewey and Whitehead held academic subject matter in high regard. The difficulty that both perceived was its remoteness from the lives of students. They did not, as many of their successors have done, recommend replacing it with content more 'relevant' to students' interests. Rather, they saw the educational problem as one of making contact. The value of what was being taught had somehow to be realized by students in the here-and-now. It had to serve some purpose in activities that were already meaningful to them.

That challenge to pedagogy remains largely unmet even to this day. Whitehead's description of the school curriculum early in the 20th century applies with little modification to what may be observed today:

Algebra, from which nothing follows; Geometry, from which nothing follows; Science, from which nothing follows; History, from which nothing follows; a Couple of Languages, never mastered; and lastly, most dreary of all, Literature, represented by plays of Shakespeare, with philological notes

and short analyses of plot and character to be in substance committed to memory. Can such a list be said to represent Life, as it is known in the midst of the living of it? The best that can be said of it is, that it is a rapid table of contents which a deity might run over in his mind while he was thinking of creating a world, and had not yet determined how to put it together. (p. 19)

Despite several generations of effort to make school subject matter more meaningful to students, evidence indicates that the outcomes are still deplorable. It is no great exaggeration of the findings from research on students' misconceptions to say that students understand hardly anything of what they are taught (cf. xx). This is most strikingly true of science and mathematics, but there are similar indications in history (xx) and social studies (xx). Literature teaching has perhaps changed the most since Whitehead wrote. Shakespeare has largely given way to contemporary writers whose themes are closer to students' experience; analyses of plot, character, and language have given way to thematic discussions. Yet writing assessments in the United States indicate that most students cannot put together any sort of articulate response to a literary text (xx).

Although both philosophers concluded that the way to make academic subject matter meaningful was to make it useful (a more radical idea in their day than it seems now), they understood usefulness somewhat differently. Whitehead, I think, had a broader conception and one more in tune with modern requirements. Dewey, with his American pragmatism, saw usefulness in more concrete terms. His was the conception that prevailed and that became degraded into the 'learning-by-doing'—which is now part of the mindlessness of schooling rather than an antidote to it.

Broadly stated, Dewey's position was thoroughly consistent with Whitehead's, insisting only that there be genuine contact between students and subject matter. In discussing the value of information conveyed in school, Dewey asked:

Does it grow naturally out of some question with which the student is concerned? Does it fit into his more direct acquaintance so as to increase its efficacy and deepen its meaning? If it meets these two requirements, it is educative. The amount heard or read is of no importance—the more the better, *provided* the student has a need for it and can apply it in some situation of his own. (p. 186)

In moving from these general criteria to the specifics of subject matter content, however, Dewey made two assumptions that must have seemed self-evident to him, as they still do to many childhood educators, although both are glaringly wrong. The first was that children's knowledge and interests are confined to the concrete and familiar. To appropriate a current term, we may call this the 'hands-on' fallacy. Dewey was quite explicit in endorsing it and in holding that abstraction is bad stuff for the young:

It is not true that the experience of the young is unorganized—that it consists of isolated scraps. But it is organized in connection with direct practical centers of interest. The child's home is, for example, the organizing center of his geographical knowledge. (p. 183)

The things we are best acquainted with are the things we put to frequent use—such things as chairs, tables, pen, paper, clothes, food, knives and forks... the things with which we are not accustomed to deal are strange, foreign, cold, remote, "abstract." (p. 185)

I have encountered teachers, imbued with this Deweyan belief, who could not countenance having children read a story in which a canoe figured without first bringing a real canoe into the classroom and letting the children sit in it and paw it over until they were familiar enough with it to go ahead with the story. Yet these same children would go home, turn on the television, and immerse themselves in worlds of dinosaurs, space travel, fantasy heroes and monsters, princes and princesses. But these exotic interests are only part of the story. As I will show later, young students can get interested in such topics as gravity, electricity, evolution, the adaptive mechanisms of animals they have never seen, and the customs of peoples long dead. Dewey remarked at one point on the fact that children outside of school are full of questions yet display no curiosity about the content of school lessons. (p. 155) This he attributed to the children's doing things outside school that give rise to questions. But the most profound of children's questions seldom relate to activities of the moment. They relate to the larger issues and forces that shape their world—birth, death, good, evil, power, danger, survival, generosity, adventure (cf. Egan, 19xx; xx). Adults, even the most 'child-centered,' tend to trivialize children's interests, making them out to be more mundane and egocentric than they

really are, and thus positing a distance between children's interests and intellectual subject matter that is greater than it needs to be.

The other fallacy that Dewey promoted is one firmly held by today's advocates of problem-centered and project-based learning. It is that practical tasks and problems lead naturally to inquiry into the underlying science (cf. Schank, 19xx). I know of no evidence that this is true, and so I chalk it up to wishful thinking.

If practical problems or projects are significant enough in their own right, then there is no need to claim far-fetched cognitive benefits. If students are learning to sail a boat, we do not need to claim that this will arouse their interest in reactive forces. If students are learning to put together their own televised news reports, we may count it as a lucky bonus if their coverage of some event leads them to investigate its historical antecedents. If the students are carrying out a public opinion survey, we need not expect this to fill them with curiosity about the mathematical basis of statistical estimation. In each case the activity can be justified by what is learned up-front. But, as noted in the preceding chapter, schools are sorely limited in the extent of real world problems and projects they can mount. Few schools can teach sailing or anything else that requires an environment beyond school and neighborhood. And it is very difficult to manage projects such as newscasting or opinion research in such a way that all 20 or 30 students in a class are doing something educationally productive. As a result, school problems and projects tend to be contrived for the purpose of indirect cognitive benefits, and if those should prove illusory the effort will have been wasted. That, I suspect, is why educators cling to the learning-by-doing fallacy despite its incompatibility with reason and evidence. They have to believe in hidden cognitive benefits, because otherwise what students do in school will be seen as contrived and frivolous, a diversion from teaching what students really need to learn.

There is, of course, some truth in both the hands-on and the learning-by-doing fallacies. Not only children but adults as well are engaged with immediate practical and social matters much of the time and tend to get lost if they stray too far from the concrete and palpable. But we look to formal education to develop precisely that part of human competence, present even in the young, that is able to deal with ideas and other abstract entities. We do learn by doing. The trouble with folk theory of mind is that it does not allow educators to recognize that working with ideas is also learning-by-doing.

What Makes Knowledge Useful?

Independently of each other, it seems, Dewey and Whitehead settled on the radical notion that school subject matter should be useful to students in the here-and-now. If taken seriously, this notion completely undermines the conventional approach to curriculum design. Two criteria guide the conventional approach, both of them vague: the criterion of usefulness in later life and the criterion of adult consensus on what students ought to know. The two tend to merge when it comes to the core academic subjects. Their anticipated usefulness is too diffuse to have a bearing on the selection of specific content and so potential usefulness becomes just one of the issues in discussions of what students ought to know. At the highest levels, where official guidelines are laid down for schools to follow, these discussions tend to be dominated by experts in the academic disciplines, and so what every student ought to know tends to reflect the requirements of the discipline rather than requirements of the world at large, and certainly not the requirements of the students' immediate lives.

To several generations of educators influenced by Dewey, making subject matter useful to students in the here-and-now has meant trying to twist the traditional school subjects around somehow to make them either practical or significant for the students' personal lives. Practicality has often worked well with older students (witness the technical schools and colleges), but not with the young. At the age when children are supposed to be mastering arithmetic they have little interest in the checkbook balancing, comparison shopping, and home handyperson calculations that represent the everyday uses of arithmetic. In fact, children's practical concerns tend to be of such a highly situated kind that they have little call for formal knowledge of any kind.

In a study concerned with the relations between schooling and work, Alan Lesgold (1996) and his associates interviewed expert machine tool makers. When asked about the relevance of school subjects to their work, they unanimously endorsed trigonometry. Lesgold worked out with them a trigonometric problem representative of those they came across in their jobs but not requiring any knowledge beyond the mathematical. When he presented the problem to high school mathematics teachers, they had considerable difficulty with it, although vocational education teachers solved it with ease. Lesgold concluded with the very

Deweyan observation that “School subjects have strayed too far from life” (p. 156). He offered sound proposals for bringing school subject matter into closer alignment with needs of the workplace, but—except for students who already have one foot in the workforce—such reforms are unlikely to result in subject matter of more immediate use to the learners. They might even have the opposite effect, replacing intrinsically appealing material with material whose value lies in practical applications of no immediate interest to the students. Certainly that has been the case with practical mathematics, a low-road alternative to algebra intended to equip students with mathematical skills useful in everyday adult life but succeeding mainly in setting a standard for dullness.

Whitehead, as I remarked, seemed to have a broader conception of the usefulness of subject matter than Dewey did. “Of course, education should be useful,” he wrote (1929, p. 14), “whatever your aim in life. It was useful to Saint Augustine and it was useful to Napoleon. *It is useful, because understanding is useful* [emphasis added].” Like Dewey, he meant useful in the student’s immediate experience: “I would only remark that the understanding which we want is an understanding of an insistent present. The only use of a knowledge of the past is to equip us for the present.... The present contains all that there is.” (p. 14) But he did not see usefulness in such pragmatic terms as Dewey was wont to do:

By utilising an idea, I mean relating it to that stream, compounded of sense perceptions, feelings, hopes, desire, and of *mental activities adjusting thought to thought*, which forms our life. (p. 15, emphasis added)

The goal was not simply practical efficacy and the enrichment of personal meanings but was, as quoted in the epigraph to this chapter, enabling students “to appreciate the current thought of their epoch” (p. 83).

Dewey saw the importance of understanding as well and the value of education in enriching meaning, so perhaps the only difference I am talking about is one of focus. The image of the student that comes through from Dewey and that seems to have shaped his educational proposals is that of the energetic 4-H Club member, busy going to meetings, raising a calf, conducting a bake sale, and helping Dad figure out how much seed corn to buy (remember, this was the early 1900s). The image that comes through from Whitehead is that of the forlorn schoolboy, far from home in

some moldering academy, boning for exams and wondering what it is all about. Two consequential differences spring to mind. The first is that to produce Dewey's kind of youngster you should not be looking to the schools, you should be looking to 4-H Clubs and the like. Schools will always prove inadequate and fundamentally ill-suited for such a purpose. The second is that, although Whitehead's kind of student may also be absorbed in hobbies and various practical and social pursuits, these take place within an encompassing mental life. The student is not merely trying to solve this or that problem that has arisen out of practical activities but is engaged in a more global effort to make sense of the world. This is an effort in which schooling could be but usually is not profoundly relevant.

As I try to read between the lines of these two estimable philosophers, it seems to me that the most fundamental difference between them lay in Whitehead's greater willingness to regard ideas as real things. Accordingly, an idea could be truly useful without its having to solve some practical or social problem. It could be useful because it helps in understanding some other idea or in resolving an apparent inconsistency or anomaly or because it opens up an exciting new line of thought, leading to the generation of new ideas.

A study reported by Bereiter and Scardamalia (1989) illustrates the use and nonuse of new ideas. We presented what were presumed to be new ideas to elementary school students and asked them to think aloud in response. One was the idea that, contrary to the image projected in television cartoons, commercials, and health lessons, harmful germs are not really trying to be bad: "They just want to live quietly, eat, and make more germs." At the lowest levels of response, children ignored, misunderstood, or contradicted the statement and went on declaiming against microbial aggressors. Then there was an interesting level of response at which children indicated they had grasped the point, but showed no appreciation of its novelty or its incompatibility with their existing conceptions. They might, for instance, merely paraphrase without comment. Such behavior suggests a kind of pathological response to school-based information that Dewey noted: "All too frequently it forms another strange world which just overlies the world of personal acquaintance" (p. 186). Research on children's scientific conceptions has documented such anomalies. Having been taught in school that the earth is round, whereas they can plainly see that it is flat, some children resolve the discrepancy by concluding that there are two earths, the one where

they live and the one they hear about at school (Vosniadou & Brewer, 19xx). The children interviewed in our research may similarly have been on the way toward constructing two orders of germs, the hostile kind that make you sick and the indifferent kind existing in the fictitious world of school subject matter.

These responses indicate a failure or disinclination to think about the relations of ideas to one another, to engage in the “adjusting of thought to thought,” as Whitehead put it. But some students did recognize that there was something new to think about. “That’s not exactly my idea of a germ,” one child said. Such students might try to reconcile new ideas and old. For instance, “Well, they don’t really know that they’re bad, but they’re just living their normal way, but everybody else thinks they’re bad.” And one child started to run with the new idea, expanding on its implications: “I wonder if germs are intelligent. I guess not. Maybe there’s a whole new world, like... there is fighting going on between the good and the bad... It’s kind of neat when you think about it, ‘cause to think of a whole new world inside your body.”

Making sense of the world, increasing coherence, resolving anomalies—these are the most immediate uses of school subject matter. There may also be practical uses, which ought surely to be exploited, but sense-making uses are the bread and olive oil of academic life, whether in the kindergarten or the university. Therefore it is the failure of schools to promote these uses of knowledge that constitutes their most profound failure, a failure that no amount of drill and practice on one hand or practical projects and hands-on activities on the other can remedy.

What are Concepts for?

What is the concept of *gravity* good for—or the concept of *oxygen*, *human rights*, or *triangle*? I am not asking what good does it do students to learn such concepts, although that question follows closely. I am asking what is the good of having such concepts at all? That is a question I have never seen addressed in school textbooks, yet it is surely prior to the question of why students should be expected to learn them. Schoolbooks will say why gravity and oxygen themselves are important, but that is something quite different. The *concept* of oxygen came some years before discovery of the actual substance, and as for gravity, Newton went to his grave dissatisfied because he did not know what it was—and in a concrete sense we still don’t know. Theoretical concepts were created to serve

certain purposes. It would seem that in at least some cases those purposes ought to be relevant to the students' own purposes. Instead, textbooks present concepts as if they were talking about the natural world. Gravity, capital, metamorphosis, and so on are defined, explained, illustrated with examples, as if they belonged to the same order of things as opossums, thunder storms, and mold. They are treated as constituting how the world is. One no more asks the purpose of the concept of gravity than one asks the purpose of turtles. Children will tell you that the purpose of gravity is to keep us from falling off the earth (one child even brilliantly deduced that the reason there is less gravity on the moon is that there are fewer things there and so less gravity is needed to hold them down). But children are talking about gravity conceived of as perhaps a substance, not gravity the concept. They shouldn't be criticized for this. Nothing they have been taught in school is likely to have suggested anything different.

Gravity, the concept, is something real, too—or so I have been arguing, following Popper. But it is a real artifact. With artifacts, one does ask what they are for. If you have visited collections of gadgetry of the past, such as those found in restored villages, you have probably seen puzzling contraptions that elicit the same question from nearly every spectator: "What's it for?" It is the first thing you ask about a novel artifact, and it is the first thing students ought to be asking about a newly encountered idea. "The vital first step towards understanding a theory," Popper (1972, p. 182) said, "is to understand the problem situation in which it arises." Without that, it is hard to see how academic subject matter could ever be rendered useful.

Oxygen, we know now, is material stuff. You can buy containers of it or purchase whiffs of it in some bars. But before the material stuff was isolated, oxygen existed as a concept, which was invented to account for such puzzling facts as that iron gets heavier when it rusts. Most of the concepts taught in school are of this kind. They were invented in an effort to explain something. Their use lies in making sense of the world.

There is a whole other range of concepts, however, that do not have this problem-solving character. These are everyday concepts like *dog*, *chair*, *cloud*, *man*, *woman*, *tree*, *breathe*, *run*, *sleep*, *green*, and *telephone*. In a practical sense these concepts do simply constitute how the world is. That is, they divide the world up into

categories that correspond to how we experience it. Of course, to an extent we experience the world the way we do because of the categories we have learned, but subjectively it all comes to the same thing. An important line of research has produced evidence that these *basic-level* concepts, as they are called, are psychologically quite different from the higher-level concepts of the sciences and disciplines.¹ For the most part they are not definable. People learn them by generalizing from instances. And people are astonishingly good at doing it. Very young children will quickly learn to recognize elephants, giraffes, hippos, kangaroos, lions, chimps, and so on from picture books; when they are then taken to a zoo, they will quite amazingly recognize these animals in the flesh, even though all they had previously seen was one cartoonish drawing of each. Basic-level concepts typically have short names and many identifying characteristics, making them easy to learn and hard to confuse with one another. They divide the world up in ways that make a difference in day-to-day living. As I remarked elsewhere (Bereiter, 1992), it makes a difference whether the animal in your garden is a cow or a dog; it makes much less difference what breed of cow or dog it is and hardly any difference at all that it is a mammal and not a marsupial.

The difference between basic-level concepts and the higher- and lower-level concepts that are the concern of formal education is essentially the difference between Popper's World 2 and World 3. Basic-level concepts belong to the psychological world. Folk theory would consider them to be things in the mind. They are more accurately thought of as abilities or dispositions. Fairly simple connectionist networks can form basic-level concepts simply by adjusting to covariances in information, without creating anything resembling a mental object (Hinton, et al., 1986). To say that your concept of *chair* and mine are similar is only to say that our cognitive systems are tuned to respond similarly when it comes to applying the label 'chair.' We should probably find that the similarity is near perfect as regards objects found in a typical furniture store but that it would falter as we encountered the more fanciful creations found in design galleries. But if you thought something should be called a chair and I did not, we would not find it profitable to argue about the matter. The concept *chair* is not a proper World 3 object. It is not discussible, subject to criticism, susceptible to improvement the way World 3 objects characteristically are.²

Concepts like *gravity*, *genes*, and *contract*, however, are World 3 objects. They have histories. They exist independently of what you or I know or think about them. We can participate in efforts to refine, improve, find new uses for them, or retire them from use. What is most important from an educational standpoint, however, is that students can become knowledgeable concerning the concepts themselves, not merely about what the concept refers to. In fact, it is a very important consideration that many of the higher-level concepts do not have referents. Students tend to assume that they do, that the concepts refer to objects or substances (Chi, 19xx). But this is further to confuse them with basic-level concepts.

Much of school instruction is of the 'all about' variety—all about dinosaurs, Alaska, volcanoes, Harriet Tubman, the Aztecs, fossil fuels, or whatever. There is not much difference between textbook-oriented and activity-oriented classrooms in this regard, except that in the former all the students are likely to be acquiring information about the same things whereas in the latter different students will be collecting information on different topics. Cross-curriculum integration, in the form of 'thematic units,' is currently hot with progressive educators. This means that a unit on the Aztecs, for instance, will not only occupy social studies but will ring all the other areas of the curriculum as well into amassing information related to the topic. There is also not much change from the primary grades to high school. The most extreme example of an 'all about' textbook I have seen was one for high school chemistry, which went on for over 500 pages of small print describing inorganic substance after inorganic substance according to an unvarying schedule. 'All about' learning can be fascinating or indifferent or unbearably dull, depending on the appeal of the objects being studied. The chemistry text probably wiped out whatever mild interest a generation of Pittsburgh high school students might have had in the composition of matter. Yet I have seen similar compendia of facts, except that they were about baseball players, which I found pleasantly interesting, and I imagine there are students who would find them equally absorbing. But others would not. Pity the poor elementary school student who happens not to be interested in dinosaurs or space travel!

Whatever its virtues or drawbacks in the school context, 'all about' learning is the kind of learning we naturally do with respect to basic-level concepts. The course of learning basic-level concepts

typically consists of a brief period of mastering the categorization followed by the life-long accumulation of knowledge associated with the concept. Thus, the young child may go through some months of getting it straight that not every large animal is a horse and becoming able to distinguish horses from nonhorses in various settings and despite variations in color and stature, whereas the accumulation of knowledge about horses goes on indefinitely. If the child in school undertakes a research project on horses, this will be a natural extension of the knowledge accumulation that has been going on since early childhood. I have elsewhere (Bereiter, 1992) referred to this kind of learning as 'referent-centered.' The only thing that ties it together is the referent, the real-world thing that it is *about*. If the referent is *China*, all kinds of historical, geographical, anthropological, and political information may be processed, which have nothing in common except that they all have to do with China. Whether this constitutes useful knowledge depends entirely on whether it is helpful when one reads about, talks about, or encounters the referent. With basic-level concepts, it is clearly a good thing to have your knowledge associated with the referent. Your knowledge of horses should be available when you encounter a horse—either in discourse or in the flesh. There are not many other occasions when it will come into play. But this is far from the case with your knowledge of gravity. If that knowledge only comes into play when gravity is the topic of discourse, education will have failed.

'Inert knowledge' is the term Whitehead coined for precisely that kind of failed learning. It is knowledge that students can exhibit when it is specifically called for (on an examination, for instance), but that otherwise plays no role in their lives. Whitehead attributed it to the fragmentation of the curriculum and to the lack of application. I have suggested that at a deeper level inert knowledge arises from treating higher-level concepts in the same way as basic-level ones, resulting in referent-centered learning (Bereiter, 1992). The time when we want our knowledge of gravity to come into play is not only when gravity is referred to but, more importantly, when we encounter a problem that a knowledge of gravity can help us solve. Accordingly, I called gravity a *problem-centered* concept.

The paper in which I introduced the ideas of referent-centered and problem-centered knowledge seems to have been more thoroughly misunderstood by favorably disposed readers than

anything else I have written. The difficulty, it appears, arises from confusion with the more familiar idea of ‘problem-based learning’ (xx). Problem-based learning is actually tangential to the distinction I was trying to make. It refers to a teaching method in which learning arises from work on problems. The learning that occurs could be either referent-centered or problem-centered, depending on what kind of problem solving goes on. Often the problem posed is an engineering or design problem—for instance, to design a new sports complex. The learning in such cases is likely to be referent-centered—knowledge about sports complexes. In other cases the problem may be to explain a perplexing phenomenon or to figure out what is going wrong in a situation. This is often the case with the problems posed in medical education, where problem-based learning originated. Theoretical concepts may well be brought into play to solve such problems, and in this case students should be accumulating what I called problem-centered knowledge. But problem-centered knowledge could also be acquired by listening to a lecture, if the lecturer was successful in getting students to understand the problem situations in which the concepts or principles are relevant.

I am not arguing against referent-centered learning. It is a good idea for students to know something about the various nations, historical figures, plant and animal species, and so on. To the extent that schools pursue this kind of learning, however, they must contend with the perennial problems of too much to learn, too little time, and the lack of use for what is learned. Motivation is also a problem for referent-centered learning. If the referent itself is interesting, students will eagerly accumulate knowledge about it. That is why typical school programs devote inordinate attention to dinosaurs and hardly any to soy beans. Making referent-centered learning interesting when the referents themselves are not already interesting to the students has been a continuing problem that teachers and textbooks often treat in a blundering way. Lard the lesson with interesting but tangential stories and students tend to remember the stories and forget the rest (Hidi, 19xx).

A myth that goes around among futurists is that three-fourths of the knowledge acquired in university engineering schools is obsolete within a few years of graduation. The only way this could be true would be if all the learning was referent-centered and the referents themselves became obsolete. That has been a long-standing

complaint about high school shop courses—that students learn to use obsolete tools to repair obsolete cars, for instance. But no sensible engineering program would be so referent-bound. Problem-centered concepts and skills do not go out of date rapidly. Particular problem solutions may go out of date, but the principles behind the solutions do not. Referent-centered knowledge about natural kinds does not go out of date rapidly, either.³ What is true of dogs today will very likely be true a hundred years from now. It is only high-tech artifacts that become rapidly obsolete. Whatever computer skill you may be acquiring right now, you can be sure clever people are at work figuring out ways to make that skill unnecessary.

With the accelerating growth of knowledge, there are not only more facts but also more concepts than can imaginably be taught. The problem of choosing which concepts are most worthy of being taught is a problem that every good curriculum committee takes very seriously. Solving it typically involves consultation, sometimes wide-ranging consultation with subject-matter experts, curriculum specialists, child developmentalists, teachers, employers, and parents. The result is likely to be a list that is either too long or too short. The consultative process tends inevitably toward a long list. It is much easier to justify the inclusion of a concept than to justify its exclusion. If the list gets ridiculously long, there will be a move to consolidate it. That generally means replacing concepts with categories of concepts, resulting in a short list of broad categories, like the chapter titles in a textbook, and usually just as conventional.

What curriculum planning needs is not a better process but a better criterion for selection. If the criterion is whatever seems important from the point of view of each consultant, then the more consultants you have the longer the list will be. The criterion I suggest is not an easy one to apply, but I think it is the only criterion that can sift out the concepts that are not only important but optimally learnable: *What use can students of the designated age and kind make of this concept in their efforts to understand the world?* It may strike you that this proposal is utterly impractical. On the typical curriculum committee not one person will have a basis for answering the question. I admit it. That's what's wrong with educational thought. That's why we need a new theory of knowledge and mind. That's why I am writing a book about knowledge and mind instead of a book about how to reform education.

Understanding the World vs. Understanding Theories About the World

One of the most serious objections I encounter to adopting Popper's three worlds metaphor for educational purposes runs as follows: The biggest problem in subject-matter teaching is that teachers are inclined to treat their subject as consisting of a body of knowledge to be transmitted to the students. The World 3 concept reinforces this tendency. Better, therefore, to focus on the processes of inquiry and meaning-making rather than on knowledge as such.

It could be argued that the cure in this case often turns out worse than the disease (cf. Hirsch, 1996, but more to the point is that the disease has been incorrectly diagnosed. The naive epistemology lying behind knowledge-transmission pedagogy is a two-worlds epistemology. The absence of a clear conception of the third world is what makes it difficult to work out a sensible relationship between already available knowledge and students' own knowledge-building efforts.

In the two-worlds epistemology, subject-matter knowledge is treated as no different from any other worldly knowledge. Suppose your partner asks you where the electric heater is and you say it is in the basement locker. There are two issues in this situation. One is your belief, held with greater or lesser confidence, about the whereabouts of the electric heater. This is a World 2 issue. The other is the actual location of the heater, a World 1 issue. Irrespective of your World 2 state of knowledge, the heater either is or is not in the basement locker. There is no World 3 object involved here. If you say, "My theory is that the heater is in the basement locker," you are not using the word 'theory' in a way that distinguishes theories from personal opinions.

For most everyday purposes, two worlds are enough. But see what happens when this naive epistemology is carried over into subject-matter instruction. The teacher states that a meteor hitting the earth caused the extinction of the dinosaurs. The two elements at issue parallel those in the electric heater situation. The World 2 element is the teacher's belief about dinosaur extinction. The World 1 element is what actually happened back in dinosaur times. Again there is no World 3 element involved. This is not to say that the situation is without problems. There may be considerable discussion about the plausibility of the claim that a meteor was responsible for dinosaur extinction, and during this discussion the phrase "meteor

theory” may well appear. But unless the teacher makes a point of it, the discussion is not likely to be about the theory. The discussion will be about what *really* happened, just as a household discussion may be about where the heater *really* is.

There is a difference between the household situation and the classroom situation, however, and it has to do with the relative importance of World 2. Where the electric heater is concerned, what people believe or claim to know is quite secondary to the World 1 issue of where the heater actually is. But in schooling, as we have noted, the focus is on World 2. Schooling is not fundamentally concerned with what happened to the dinosaurs, it is concerned with what students believe or know about dinosaurs. Of course, there is a concern that what students learn should be right, and so what actually happened to the dinosaurs is not irrelevant, but that issue has become badly muddled by forcing it into a two-worlds framework.

The pages of science education journals have become full of worrying about how to teach, given the problematic nature of scientific knowledge. Few teachers who read such journals would any longer state baldly that a meteor brought an end to the dinosaurs or even that the earth is a globe. They would hedge their statements somehow or would put it as, “Scientists now think that a meteor was what caused the dinosaurs to become extinct.” If they are really *au courant* they will introduce or invite alternative explanations, may even draw in a handy myth, and encourage the students to talk it over and make up their own minds. None of this does much to the underlying epistemology, however. There are still just people’s beliefs (World 2), which have some problematic relation to a truth of the matter (World 1). Some bold teachers, influenced by postmodernism, may reject World 1, thus making everything a matter of personal or collective belief, but such advanced notions are unlikely to have any effect on their students. As far as students (and most teachers, we may assume) are concerned, there really were dinosaurs and something really happened to them; that World 1 reality is what they are studying and talking about.

There is nothing particularly wrong with this, and with young children there is probably no alternative to the two-worlds model. Subject-matter learning is then a matter of bringing beliefs into conformity with the way things really are. A lot of good science has been done with just such a model, and a lot of good education as

well. The two-worlds model does, however, lend itself to the unfortunate tendencies sophisticated educators worry about. It disposes teachers to think of themselves as intermediaries between a body of truths held by scientists and scholars and the innocent minds of the students. The result too often is slavishness to the printed word, investment of scientists with priestly status, reduction of experiment to demonstration of pre-established truths, and reduction of study to memorization.

As long as the two-world's model remains in force, however, there is no escaping these tendencies. It does no good to harp on the fact that today's truths may become tomorrow's fallacies. Everyone knows that, and it will not trouble the sensible teacher, however much it may preoccupy the educational theorist. The electric heater may not be in the locker after all; but that does not prevent us from declaring it to be there, given that we have no present reason to believe otherwise. Reducing the two worlds to one, by making everything a matter of unfounded opinion, may gratify some philosophical need but all it does educationally is remove any reason to study anything. Shifting the focus of instruction from substance to process can have either of two results. It can simply provide alternative ways to get the truths into students' heads—through discovery learning instead of didactics, for instance. Or it can reduce schooling to edutainment—to activities having some vague relation to a body of subject matter but pursued for their immediate amusement value.

Bringing World 3 into the instructional picture avoids most of the problems and misdirections I have been noting. Now, in addition to the teacher's and students' beliefs about dinosaurs and the actual events of eons ago we have the element of conceptual artifacts—theories—that have been constructed to explain dinosaur extinction. These may now become objects of study. As with other human constructions, such as food processors and fax machines, we may investigate what they do and do not do and how well they do it.

Bringing conceptual artifacts into instruction does raise dangers of its own, however. Even postmodernists who fancy that there is no reality to which theories are supposed to conform become uncomfortable with the prospect of students bandying theories about in the absence of experimentation or concern for evidence. And it regularly happens. Discussion focused on ideas can easily degenerate into verbalism and excessive fondness for one's own

notions. So, yes, World 1 must also figure in the classroom; and it can do so without our having to settle the timeworn problems of the relation between World 1 and World 3.

Students are perfectly capable of recognizing that a theory is in trouble when it implies something contrary to fact. One stark instance occurred when a student offered an account of how monkeys gradually became apes and apes gradually became humans. Another student entered the comment, "According to your theory there shouldn't be monkeys and apes anymore, but monkeys and apes are still alive. If you want proof, go to any zoo."

The problem is in getting students to press far enough in drawing out implications.⁴ Failing in that, their theories will never come up against troublesome facts. But in order to have such implications, theories must go out on an empirical limb. They cannot be mere verbalisms or mere descriptions of what has been observed. I once asked a class of bright seventh-graders how it is that we can see through glass. With one exception, they were all perfectly satisfied with the explanation that we can see through glass because it is transparent. That is verbalism. When, having done some experiments with dry cells and light bulbs, sixth-grade students were challenged to explain how electricity works, few of their theories went beyond stating that the electricity goes out through one wire, does something to make the light bulb light up, and then returns through the other wire. Although one could derive some empirical implications from such an account, as employed by the students it does little more than describe what happened. Including the term 'electricity' contributes nothing to the explanation. It is another verbalism, like 'transparency.'

The conventional antidote to verbalism is hands-on-learning; more experimentation, in the electricity case. But a more direct antidote is to ask a deeper question. That is how the teacher, Jim Webb (Hewitt, Webb, 19xx), dealt with students' verbalistic explanations of electricity. The next year, instead of simply asking the students to explain how electricity works, Webb instructed them to pay special attention to what goes on inside the wire. In doing so, the students had to deal with the problem of how electricity could get from one place to another through a solid substance. They then started to produce explanations like the following:

I think that in some materials there might be a certain grain, like the grain in wood, that stops electricity or does not let it go

by in it, but this “grain” is only in a few materials so the other materials would conduct electricity. I also think that if materials don’t conduct electricity very well then they have a little a bit of this grain in them but not enough to stop electricity totally.

I found some information that will probably help you. In order for electricity to flow through a wire, electrons that are loosely bound to atoms are wrenched away (these are called free electrons). This is called ionization. If ionization does not occur then electricity cannot flow through the wire. Electrons sometimes collide with other atoms which causes them to slow down or stop. This sometimes appears as heat. Inside the wire the electrons don’t move very fast.

The first of these is obviously a conjecture motivated by the observation that wood does not work as a conductor the way metal does. The second is information obviously taken from a book. The first could conceivably lead to empirical testing (there are, for instance, grainy metals); the second could not realistically be expected to do so. But both are significant steps beyond verbalism and mere description. What gives them their added bite is that they are attempts to solve a problem. How electricity works evidently did not strike most students as a problem, anymore than the question of how we see through glass. When there is no problem to solve, that is when verbalism and mere playback of observations take over. How electricity could get through a solid wire was a problem for the sixth-graders. In the seventh-grade class, the one student who was not satisfied with transparency as an explanation recognized a problem there as well. He was so excited he could hardly stay in his seat. “Here I’ve been looking through glass all my life,” he piped, “and I never thought about how the light could get through!” As Popper said, World 3 and World 1 meet each other in World 2, in people’s minds. Bringing about that kind of meeting should be the point of subject matter teaching.

Not just any old problem will produce this meeting of World 3 and World 1, however—not even any old attention-grabbing and intriguing problem. To elaborate this point, I want to go back to the study discussed in Chapter 8, in which students had the task of explaining a demonstration of evaporation and condensation. The problem posed to the students was not a general one of explaining

how evaporation and condensation work. It was the very specific one of explaining how liquid left one part of an apparatus and reappeared in another without being seen in transit from one place to the other. I expect that almost all teachers would prefer the specific problem to the general one. It is more striking. It arouses curiosity. It poses a much clearer problem of explanation. Furthermore, they may argue, solving the specific problem in detail (recall that the students were required to produce a demonstration using models of molecules) entails explaining evaporation and condensation. And yet the problem was a flop as far as motivating an effort at understanding was concerned.

To scientists, a strange and puzzling phenomenon is often a stimulus for inquiry, but not always. It is a stimulus when they already have an explanation for the general class of phenomena but it doesn't fit the new observations. In other words, what motivates inquiry is a perceived shortcoming in World 3. For the young students observing the migration of liquid in a glass vessel, no prior theory was endangered. For them it was a task of explaining an isolated phenomenon, using whatever knowledge they had available. This can sometimes be engaging, but it is not how World 3 is constructed and transformed. Scientific inquiry is seldom concerned with bizarre phenomena. Most of what appears in supermarket tabloids would not be of much scientific interest even if it were true. It is the problems of explaining the normal that have driven the big scientific advances—the normal motions of the planets, the circulation of the blood, the souring of beer, the spread of disease, the multiplicity of species. It is only as they reveal weaknesses in explanations of the normal that strange phenomena become scientifically interesting—when they result in those collisions of Worlds 1 and 3 in the well-prepared mind.

Students, however, lacking explanations of the normal, are in no position to appreciate the significance of anomalous observations. For them the demonstration of mysteriously migrating liquids is in the same class as card tricks and three-headed calves, only not as amazing. But seeing through glass is not a problem that stimulates inquiry for most of them, either, because it is just the way things are.

Finding the right level of problem is a challenge, for only if it is at the right level is it actually a problem for the students. Explaining condensation and evaporation is too abstract and general to be a problem for school-age students. Explaining the barbell phenomenon

is too isolated. Here is a problem in between that I think might work, although I don't know of its having been tried: *Has there always been the same amount of water since the earth began, or is water created and destroyed?* Pursuing an answer to that question will quickly lead into the evaporation-condensation cycle and to the realization that evaporation doesn't destroy water and precipitation doesn't create it. Experiments might then be conducted to determine whether the amount of water does indeed remain constant through such cycles. But then questions would arise about regions we hear of that are getting drier. Are these matched by other regions that are getting wetter? Further probing into chemistry will reveal that there are processes that create water and others that destroy it. But do these take place on a scale that would have much effect on the overall amount of water? I don't know the answers and I would not expect many elementary school teachers to. Yet it is easy to see that the initial problem expands naturally into other interesting problems that build toward a coherent understanding. These subproblems get into geology, geography, climate, and ecology; but so long as they remained tied to the original question, basic scientific knowledge should continue to develop.

Fortunately, students themselves can often generate the problems, and that virtually insures that they will be at the right level.

How Do the Humanities Matter?

Art and history are the most powerful instruments of our inquiry into human nature. What would we know of man without these two sources of information? We should be dependent on the data of our personal life, which can give us only a subjective view and which at best are but the scattered fragments of the broken mirror of humanity.

Cassirer, 1950, p. 206

So far my discussion of "subject matter that matters" has dealt almost entirely with science. Note that I have said nothing about the practical and economic value of science. Those values may be why science gets the funding it does and why there is so much emphasis on it in educational policy, but that is not why science will matter to

students. Those who adhere to a literal interpretation of Dewey and look for science to emerge from and play a useful role in students' worldly pursuits are going to come up short. My argument has been that scientific ideas matter to students to the extent that they help them solve problems of understanding. That is why, if you want students to take an interest in science, you have got to get them intensely involved in trying to understand the world.

The same argument can apply to getting students to take an interest in the humanities, but with important modifications. For purposes of this discussion let us define the humanities broadly to include literature and the arts, history, and geography and social studies in their cultural rather than theoretical aspects. To the educated adult, these matter in much the same way that science matters. They help in understanding the world—the world of human motives, actions, and values. They may matter in other ways as well, but their contributions to understanding are what mainly justifies their being treated as necessary parts of the curriculum. True, the humanities are treated as poor relations, but they would probably have dropped out of the curriculum altogether if it were not that many influential people experience them as somehow contributing to their own intelligence. The problem is to get students to experience them that way.

If you are pursuing a problem of scientific understanding, getting hold of the right fact or idea can have an immediately illuminating effect. The 'aha!' experience convinces you on the spot that this is a valuable piece of knowledge. I have seen this happening with children. To kids who have been wondering about the vagaries of family resemblance—how you can resemble your aunt more than you do your mother, for instance—Mendelian genetics comes as a revelation. Teach it the other way around—present the Mendelian model first and then show how it explains things kids may have observed—and you are likely not to get the same effect. So problem-driven inquiry becomes the method of choice in teaching science; but it cannot work in the same way in the humanities.

If you are puzzling over some current event or some aspect of the human situation, the likelihood that you will hit on an illuminating piece of literature or history is not very high, but if you are 12 years old the likelihood is essentially zero. The reasons boil down to your needing to know a great deal before you know anything of much value. Isolated bits of literature, history, geography, and

anthropology have little value. Relatedness brings wisdom. The same is true in science, except that in science there are these big principles (like Newton's laws or the Medelian model) that do the connecting. There is nothing like that in the humanities. You have to learn a great deal of history before you develop enough implicit understanding to draw useful connections between one event and another or between past epochs and our own. The same is true with literature and with knowledge of different peoples and places.

From an instructional standpoint, it is always unfortunate when students have to learn things first before they can appreciate their value. Motivation becomes difficult. Instruction gets caught in a Catch 22, in which students will not learn unless they see the value of what they are being taught and they cannot see its value until they learn. To escape it, teachers find themselves resorting to carrots and sticks, fun and games, and extraneous material to enliven the subject matter. All of these are abundant in the teaching of the humanities, along with generally pathetic efforts to make material relevant to students' present lives. But these all miss the strongest motivational angle of all in teaching the humanities—the fact that they are about humanity.

It is hard to make out why the Boston Tea Party should matter to a Latino student in Houston, Texas. It is foolish even to try. You could, however, try to show why the Boston Tea Party mattered to the people who took part in it. But that is where school history textbooks conspicuously fail (Beck & xx, 19xx). [xx quote Beck et al] Powerful narratives, whether in the form of fiction, history, biography, books of travel, or some hybrid, create in the reader the experience of significant conditions and events. When in the grip of a story, people don't think "How is this relevant to me and my problems?" They experience events through the protagonists and do not look for significance outside the world of the story.

This does not mean that good stories are timeless and universal, although the occasional one is. They must engage our feelings, and what it takes to do this may vary from age to age and culture to culture.⁵ Many historians, following in the tradition of Herder, try to make the past come alive for their own generation, and this too means that there may need to be different histories for different times and different sensibilities (Cassirer, 1950). Thus there must be connection to our own concerns; but it is the writer, not ourselves, who does the connecting. If the novelist, historian, biographer, or

travel writer is successful, we are not even aware of the connections. We are simply engrossed in the world of story.

Eventually, of course, we want students to be aware, to read critically, to make their own connections between what they read and what they are trying to understand. But that is what requires wide prior knowledge. Stories provide a way around the Catch 22. They provide a way for students to acquire a great fund of episodic knowledge about human beings and how they feel and act, about the histories and current lives of different peoples, about what it is like to live in different conditions and with different purposes, without having first to understand the value of this knowledge. They don't even need to know they are learning.

No one can come even close to being an educated person without knowledge acquired in this way. But it is a way of learning that flies in the face of all the pedagogical conventions. It violates the traditional conventions because nothing in particular is specified to be learned. It violates the newer constructivist conventions because it is passive, not active learning. Progressive educators conveniently ignore this fact, but our everyday metaphors give it away. A story "grabs you." It "holds your attention." You are "carried away" by it. Experiencing a story does not involve critical thinking. (What goes under the label of critical thinking in reading programs is nothing more than puzzle solving.) It is not purposeful or problem-driven. Although social, it is not collaborative. And this passivity is if anything even more pronounced when we come to the story via television or cinema.

There should be nothing paradoxical or disturbing in this, if we recognize that different kinds of personal knowledge are at issue. In science, regardless of how it is pursued, the focus is on negotiable knowledge—knowledge of conceptual artifacts. Conceptual artifacts are constructed on purpose, they do not just happen. They are the natural objects of critical thinking. Their construction, criticism, and improvement are best carried out through collaborative work. Therefore, scientific knowledge building properly touches all the constructivist bases. But the main knowledge we get from stories is not negotiable knowledge. It is impressionistic and episodic. These are kinds of knowledge that arise incidentally from experience. You cannot deliberately acquire such knowledge, you can only deliberately seek out the kinds of experiences that produce it. The expression "soaking up" experience describes the process well.

All of this, I believe, Cassirer might have agreed with. In fact, I owe much of it to him. But he clearly means more than the passive absorption of stories and impressions when he says “Art and history are the most powerful instruments of our inquiry into human nature.” Now he is talking about purposeful, critical inquiry and is naming art and history as the tools of choice, as against science. Does that mean we are back to “What lesson does this poem teach you?” (Rosenblatt, 19xx) No, it means that when we pursue critical inquiry in the humanities we reason from cases rather than principles, and history and the arts are our main source of cases that go beyond the limits of our personal lives. Young people can carry out critical inquiry into problems of human nature and affairs—I am not suggesting it should be held off till maturity—but they will be mainly limited to their own experience and to what they have absorbed from television and incidental reading. If the television and reading they experience are of low quality,⁶ the impressionistic and episodic knowledge acquired may well have negative value as far as understanding the human world is concerned.

There are other reasons for studying the humanities besides acquiring impressionistic and episodic knowledge for use in building knowledge about the human world. If it is construed broadly enough, the word ‘appreciation’ covers many of them. But the providing of tools for understanding the human world is an important one, which results-oriented policy-makers ought to be able to recognize. Recognizing that value, however, requires a more complex and differentiated conception of knowledge than folk theory provides. Similarly, teaching in such a way as to allow impressionistic and episodic knowledge to develop unimpeded requires a theory of knowledge and mind that does not fetishize active learning and critical thinking.

In all kinds of inquiry, there needs to be a balance between active pursuit and passive reception. I am always saddened by doctoral students who think that before they sit down and watch the videotapes or whatever that they have collected for their research they must have a coding scheme that determines what they will categorize and count. I urge them, “Let the data speak to you,” but they don’t know what that means. Well, it means, for instance, watch your videotape as if you were watching a movie; allow it to “grab you” and “carry you away”; then, as you begin to sense that something significant is afoot, look for ways to capture it in a

discussible and criticizable form. In the humanities, the passive receptive phase is more extended and if you slight it you end up with nothing at all. Schopenhauer put it in a rather dated but still compelling way: “A work of art must be treated like a prince. It must speak to you first.” In contrast, almost everything that goes on in school—especially everything that goes on in the name of constructivism and critical thinking—is yattering away at the cultural artifact without ever giving it a chance to speak.

Where Quantity Counts

Breadth-versus-depth is an educational issue that will never go away. The long-range hope, of course, is to have students end up with knowledge that is both broad and deep. The controversy is about how best to start. Irrespective of what is the best way to get students to an eventual state of breadth-*plus*-depth, however, the fact is that for a great many students the first course they take in a subject is the only course they will ever take. Consequently, the breadth-depth issue has a certain finality about it. It is not just a question of strategy.

The whole modern constructivist turn has been toward depth first. Having elementary school students spend half a year studying an exotic species of cockroach is held up as exemplary, on grounds of the depth of learning and the amount of problem-driven inquiry (Lamon, Caswell, ...19xx). At the opposite extreme is the movement known as Core Knowledge (Hirsch,) which itemizes a vast range of things that students at each grade level are to be taught. In the meantime, the survey course lives on, because when you get a committee of knowledgeable people together to discuss what ought to be in an introductory course, they will inevitably—and regardless of their pedagogical philosophies—end up with a long list.

Breadth-versus-depth is too big an issue to explore fully here, although it is sorely in need of nonpartisan exploration. Instead, I want to introduce one idea that ought to figure in discussions of the issue but that usually stands no chance because of the way partisan lines are drawn. The idea is this: *There are some domains in which depth is more valuable than breadth, but there are other domains in which how much you know is more important than what in particular you know.*

Much of what bears on this point has already been said in the preceding section. Science provides the clearest case for depth, and is invariably the case constructivists base their arguments on. That is

because the natural sciences exhibit what E. O. Wilson calls *consilience*— “literally a ‘jumping together’ of knowledge by the linking of facts and fact-based theory across disciplines to create a common groundwork of explanation” (1998, p. 8). As a result, the pursuit of deeper explanations within any particular problem area will lead to the same conceptual substrate, where the big scientific ideas are. Wilson himself got there by studying ants. Studying Madagascan hissing cockroaches may do just as well for a class of fourth-graders, whereas going hop-skip-and-jump over a number of topics may never bring students into contact with the big ideas at all.

The humanities have their universals too. Wilson (1998, Ch. 10) locates them in a universal human nature. But however that may be, it is true that deeply understanding one great literary work or one great historical episode is to gain some understanding of all others. But the universality depends on our ability to make connections—connections to other literary experiences, to other moments in history, and to our own life experiences. The connections have not been made for us by a Darwin or an Einstein so that we have only to reconstruct them. The result is that you cannot really understand one great book until you have read many others; you cannot appreciate the significance of a particular history until you know a lot of history.

Here is where quantity counts and quality—although not unimportant—takes second place. It does not matter so much what books you have read so long as they have some literary quality. (Again, don’t expect me to say what that means; let it mean whatever you seriously want it to mean.) It does not matter so much what history you have learned so long as it is connectable to other history and to current events in ways that add at least a little to your understanding. What matters is having a lot of hooks to which new information and experiences can be attached.

There is empirical and theoretical support for the claim that quantity counts. Keith Stanovich (1993) has shown that a simple inventory that estimates how many books one has read correlates with a variety of indicators of educational attainment, even after one controls for other variables like IQ. Tom Landauer and his associates have been studying knowledge acquisition using a model, Latent Structure Analysis (LSA), which they claim learns word meanings in much the same way that humans do, through repeatedly encountering the words in similar meaningful contexts (xx).

According to Landauer, when LSA has acquired a vocabulary of 90,000 words it learns new words at four times the speed that it does if it has a vocabulary of only 10,000 words. Both Stanovich's and Landauer's results illustrate the "Matthew effect": the rich getting richer while the poor fall farther behind.

The educational case for quantity was well argued by E. D. Hirsch, Jr., in *Cultural Literacy* (1987), a book that has drawn hardly anything but abuse from educationists. Hirsch was seen to be arguing for dogmatic prescription of content, superficiality, and rote learning. Hirsch brought these criticisms on himself, however, because where his argument led him was to the creation of long lists of items that students should know a little bit about. Of the three kinds of reductionism I discussed in the previous chapter—reduction to content, reduction to activities, and reduction to self-expression—two are well accepted by contemporary educators and one is scorned. Hirsch chose the one that is scorned, reduction to content.

What would be a nonreductionist approach to teaching for quantity? Assuredly it would not be based on lists. Lists are an accommodation to conventional teaching and testing. If you are running a class in which everyone is supposed to be learning the same things at the same time, then you need a list of things to be learned. If you want to test how much students know, using paper-and-pencil tests, then you need a list of test items that samples the domain. But modern information media make it unnecessary to march everyone through the same content, if quantity rather than specific mastery is your objective; and modern analytic tools such as LSA makes it possible to assess quantity of knowledge without need to particularize it (xx). Freed from lists, schools could encourage wide reading; viewing of historical and literary films, travelogues, and natural science and public affairs broadcasts; and sharing of interesting information through discussion groups and contributions to collective knowledge bases. This starts to sound suspiciously like having fun, but that is part of the glory of recognizing the educational value of quantity. Getting deeply into a subject is hard work—very satisfying and exciting work, perhaps, but work nonetheless. But lapping up information about interesting and important things is something educated people do for enjoyment. There is no reason to deny students that enjoyment.

But meanwhile curriculum committees produce longer and longer lists, defeating efforts to teach for depth while at the same time reducing breadth to cramming.

Stanovich, K. "Does Reading Make You Smarter? Literacy and the Development of Verbal Intelligence."

In *Advances in Child Development and Behavior*, edited by H. Reese, Vol. 24, pp. 133-180. San Diego,

CA: Academic Press, 1993.

Why Do We Have to Learn This?

"Why do we have to learn this?" is a question teenagers begin to ask. When they discover how it annoys and embarrasses their teachers, some of them begin to ask it insistently. Telling them they have to learn Algebra I so they can learn Algebra II only pushes the question up a notch, and so teachers will often resort to feeble claims about the practical or economic value of the knowledge. To forward-looking students, awareness that they need to do well in their courses in order to get into a good university may provide motivation enough to keep them working, but it is the wrong kind of motivation for the pursuit of knowledge. For students who do not look ahead or who look ahead only to uncertain and low-skilled employment, there is nothing a teacher can say that provides a convincing reason to study.

For several generations of educators, the preferred way of dealing with "Why do we have to learn this?" has been not to answer the question but to prevent it from arising. 'Intrinsic motivation' is the watchword. If learning activities are sufficiently engaging and sufficiently rewarding in themselves, students should not demand justifications or inducements. Both Whitehead and Dewey were looking for intrinsic motivation. But like all other educational ideas intrinsic motivation is susceptible to reductionism—the same kinds of reduction that I discussed in the last chapter: reduction to subject matter, reduction to activities, and reduction to self-expression. When intrinsic motivation is reduced to subject matter, it means choosing content that is inherently interesting. Roger Schank (19xx) has discussed topics that appear to be universally interesting: sex, danger, etc. And then there are individual interests. Schank (19xx) suggests that for students who happen to be interested in trucks the whole curriculum could be built around trucks. When intrinsic interest is reduced to activities, it means having students do things

that are enjoyable irrespective of what is supposed to be learned. Educational games are an example. Reduction to self-expression means that the motivation comes from self-enlightenment or the solution of personal problems—a sort of psychological version of Dewey’s proposal that schooling should be linked to students’ real-life needs. There is value in all of this, but it is all peripheral. Motivation may be intrinsic to the learning activities but it is extrinsic as far as knowledge building is concerned.

A kind of motivation that seems to be more central to knowledge acquisition has long been revered under the name ‘love of learning.’ In conjunction with ‘lifelong learning,’ it has begun to rise in prestige. The Royal Commission on Learning, whose task was to “set new directions in education to ensure that Ontario youth are well-prepared for the challenges of the 21st century” titled its report *For the Love of Learning* (1994). But love of learning is not an idea that stands up well under critical scrutiny. There is something gratifying about feeling that you are learning something, regardless of what it is. But it is gratification of a lowly sort, on a par with the gratification of finding something to read—anything will do—when you are having to sit and wait somewhere for a long time. Youth “well-prepared for the challenges of the 21st century” ought to care what they are learning and not just learn any old thing for the joy of doing so.

Whether intrinsic motivation is of the base variety catered to by edutainment or the high-minded kind glorified as ‘love of learning,’ it is always a matter of instant gratification. The subject-matter or the learning activities must have an immediate appeal. Yet one of the marks of education and maturity (and also of social status—see Banfield, 19xx) is an ability to tolerate delayed gratification. So we end up in a bind. That which is ‘meaningful’ or intrinsically motivating in education offers immediate gratification. The delayed gratifications are extrinsic—getting into a selective university, getting a high-status job, and so on. A legitimate concern about child-centered education is that, with its exclusive reliance on intrinsic motivation, it produces people who expect all work to be enjoyable and who are unable to cope with necessary but unpleasant tasks. But is the behaviorist approach of setting up reward schedules the only alternative?

As long as knowledge is treated as the contents of a mental filing cabinet, to be put to use through the application of mental skills, we

can never get beyond merely practical or merely subjective reasons for why anyone should care about the pursuit of knowledge. Common sense does, however, afford us one point of departure from this dilemma. Every educator recognizes that much of the value of what we learn lies in what it enables us to learn. Usually this insight is translated into conventional pedagogical wisdom: Build a firm foundation and cultivate learning skills. It becomes one more cliché to nod at while going on with business as usual. But the insight can also be turned to motivational account: A powerful motivator, one that can sustain purposeful action over long periods and over ups and downs, is the feeling that we are getting somewhere. It is the joy of the promising quest, the continual revival of hope. That kind of forward-looking motivation is virtually nonexistent in school. The teacher may monitor progress closely and record it on 'progress charts,' but the students are treated as if they live in a timeless void.⁷

This is how I read Whitehead's complaint about "Algebra, from which nothing follows; Geometry, from which nothing follows; Science, from which nothing follows; History, from which nothing follows...." Of course something follows—from the school's point of view. Algebra I is followed by Algebra II. General Science is followed by Introductory Physics and Chemistry and Biology, from which follow more advanced courses in each of these sciences. The students may also be aware of this in a general way, but it is not something they experience in the course of their work. They experience a succession of tasks, problems, projects, games, and other kinds of activities, but there is no sense that any of this is leading somewhere.

In Jean-Paul Sartre's *Nausea*, the protagonist reflects on the difference between a mystery story and ordinary life. In the mystery, every detail is of interest because it may later prove to be a significant clue. Ordinary life offers no such likelihood, and so we ignore everything that does not have immediate significance. He speculates that life would have more meaning if it could be lived like a mystery story. Yet there are people, and not only detectives, whose working lives do have the character of mystery stories. They are researchers. Today's work and observations take on importance to the researcher because of the possibility that they will figure in a solution of the problem that is driving the research. There is no guarantee that this will be the case. In some kinds of research much of the information turns out eventually to be worthless, just like most of the information gathered in a criminal investigation. What

sustains effort, however, is the occasional fitting together of pieces, renewing confidence that the search is getting somewhere. Every discipline taught in school potentially has this mystery story quality. It sustains scholars and scientists through their 60 and 80 hour weeks of effort to advance their disciplines. But how can anything like that be achieved with beginners?

Rather than trying to answer this question directly, let us back off from practicalities for a bit and examine the metaphors that may guide or constrain our search for an answer. All metaphors have drawbacks. The building metaphor that I have been pushing —as in ‘knowledge building’—is appropriately constructivist in connotation, but it suggests a methodical process with a definite point of completion. It has perhaps not carried that suggestion as strongly for Marlene Scardamalia and me as it might for other people. We live in a house that has been under continuous reconstruction and enhancement for a quarter century, and the work has been anything but methodical.

A potentially more serious drawback of the knowledge building metaphor is that it ties in with the foundation metaphor. Educators have been talking about foundations for so long that it no longer seems metaphorical—but that is when metaphors become the most dangerous. All that ‘foundation’ literally means in the context of instruction is something taught initially in order to facilitate future learning. This may or may not have anything to do with foundational ideas of the discipline, but the metaphor disposes people to prejudge this issue. The concept of energy figures prominently in elementary science curricula because of its central importance in physics, but, as noted earlier, its value in elementary science is questionable because, as understood at that level, it has no explanatory value. It serves instead as an invitation to verbalism.

But the insidious effect of the foundation metaphor does not stop there. No builder would construct a foundation without having a pretty clear idea of the building to be erected upon it; only a subcontractor would do that. Beginning students, having no way to foresee the the eventual structure of knowledge, are therefore cast into the role of subcontractors. All the vision is held by the teacher and the student merely executes work orders. “Trust me,” the teacher has to say. “The value of what I am teaching you will become clear to you someday.” Not a good paradigm for active learning.

The mystery metaphor has not always been a metaphor. If, along with Newton and scientists before him, you believe that the visible world is a puzzle with clues set out by God, then science is literally the solving of mysteries. To those of a more naturalistic persuasion, however, mystery solving is a metaphor. It nicely captures the excitement of research and the value of attending to facts whose significance is not immediately apparent. But it has two less fortunate implications. First, it implies that there are solutions waiting to be found out. Somebody killed Cock Robin, even if we never find out who. But inquiry in the learned disciplines is not that simple. We may be asking questions to which there are no answers. Second, and much more seriously, it implies a world constructed differently from the world we actually occupy. In the world of detective fiction the ratio of significant clues to irrelevant or misleading ones is high enough to keep up the reader's spirits, but in the real world it is vanishingly low. Sartre's protagonist was attracted by the idea of living life like a mystery story, but he recognized it could not actually be done. I take discovery metaphors to be a weaker form of the mystery metaphor, subject to the same criticisms.

We want a metaphor that suggests an endless advance, one that requires effort, which is rewarded by the progress that is made. None of the preceding does this. Here is one that does: "There's a hill beyond the hill beyond the hill beyond the hill..." As many will recognize, this potentially disheartening thought is actually part of a rousing hiking song. For sufficiently energetic and optimistic young people it evidently serves to put a spring in their step. What is the conceivable appeal of hiking up hill after hill? Surely it is not the pleasure of putting one foot in front of another, even in good company. Each hill represents a new challenge, the attainment of which offers a new vista—a vista that typically includes a yet higher hill. This is a fairly accurate metaphor for the constructive pursuit of knowledge. Each hill is a knowledge problem. Surmounting it allows you to see or understand things you could not before, and this includes being able to see an even more challenging knowledge problem lying ahead. While climbing a hill you do not see the summit, much less the hill beyond, but previous experience and trusted counsel give you confidence that they are there and that they will prove worth the climbing. The hiking metaphor is imperfect, too, of course. The next hill is already there, waiting to be brought into

view, whereas the next problem is generated out of the present one. But the hiking metaphor does have a dynamic and forward-looking character that the others lack.

How do we apply this open-air metaphor to the confined world of the classroom? To keep the metaphor from becoming entirely fanciful, it helps to regard problems and questions as real things rather than as purely mental states. Climbing a hill and solving a problem may then be seen as similar enough that the analogy is worth pursuing farther. (Hill climbing is, in fact, the name given to a problem solving strategy identified by Newell and Simon [1972] applicable in situations where you cannot see a path to the goal but you can tell which way is up.) You do not become a hiker in one day. You need to build up not only strength but expectations. Expectations are essential to keep you going, and they also serve as guides. You don't know what is coming, but with experience you learn to recognize promising directions. This is impressionistic knowledge—built up through experience, more emotional than rational, but essential in creative work or anything that ventures beyond the familiar.

In developing students as self-motivated, lifelong learners, there is of course the building up of strength—in the form of skills and background knowledge. Schooling is much concerned with that. But there is little attention to building up expectations, the impressionistic knowledge that leads you onward toward the hill beyond the hill that you can see. Impressionistic knowledge isn't recognized as knowledge. It gets folded in with motivation and so teachers concentrate on making learning immediately gratifying or providing extrinsic inducements, neglecting the kinds of experiences that would develop powerful expectations about the longer-term rewards of the pursuit of knowledge.

To develop such impressionistic knowledge, it is obvious that students must be engaged in inquiry. Passive uptake of knowledge, as in reading a novel or listening to a lecture, has its value, as I've argued earlier. But, to continue with the hiking analogy, it is like viewing a movie of a hike rather than actually going on it; it can have some instructive and motivational value, but it will not make you into a hiker. An important job for the teacher as a party to student inquiry is to ensure that there is plenty of looking back and looking ahead. Students are likely to keep their eyes on what is immediately before them, like novice hikers unsure of their footing.

The teacher can help them realize they are making progress: “What do we understand now that we didn’t understand last week?” Also remind them of lower hills that have been left behind: “Remember when we thought all we had to explain was how we see things right-side up when the lens turns things upside-down?” Encourage looking ahead: “Where do you think all this is leading?” And provide hints of future problems: “Right now we’re finding out what different parts of the brain do. But what about all those connections between the parts?” Having students work with more experienced students could also help in developing perspective and expectations.

All of these are practices that can already be found, sometimes in the same classroom. The difference would be in pursuing them with a clearer purpose. I am suggesting that the purpose of any inquiry conducted in schools should be not only solving the targeted problem (figuring out what keeps airplanes aloft, understanding why historians generally think the French Revolution was more important than the American) but also developing in students a sense of where further inquiry might lead, confidence that they can move ahead on their own, and confidence that the knowledge they pursue will prove worth gaining.

Conclusion

The traditional view of subject matter, which still holds sway, especially in state guidelines and in textbook specifications, starts with an itemization of what is to be learned. The more modern view, associated with labels such as constructivism and conceptual change teaching, looks at subject matter somewhat differently. The focus is on students’ ideas and understandings. Students come in with ideas. They leave with ideas. The ideas they leave with ought to be better in some fashion than the ideas they came in with. The two views are not miles apart—they are equally objectionable to postmodernists, who see them both as the powerful dictating what is best for the weak—but if they are pursued deeply enough they lead to quite different educational policies.

To see the difference, however, it is necessary to adopt a three-worlds rather than a two-worlds epistemology. In terms of Popper’s three worlds, the traditional view makes education out to be a matter of converting World 3 into World 2. It is taking the knowledge that is out there in the culture and getting it represented in the minds of students. One should not immediately attack this conventional view as being committed to rote learning or to any particular

pedagogy. If guided discovery, for instance, is the surest way to get certain parts of World 3 converted into World 2 mental content, then guided discovery it should be. In the view I have been advocating, however, education is entirely a matter of changes in World 2—the students’ beliefs, understandings, skills, and so on. World 3 enters the picture in two ways. First, conceptual artifacts, the objects populating World 3, are part of what students’ beliefs and understandings are about, part of what they develop skills in working with. An extremely important part, I would add. Second, working in World 3—working to interpret, create, and improve conceptual artifacts—holds promise as perhaps the most powerful way to bring about significant changes in World 2.

In the traditional view, conceptual artifacts are the actual stuff of learning. Facts, theories, proofs, histories, and so on are *what* students are supposed to learn. Motivation accordingly arises as a problem. “Why do we have to learn this stuff?” the impatient adolescent demands, and after several centuries of trying, pedagogues have not yet come up with satisfying answers. In the view I have been advocating, conceptual artifacts are not things to be learned. What students are about is understanding the world, trying to improve their own theories and beliefs. Conceptual artifacts already available in the culture should help in this effort. Whether a particular artifact is helpful or not is something for students to investigate, to form their own judgments about. Thus subject matter content does not have to be justified to students in advance of their learning. An important part of learning is learning what a conceptual artifact is or is not good for. When education is locked into a two-worlds epistemology, in which concepts are either things in people’s minds or else distillations of physical reality, there is no way to hold a concept up for examination and ask what it is good for. Accordingly, the question “What’s the point of learning this stuff?” is rendered fundamentally unanswerable.

In the absence of theory, educators are apt to demand ideological consistency. In the absence of an epistemology adequate to deal with subject matter, educators will press for conformity to a pedagogical philosophy. The notion that both quantity and quality could be important and that they call for different pedagogies becomes virtually unthinkable. Instead, we have direct instruction pitted against activity methods, as if everything turned on the resolution of this conflict. Meanwhile the over-riding questions that Dewey and

Whitehead addressed remain neglected: How do you make contact between students' interests and the big ideas that form the intellectual life of a civilization? How do you teach things that lead somewhere? How do you ensure that the quest for understanding maintains a continually growing edge?

¹ refs on basic-level concepts xx

² Lexicographers might argue at length about how to define the word 'chair,' but that only indicates the difficulty of translating habits into rules.

³ But referent-centered knowledge about institutions and artifacts does go out of date, of course. I have been told of an impoverished church school where the students were obliged to memorize facts about rice production and railroad lines in China from a textbook that dated from before World War II.

⁴ This is not how the problem is commonly seen by science educators. The more common interpretation is that students are unclear about the nature of theory and evidence (Kuhn, 19xx). But everyone is unclear about that (Ranney, 19xx).

⁵ This relativism has been carried to an absurd extreme in the multicultural standards now imposed on school textbooks. If you are an Asian child it is assumed that you cannot identify with any character who is not Asian. Unfortunately, there is some truth in this, because due to other restrictions the characters are likely to be so bloodless and bland that they have no other basis of appeal.

⁶ What does 'quality' mean here? No one can define it but everyone can recognize it, as Robert Pirsig maintained in *Zen and the Art of Motorcycle Maintenance*.

⁷ I still remember my daughter's learning to hop on a pogo stick. She was around eight years old. The moment the pogo stick was put in her hands she took it outdoors and started trying to bounce on it. For the next three or four days it looked as if she wasn't doing anything but failing, and yet she kept at it with hardly any encouragement. She must have been getting some sensations of progress. Finally these became visible, and before the week was out she was happily bounding down the street on this strange device.