Multiple Approaches to Understanding

Topics Worth Understanding

Certain topics suffuse the discourse of an era. Hardly a week goes by without some reference in the media to key scientific ideas, like the theory of evolution, or to pivotal historical events, like the Holocaust. Even the culturally illiterate have heard of these topics; all who would presume to be educated should be able to recall central points about evolution or the Holocaust from their education, their casual reading and movie- or television-viewing and their residence in a news-dense culture. Educated persons should also be able to assimilate new information. They should be able to comment on news stories about the disappearance of dinosaurs, the rise of creationism, the apparently punctuated bursts of new species. They should have views about the Swiss hoarding of Nazi gold, a fictional work about a survivor, the collective guilt of the German people.

All too often, however, contemporary discussions of education skirt these hallmarks of the educated person. We find ourselves impaled on questions of methods, for example, should we encourage tracking, cooperative learning, the use of projects in the classroom; or we debate political topics, for example, should we embrace vouchers, choice, national standards? While worth discussion, these issues seem

suspended in surreality when they are considered in the absence of consensus, or even debate, about what should be taught and why.

Issues of curriculum inevitably arouse segments of the community. While texts on evolution or the Holocaust would seem straightforward in most educational contexts, we have seen in our own time fundamentalist efforts to exclude evolution from the textbooks or to denigrate Darwin's work as "just another theory." And while few educators directly question the occurrence of the Holocaust, cultural commentators have attacked Holocaust curricula either because they do not adequately represent the German point of view or because they claim that the treatment of six million European Jews was qualitatively different or qualitatively more brutal than that of other groups at other times. Perhaps it is safer simply to memorize a few facts or a few definitions, and then move on swiftly to other theories and to other historical events.

The Goals of Education

A brief essay scarcely allows one to adjudicate purposes of education or to lay out and defend the "ideal curriculum." My purpose is different. I do not think it is possible to talk intelligibly about how to teach unless one has taken a stand on what one should teach and why. And even if one's position on these questions may seem straightforward (particularly in the company of friends), it is salutary to lay one's curricular cards on the table.

Education in our time should provide the basis for enhanced understanding of our several worlds: the physical world, the biological world, the world of human beings, the world of human artifacts, the world of self. Individuals perennially have been interested in these topics: contemporary disciplines have added to and revised insights put forth originally in mythology, art, and folk knowledge. Evolution and the Holocaust are hardly the only topics worth understanding. Yet it is hard to see how an individual could understand the world of biology without some mastery of evolutionary theory; or attain comprehension of the world of human beings, in the absence of a study of the Holocaust (or another genocidal episode).

Note that this goal does not mention the acquisition of literacy, the learning of basic facts, the cultivation of basic skills, or mastery of the moves of the several disciplines. Though they are important, these achievements should be seen as means, not ends in themselves. One learns to read, write, and compute not so that one can report these milestones (as one would report one's attendance record), nor even so that one can achieve a certain score on an admission test. Rather, literacies, skills, and disciplines ought to be pursued as tools which allow one to enhance one's understanding of important questions, topics, and themes.

This set of goals may sound quaint or idealistic. After all, aren't the real purposes of education to learn to get along with others, to acquire personal discipline, to

become well rounded, and to prepare for the workplace and for the ultimate rewards of success and happiness? Certainly, arguments can be mounted in favor of these and other instrumental ends. Yet, each of these goals ought to be seen as the responsibility of the broader society, ranging from parents and families, on the one hand, to religion, the media, and community institutions, on the other hand. I believe that resources invested in formal education, in our and other countries, can best be justified if, at the end of the day, all students can demonstrate enhanced understanding of the important questions and topics of the world.

A Performance View of Understanding

Both folk wisdom and contemporary psychology conspire to convince us that understanding is an event or process that occurs between the ears: in the mind/brain. Certainly, as a psychologist who also honors common sense, I would underscore the importance of the processes of mental representation that occur in the assimilation and transformation of information and knowledge. Yet, from the perspectives of the teacher and the learner, the physical events in the mind/brain are far from transparent and in any event irrelevant to their educational missions.

Instead, when it comes to understanding, the emphasis falls properly on performances that can be observed, critiqued, and improved. Strictly speaking, we do not care

about the elegance of a mental representation if it cannot be activated when needed; and while it is unlikely that performances of quality will emerge in the absence of intricate mental representations, such performances may in fact emanate from a variety of cognitive schemas across situations and individuals.

Accordingly, when it comes to probing a student's understanding of evolution, the shrewd pedagogue looks beyond the mastery of dictionary definitions or the recitation of textbook examples. Students "perform" their understanding when they can examine a range of species found in different ecological niches and speculate about the reasons for their particular ensemble of traits, or when they can point out the similarities and differences among the Malthusian, Darwinian, and social Darwinist versions of "survival of the fittest." By the same token, students perform their understanding of the Holocaust when they can interpret the contents of a diary of an SS (German Stom Troopers) officer in light of claims about the "good German," or when they can compare the events in a German concentration camp to those that occur in contemporary genocidal efforts, such as those in Bosnia.

Such measures of understanding may well seem demanding, particularly when contrasted with current, often superficial, efforts to measure what students know and are able to do. And indeed, recourse to performing one's manifestations of understanding are likely to stress students, teachers, and parents, all of

whom have grown accustomed to traditional ways of doing (or not doing) things.

Nonetheless, embracing a performance approach to understanding is justified. To begin with, the fact that something is new is hardly a justification for avoiding it, though that fact may signal obstacles to its ready implementation. More importantly, the actual decision to focus on performances immediately shifts the emphasis from mastering content to thinking about the reasons why a particular content is being taught and how best to display one's comprehension of that content in a publicly justified manner. When students realize that they will have to apply knowledge and insights in public form, they assume a more active stance vis-à-vis material, seeking to exercise their "muscles of performance" whenever possible.

Let me offer a personal example. Having adopted a performance view of understanding some years ago, I revised my standard graduate student course on "theories of cognitive development." My goal was not just "knowing the theory," but being able to use it productively. Under the new dispensation, each week students sought to master a particular theory of development, such as the ones put forth by Jean Piaget or Lev Vygotsky. Students were given prompts, for example, a set of data or a story about an educational practice, and asked to illuminate that prompt by invoking "the theory of the week." One day a student approached me and said, "Dr.

Gardner, how can I apply the theory if I don't understand it?" I thought for a moment and responded, "You'll never understand the theory unless you apply it." An emphasis on performance not only stimulates the student's active consumption of classroom material; frequent opportunities to perform constitute the best way to achieve enhanced understanding of the material.

Understanding: Obstacles and Opportunities

I have yet to mention an important and troubling consideration. There has been a virtual conspiracy to avoid assessment of understanding. Perhaps this avoidance has been innocent: if one assumes that understanding is equivalent to mastery of factual materials, or if one assumes that understanding follows naturally from exposure to materials, then there is no reason to require performances of understanding. But it is more likely that we have avoided the assessment of understanding because such assessment takes time and because we lacked confidence about what we would find.

Thanks to hundreds of studies carried out in the past few decades by cognitively oriented psychologists and educators, we now know one truth about understanding. Most of the students in most of our schools — indeed, many of the best students in the best schools — are not able to exhibit appreciable understandings. The most dramatic findings are manifest in physics. Students who are awarded top grades in high school and college courses

are not only unable to apply their presumably mastered knowledge when asked to invoke it appropriately in a new situation. Even more damning, they also tend to respond much the way young children do: in a manner that has been described as "unschooled" (Gardner, 1991).

Would that the problems surfaced only in physics! Throughout the sciences, researchers find, students are rife with misconceptions. In the case of the theory of evolution, for example, students gravitate almost ineluctably to a teleological and perfectibility view. That is, despite the fact that evolution consists of random mutations that cannot follow from any kind of a predetermined script, students typically reframe this state of affairs. In their description of evolution, the process is guided by an unseen hand: each species is in some sense more perfect than the previous one, with the height of evolution magically coinciding with our own species in our own time. Similar misconceptions crop up in physics, biology, geology, astronomy, and kindred sciences.

In other areas of the curriculum, analogous "unschooled" difficulties abound. In mathematics, students are at the mercy of rigidly applied algorithms. They learn to use certain formalisms in certain ways, and do so effectively, so long as they pick up a signal that a particular formalism is wanted. If, however, no cue for the formalism is provided, or the students have to derive the formalism afresh, they are stymied; after all, they never really understood the formalism, they just waited

for the signal that has reliably invoked it in previous situations.

In social studies and the humanities, the enemies of understanding are scripts and stereotypes. Students readily believe that events occur in typical ways, and evoke these scripts whether or not they are appropriate. Struggles between two parties in a dispute, for example, are readily assimilated to a "good guy/bad guy Star Wars" script, where one roots for the good guy to prevail. Superficial understandings of the Holocaust deny its existence altogether, blame it entirely on the evil Germans, treat the Jewish people as unique, or say that such an event could never happen again. A deeper understanding — that human beings everywhere have the potential to engage in genocide or to become victims of such cruelty — requires more intensive and extensive grappling with the historical, social, and personal worlds.

Obstacles to understanding are ubiquitous: They cannot be readily averted. Moreover, misunderstandings are inevitable so long as individuals succumb to the American temptation (shared by other countries) to "cover everything:" to jet from Plato to NATO in a 36-week course on Western history. Nonetheless, in recent years, four promising approaches to understanding have evolved. Each of these recognizes the obstacles to understanding and seeks to inculcate more productive performances of understanding. I will mention three briefly and then turn to the fourth approach, which is my principal focus in this essay.

The first approach involves study of institutions that have successfully inculcated understanding and application of the lessons learned thereby. The traditional institution of the apprenticeship is one such example. Young apprentices spend much time in the presence of a skilled "understander," have the opportunity to observe this person up close, and are gradually drawn into the daily practices of problem-solving and product-making. The contemporary institution of the children's museum or the science museum is another exemplary molder of understanding. Students have the opportunity to approach intriguing phenomena in ways that make sense to them. They can take their time, because "no one flunks museum." More importantly, they may bring issues with them from home to school, to the museum, and back again, gradually constructing sturdier understandings by making use of multiple inputs. In deciphering how these institutions have generated deeper understandings, we receive clues about how best to teach for understanding.

A second approach to enhanced understanding features frontal tackling of the obstacles described above. One comes to grips directly with one's own misconceptions. For example, if one believes in the inheritance of acquired characteristics, one can cut off the tails of generations of salamanders and see whether a shorter tailed salamander gradually (or abruptly) emerges. If one is prone to invoking rigidly applied algorithms, one can be given the opportunity to construct one's own formula through experimentation with relevant variables.

Or if one engages habitually in stereotypical thinking, one can be encouraged to consider each event or work of art from multiple perspectives.

To be sure, none of these approaches constitutes a fool-proof antidote to misunderstandings. Occasional adoption of "multiple perspectives" or occasional challenges to misconceptions will not suffice. Teachers encourage understandings by recognizing and pointing out inadequate conceptualizations. If such challenges are invoked regularly, and their consequences reflected upon, students will gradually learn to apply such ploys on their own. Internalization of these "checks" should facilitate the cultivation of habits of understanding.

A third approach to understanding has been developed in recent years in collaboration with David Perkins, Vito Perrone, Stone Wiske, and others. Called "teaching for understanding," this approach takes an explicitly performing stance. Teachers are asked to state a limited set of explicit understanding goals and to stipulate the correlated performances of understanding. These perspectives are shared with the students. Other key features of the "understanding framework" include a stress on generative topics that are at once central to the discipline and attractive to students; the identification of "through-lines" that percolate a unit or course; and an insistence on assessment that is ongoing — that takes place from the first and regularly involves the student as well as the teacher (Wiske, 1998).

Multiple Intelligences: A Potential Ally for Understanding

Until this point, I have intimated that understanding is a generic problem with a set of generic solutions. It is important for students to understand; the achievement of such understanding is challenging; there exist a variety of means that might aid students. Initially, such a generic approach is justifiable. It is reasonable to approach a problem in terms of its fundamental constituents; certain tacks may in fact prove successful with all, or at least the vast majority of students.

Recent work in cognitive and differential psychology challenges a faith in the generic approach: considerable research suggests that not all human minds work in the same way and that not all human beings exhibit the same profile of cognitive strengths and weaknesses. To the extent that this characterization is true, it ought strongly to influence how we teach students and how we assess what they learn. In what follows, I introduce this new perspective on cognition. Thereafter, I turn to a hitherto unappreciated aspect of this novel stance, one that might aid us in inculcating and enhancing student understanding.

Traditional psychology and psychometrics have long assumed that human beings possess a single intelligence, that it is relatively fixed, and that psychologists can accurately assess a person's intelligence through the use of simple paper-and-pencil-style measures. On this view, we

all represent discrete points on a single "bell curve" (Herrnstein & Murray, 1994). There is no reason to individualize education except by creating tracks composed of students of differing abilities. We all learn pretty much in the same way, and the major difference among us consists in how quickly we can proceed down the single path to enhanced learning, knowledge, and understanding.

Though research evidence supports certain aspects of the traditional view, this view is no longer a compelling one. Findings from neuroscience, cognitive science, and anthropology converge to call into question each of the building blocks of this view. In other words, many authorities now challenge the hegemony of a single intelligence, the claim that intelligence(s) is (are) fixed at birth, and the adequacy of standard psychometric measures (Sternberg, 1985).

My own work has led to the development of a theory of multiple intelligences (Gardner, 1993a, 1993b, 1998). On this view, all human beings represent the culmination of an evolutionary process that has yielded at least eight relatively discrete information-processing mechanisms. All of us possess linguistic intelligence (epitomized by the poet or orator); logical-mathematical intelligence (the scientist, the logician); musical intelligence (the composer or performer); spatial intelligence (sailor or sculptor); bodily-kinesthetic intelligence (athlete, dancer); naturalist intelligence (hunter, botanist); interpersonal intelligence (clinician, salesman); and intrapersonal intelligence

(individual with a keen understanding of himself/herself). There may also be an existential intelligence that reflects humans' propensity to pose and struggle with the enigmas of life, death, the cosmos, and fate.

We all possess this ensemble of intelligences; in one sense, it represents our species' intellectual heritage. Yet, we do not exhibit equal strengths or similar profiles. Some individuals are strong in one intelligence, others, in another. Strength in a particular intelligence does not necessarily predict strength (or weakness) in another intelligence. Directly challenging the standard theory, individuals are able through practice to enhance their particular intelligences or to alter the profile of intellectual strengths and weaknesses. And whereas paper-and-pencil measures can provide limited insights into certain of the intelligences, intelligences are best assessed in an "intelligence-fair" way: by placing individuals in situations where they must use an intelligence directly. As I have sometimes quipped, a fair measure of spatial intelligence is to place a person in downtown Boston (a warren of narrow, curved streets) and see whether he or she can find the way home.

To the surprise of many, including me, the theory of multiple intelligences has become influential in educational circles. It is often assimilated, inappropriately, in my view, into work on cognitive or learning styles. Educators have sought to determine the intellectual strengths (the intelligence profiles) of their students through a

variety of informal, jerry-built methods. They have also drawn a multitude of often inconsistent inferences about practice from the theory. These range from teaching seven or eight different subjects, each centering on a particular intelligence; to organizing groups of students based on their favored intelligences; to building curricula that focus on specific intelligences; to teaching subjects in seven or eight different ways. I have learned a great deal from attempts by others to adapt my theory to educational settings. Yet, it has become clear that, for most educators, the theory is basically a Rorschach test; individuals discern within the theory the educational practices that they already value, rather than deducing educational implications from a sober confrontation of this new psychological theory (Gardner, 1993b).

Many educators see multiple intelligences as an end in itself. That is, a school or program is meritorious to the extent that it extols multiple intelligences, or measures students' intelligences, or features the various intelligences in curriculum or pedagogy. While I do not consider these achievements to be insignificant, they suffer from the problem described above; that is, a failure to proceed from, or consider sufficiently, the goals of education.

My own view is that "multiple intelligences" does not in itself constitute a suitable goal of education, any more than a single intelligence or cooperative learning or self-esteem should so qualify. "Multiple intelligences" is better thought of as a handmaiden to good education, once

educational goals have been established on independent grounds. Indeed, I would argue that "multiple intelligences" is most usefully invoked in the service of two educational goals.

The first goal is the achievement of certain valued adult roles or end states. If one wants every individual, or, at any rate, some individuals, to be able to engage in artistic activities, it makes sense to develop linguistic intelligence (for the poet), spatial intelligence (for the artist), and/or musical intelligence (for the composer or performer). If one wants every individual, or some individuals, to be civil, then it is important to develop the personal intelligences.

The second goal is the mastery of certain curricular or disciplinary materials. Following the line of argument introduced above, one might decide that it is important for students to study biology, so that they can better understand the origins and development of the living world; and to study history, so that they can better understand the good and the evil which human beings have achieved in the past. One could take the position that everyone should study the same thing in the same way, and be assessed in the same way. The standard view of intelligence leads readily, perhaps ineluctably, to that educational course. Yet, if there is validity to multiple intelligences — if individuals indeed harbor different kinds of minds, with different strengths, interests, and strategies — then it is worth considering whether pivotal

curricular materials could be taught and assessed in a variety of ways.

Understanding: An Approach Through Multiple Intelligences

Here, at last, I can introduce the core ideas of the educational approach that I embrace (see Gardner, 1999). I believe that every person ought to master a central body of curricular materials and approaches, though I am not thereby wedded to a specific canon. For this essay I have selected the examples of evolution and the Holocaust, though they are not without controversy, because I think that they lie comfortably within the ensemble of ideas that every educated person should have encountered, grappled with, and mastered. (Elsewhere, I have added to the true [evolution], and the evil [the Holocaust] an example of the beautiful [the music of Mozart].) I depart from traditional educators, and from their allies in psychology, in the assumption that such topics need to be taught or assessed in a single way.

Because of their biological and cultural backgrounds, personal histories, and idiosyncratic experiences, students do not arrive in school as blank slates, nor as individuals who can be aligned unidimensionally along a single axis of intellectual accomplishment. They possess different kinds of minds, with different strengths, interests, and modes of processing information. While this variation (a product of evolution!) initially complicates the job of the

teacher, it can actually become an ally in effective teaching. For if the teacher is able to use different pedagogical approaches, there exists the possibility of reaching more students in more effective ways.

Differences among students can be described in innumerable ways, and it is a simplification to prioritize any. For my purposes, I will speak of students as highlighting different intelligences. However, to follow this argument, one need not endorse my particular theory of intelligences. Any approach that recognizes and can somehow label or identify differences in intellectual proclivity will suffice.

Assume that our educational goals include an enhanced understanding of the theory of evolution and the events called the Holocaust, topics drawn respectively, from biology and history. Specifically, we want students to appreciate that evolution, a process of random mutation in the genotype, is the driving force behind the variety of species that have existed historically and contemporaneously. The diverse phenotypes yielded by genetic variation result in organisms that are differentially able to survive in specific ecological contexts. Those that survive to reproduce in abundance have a competitive advantage over those who, for whatever reason, are less prone to adjust adequately to a given ecological niche. If these trends continue over the long run, the survivors prevail while those who cannot compete successfully are doomed to extinction. The fossil record documents the

course and fate of different species historically; one sees the gradual increase in variety of species, as well as the increasing complexity of certain lines of descent. It is possible to study the same processes contemporaneously, with relevant research ranging from the breeding of Drosophila of various strains to experimental investigations of the origin of genes.

Turning to the Holocaust, we want students to appreciate what happened to the Jewish people, and to certain other condemned minorities and political dissidents, during the Nazi Third Reich, from 1933–1945. Efforts to castigate and isolate the Jewish people began with simple verbal attacks and laws of exclusion, gradually evolved to more violent forms of abuse, and ultimately culminated in the devising of camps whose explicit goal was the extinction of European Jewry. The contours of anti-Semitism were laid out in Hitler's early speeches and writings; but the historical course from plans to actualities took several years and involved hundreds of thousands of individuals in various capacities. Genocide, the effort to eliminate a people in its entirety, is hardly a new phenomenon; it dates back to Biblical times. Yet, the systematic way in which an allegedly civilized, modern nation proceeded to eradicate six million Jews is without precedent.

In brief form, these understandings would constitute a reasonable goal for a course or unit. Sheer memorization or faithful paraphrase of these paragraphs, of course,

does not count as understanding. Rather, as noted above, students exhibit understanding to the extent that they can invoke these sets of ideas flexibly and appropriately to carry out specific analyses, interpretations, comparisons, critiques. An "acid test" of such understanding is the students' ability to perform their understandings with respect to material that is new — perhaps as new as today's newspaper.

How to approach these formidable topics? From the vantage point of multiple intelligences, I propose three, increasingly focused lines of attack.

A. Entry Points

One begins by finding a way to engage the students and to place them centrally within the topic. I have identified at least six discrete entry points, which can be roughly aligned with specific intelligences. In each case, I define the entry point and illustrate it with respect to our two topics:

1. *Narrational* — The narrational entry point addresses students who enjoy learning about topics through stories. Such vehicles, linguistic or filmic, feature protagonists, conflicts, problems to be solved, goals to be achieved, and tensions aroused and, often, allayed. Evolution invites treatment in terms of the story of Darwin's voyages (as it contrasts with the story of origins told in the Bible) or of the "course" of a

particular species. The Holocaust can be introduced through a narrative account of a particular person, or through a year-by-year chronicle of events in the Third Reich.

2. *Quantitative/numerical* — The quantitative entry point speaks to students who are intrigued by numbers, the patterns that they make, the various operations that can be performed, and the insights into size, ratio, and change. From an evolutionary perspective, one can look at the incidence of different individuals or species in different ecological niches and at how those aggregates change over time. With respect to the Holocaust, one can look at the movement of individuals to various camps, the survival rates at each, the comparisons of the fates of Jews and other victim groups in different cities and nations.

3. *Foundational/existential* — This entry point appeals to students who are attracted to fundamental "bottom line" kinds of questions. Nearly all youngsters raise such questions, usually through myths or art: the more philosophically oriented come to pose and argue about issues verbally. Evolution addresses the question of who we are and where we come from, and whence all living matter emanates. The Holocaust addresses the questions of what kinds of beings humans are, and what are the virtues and vices of which they/we are capable.

4. *Aesthetic* — Some individuals are inspired by works of art, or by materials arranged in ways that feature balance, harmony, or a carefully designed composition. The tree of evolution, with its many branches and interstices, may attract such individuals; Darwin himself was intrigued by the metaphor of the "tangled bank" of nature. Many efforts have been undertaken to portray the Holocaust in works of art, literature, and music, both by those who were ultimately killed and by those survivors and observers who have tried to capture its horror.

5. *Hands-on* — Many individuals, particularly young persons, find it easiest to approach a topic through an activity in which they become actively engaged: one where they can build something, manipulate materials, carry out experiments. The chance to breed generations of fruit flies (Drosophila) gives one the opportunity to observe the incidence and fate of genetic mutations. Holocaust displays can provide a harrowing introduction to this event. When students receive an alternative "identity" upon their entrance and later ascertain what happened to this person in the course of the Holocaust, the personal identification can be very powerful. Being a subject in a psychological experiment that documents the human proclivity to follow orders can be a jarring experience as well.

6. *Social* — The entry points described thus far address

the individual as a single person. Many individuals learn more effectively, however, in a group setting, where they have the opportunity to assume different roles, to observe others' perspectives, to interact regularly, and to discuss and debate issues to complement one another. A group of students can be given a problem to solve, for example, what happens to various species in a given environment following a dramatic change in climate, or how would the Germans have reacted had the Allies blown up the train tracks that led to a concentration camp. Or they can be asked to role-play, e.g., different species in a shifting ecology or different participants in a rebellion in a ghetto that is under siege.

B. Telling Analogies

An entry point perspective places students directly in the center of a disciplinary topic, arousing their interests and securing cognitive commitment for further exploration. The entry point, however, does not necessarily inculcate specific forms or modes of understanding.

Here the teacher (or the student) is challenged to come up with instructive analogies, drawn from material that is already understood, and that can convey important aspects of the less familiar topic. In the case of evolution, for example, analogies can be drawn from history or from the arts. Societies change over time, sometimes gradually, sometimes apocalyptically. The processes of human

social change can be compared with those of biological change within and between species. Evolution can also be observed in works of art. Characters change within the course of a book, and, sometimes, over a series of books. Themes in a fugue evolve and develop in certain ways, and not (ordinarily) in others.

One may search for analogies to the Holocaust. The effort to annihilate a people can be analogized to the eradication of traces of an event or even of an entire civilization. Sometimes these efforts at eradication are deliberate, as when the criminal seeks to hide all evidence of a crime. Sometimes these efforts occur as a result of time, as happens when the traces of an ancient city are virtually destroyed (absent relevant historical records, we do not know, of course, about those cities whose vestiges have altogether disappeared as the result of natural disaster or a vengeful enemy).

Analogies can be powerful, but they can also mislead. Analogies are an excellent way to convey important facets of a topic to individuals who have little familiarity with it. However, each analogy can also suggest parallels that do not hold, for example, the informing intelligence that constructs the theme of a fugue differing from the random nature of biological evolution, and a murderer working in isolation differing from a large sector of society working secretly but in concert. The obligation of the teacher is to qualify each analogy as appropriate and to make sure that the misleading parts of the analogy are

not allowed to distort or cripple the students' ultimate understanding.

C. Approaching the Core

Entry points open up the conversation; telling analogies conveys revealing parts of the concept in question. Yet, the challenge of conveying the central understandings still remains.

We now come to the most vexing part of our analysis. Traditionally, educators have relied on two seemingly opposite approaches. Either they have provided quite explicit instructions, usually didactic, and assessed understanding in terms of linguistic mastery of materials ("Evolution is …," "The five central points about the Holocaust are …"). Or they have supplied copious information to students and hoped that, somehow, the students would forge their own syntheses ("On the basis of your reading, our trip to the museum, and various classroom exercises, what would you do if …"). Some teachers have pursued both approaches, either simultaneously or successively.

Here we encounter the crucial educational question: Can one use knowledge about individual differences in strengths and modes of representations to create educational approaches that can convey the most important, "core notions" of a topic in a reliable and thorough manner?

First, one must acknowledge that there cannot be a formulaic approach. Every topic is different, just as

every classroom context is different, and so each topic must be considered in terms of its own specific concepts, network of concepts, issues, problems, and susceptibilities to misconception.

A second step recognizes that topics do not exist in isolation; they come from and are, to some extent, defined by the ensemble of existing and emerging disciplines. Thus, a study of evolution occurs within the domain of biology and, more generally, within the realm of scientific explanation. As such, it involves the search for general principles and for models that will apply to all organisms under all kinds of circumstances (though some ideographically oriented scientists seek to explicate specific events like the disappearance of dinosaurs). In contrast, a study of the Holocaust occurs within history and, sometimes, within literary or artistic efforts to render this historical event. Parts of the Holocaust may resemble other historical events, but a foundational notion of history is that it offers an account of specific events, occurring in specific contexts. One can neither expect general principles to emerge nor build models that can be tested (though some scientifically oriented historians have attempted to construct and test such models).

The third step acknowledges commonly used ways of describing and explaining a concept. Thus evolution is typically described using certain examples (e.g., the disappearance of Neanderthal man, the branching tree of

evolution), while the Holocaust is typically presented in terms of certain key events and documents (e.g., Hitler's *Mein*, the formulation at the 1942 Wannsee Conference of the Final Solution, the records kept at Auschwitz, the reports by the first Allied soldiers to liberate the camps, the chilling photographs of the survivors). These familiar examples are not randomly chosen; rather, they have helped scholars to define these topics in the past, and they have proved effective pedagogically with at least a reasonable percentage of students.

But while these examples have their reasons, one must not infer that such examples are uniquely or permanently privileged. One can certainly feature these examples without ensuring understanding; and, by the same token, it is surely possible to enhance understanding of evolution or the Holocaust by using other examples, other materials, differently formulated causal accounts. We know that this ensemble changes, because there are new historical or scientific discoveries, as well as novel pedagogical approaches that have been proved effective. (Thus, for example, the opportunity to simulate evolutionary processes in a computer program, or to create virtual realities, spawns educational possibilities that could not have been anticipated a generation or two ago.)

For me, the key step to approaching the core is the recognition that a concept can only be well understood — and can only give rise to convincing performances of understanding — if an individual is capable of

representing that core in more than one way, indeed, in several ways. Moreover, it is desirable if the multiple modes of representing draw on a number of symbol systems, intelligences, schemas, and frames. Going beyond analogies (indeed, proceeding in the opposite direction), representations seek to be as accurate and comprehensive as possible.

Several implications follow from this assertion. First, it is necessary to spend significant time on a topic. Second, it is necessary to portray the topic in a number of ways, both to illustrate its intricacies and to reach an ensemble of students. Third, it is highly desirable that the multiple approaches explicitly call upon a range of intelligences, skills, and interests.

It may seem that I am simply calling for the "smorgasbord" approach to education: throw enough of the proverbial matter at students and some of it will hit the mind/brain and stick. Nor do I think that this approach is without merit. However, the theory of multiple intelligences provides an opportunity, so to speak, to transcend mere variation and selection. It is possible to examine a topic in detail, to determine which intelligences, which analogies, and which examples, are most likely both to capture important aspects of the topic and to reach a significant number of students. We must acknowledge here the cottage industry aspect of pedagogy, a craft that cannot now and may never be susceptible to an algorithmic approach. It may also constitute the enjoyable part

of teaching: the opportunity continually to revisit one's topic and to consider fresh ways in which to convey its crucial components.

Educators and scholars may continue to believe that there is still an optimal mode for representing the core of a topic. I respond as follows. The history of disciplinary progress makes it inevitable that experts will think about a topic in terms of privileged considerations — perhaps genetic mutations and ecological niches in biology, perhaps human intentions and worldwide forces in the case of history. Such consensual portrayal is reasonable. However, one should never lose sight of the fact that evolution did not occur in biology, and the Holocaust did not occur in history; they are events and processes that happened and became available for observers and scholars to interpret and explicate them as best they could. New discoveries, as well as new disciplinary trends, gradually undermine today's orthodoxy; tomorrow's scholars might remake our understandings. Just as Darwin rewrote Lamarck's view of evolution, the believers in punctuated equilibrium aim to overthrow Darwinian gradualism (Gould, 1993). By the same token, Goldhagen's *Hitler's Willing Executioners* (1996) gives a far more "ordinary Germanic" cast to the Holocaust than had historians of earlier decades.

Generalizing the Approach

Even if I have achieved some success in suggesting how

best to approach two gritty topics of education, I have evidently left untouched the vast majority of the curriculum. My focus has been on a high school, or perhaps a college, pair of topics; I have drawn from biology and European history, rather than from mathematics, music, or meteorology; and I have focused on topics or issues, rather than, say, specific chemical reactions, or metrical analyses, or geometrical proofs.

I would be remiss were I to imply that the approach sketched here could be applied equivalently to every topic of the syllabus. Indeed, I deliberately selected two topics that are relatively rich and multifaceted and that readily allow consideration from several perspectives. I suspect that no pedagogical approach is going to prove equally effective for the full range of topics and skills that need to be conveyed; teaching French verbs or the techniques of Impressionism is simply not commensurate with covering the Russian Revolution or explicating Newton's laws of mechanics.

Still, the approach sketched here can have wide utility. First, it raises the question of why one is teaching certain topics and what one hopes that students will retain at some time in the future. Much of what we teach recurs through habit; it makes sense to teach fewer topics and to treat them in greater depth. Such an approach allows one to relate materials to a few central themes, like evolution in biology or the Holocaust in history (or energy in physics, or character in literature), and to eliminate topics if they

cannot be reasonably connected to some powerful themes or through-lines. After all, we cannot conceivably cover everything; we may as well strive to be coherent and synthetic in what we do cover.

Having determined which topics require sustained attention, one can then exploit an ensemble of pedagogical approaches. To recapitulate: one begins by considering which entry points might succeed in attracting the interest and attention of diverse students. One then considers which kinds of analogies and other kinds of comparisons (for example, metaphoric expressions) might convey important parts of the topic in ways that are powerful and not misleading. Finally, one seeks to find a small family of literally appropriate representations that, taken together, provide a rich and differentiated set of representations of the topic under consideration. Such an ensemble conveys to students what it is like to be an expert. And to the extent that the family of representations involves a range of symbols and an array of schemes, it will prove far more robust and useful to students.

Presenting materials that foster multiple representations is one component of effective teaching; the complementary component entails the provision of many opportunities for performance, which can reveal to the student and to others the extent to which the material has been mastered. In stimulating informative performances of understanding, teachers need to be imaginative and pluralistic. Although it is easy to fall back on the

tried-and-true — the short answer test, the essay question — there is no imperative to do so. Performances can be as varied as the different facets of the topic, and the diverse sets of skills of students. A variety of sanctioned performances not only provides more students with an opportunity to show what they have understood; it also ensures that no single "take" on a topic exerts an inappropriate hegemony on students' (or test-makers'!) understandings of that topic.

With respect to our present examples, then, I encourage teachers to have students engage with one another in debates, for example, on the causes of the Holocaust or the merits of Lamarckianism; to carry out experiments that probe different aspects of the evolutionary process; to interview individuals who have survived the Holocaust or various other of the global conflicts of our time; to create works of art that commemorate heroes of the Resistance; or to design a creature that can survive in an environment that has become highly toxic. Perhaps most challengingly, they might need to be asked to discuss the factors that permitted the Holocaust in terms of what we know about the evolution of behavior in that line called *Homo sapiens sapiens*. Hence, our two topics would at last be joined. Consultation of curricular guides and conversations with other teachers should stimulate the imagination with respect to other kinds of performances for other specimen curricula.

Is this just another call for projects, one of the sins of

the Progressive movement, recently castigated by Hirsch (1996)? Quite the contrary. Student projects need to be considered critically in two respects: (a) adequacy as an example of a genre (Is it a coherent essay? Is it an effective monument? Does it qualify as a causal explanation?); (b) adequacy as an occasion for performing one's understandings (Does the debater stick to the consensual facts or does she distort what is known? Does the newly designed species have a life span that allows reproduction and rearing of offspring?). Far from being a superficial measure of understanding, such projects and performances hold the students to high standards; the key features of the concept should be performed in vehicles that meet the test of cultural viability.

Coda: Technological Means, Human Ends

I have restricted myself until now almost entirely to the simplest forms of technology: books, pencils, and papers, perhaps a few art supplies, a simple biochemical laboratory. This is appropriate; fundamental discussions of educational goals and means should not be dependent upon the latest technological advances.

Yet, the approach outlined here promises to be enhanced significantly by current and future technologies. It is no easy matter for teachers to provide individualized curricula and pedagogy for a class of 30 elementary school students, let alone several high school classes totaling more than 100 students. Similarly, it is challenging to have

students present a variety of performances and then provide meaningful feedback on this potpourri.

Happily, we have in our grasp today technology that will allow a quantum leap in the delivery of individualized services for both students and teachers. It is already possible to create software that addresses the different intelligences; that provides a range of entry points; that allows students to exhibit their own understandings in symbol systems (linguistic, numerical, musical, and graphic, just for starters); and that begins to allow teachers to examine student work flexibly and rapidly. Student work can even be examined from a distance, thanks to e-mail, video conferencing, and the like. The development of "intelligent systems" that will be able to evaluate student work and provide relevant feedback is no longer simply a chapter from science fiction.

In the past, it might have been possible to argue that personalized or individualized instruction, though desirable, was simply not possible. That argument is no longer tenable. Future reluctance will have to be justified on other grounds. My strong hunch is that such resistance is not likely to persuade students and parents who are not experiencing success "in the usual way" and who might benefit from alternative forms of delivery; neither will such resistance satisfy scholars who have arrived at new ways of conceptualizing materials, nor teachers who are themselves dedicated to a variety of pedagogies and assessments.

Educators have always tinkered with promising technologies, and much of the history of education chronicles the varying fates of paper, books, lecture halls, film strips, television, computers, and other human artifacts. Current technologies seem tailor-made to help bring into reality the kind of multiple intelligences that I have endorsed here. Still, there are no guarantees. Many technologies have faded; many others have been used superficially and unproductively. And we cannot forget that some of the horrible events of human history, such as the Holocaust, featured a perversion of existing technology.

That is why any consideration of education cannot remain merely instrumental. The question is not "computers or not?", but "computers for what?", and more broadly, "education for what?". I have taken here a strong position: that education must ultimately justify itself in terms of enhancing human understanding. But that understanding itself is up for grabs. After all, one can use knowledge of physics to build bridges or bombs; one can use knowledge of human beings to help or to enslave them.

I want my children to understand the world, but not just because the world is fascinating and the human mind is curious. I want them to understand it so that they will be positioned to make it a better place. Knowledge is not the same as morality, but we need to understand if we are to avoid past mistakes and move in productive directions.

An important part of that understanding is knowing

who we are and what we can do. Part of that answer lies in biology — the roots and constraints of our species — and part of it lies in our history — what people have done in the past and what they are capable of doing. Many topics are important, but I would argue that evolution and the Holocaust are especially important. They bear on the possibilities of our species — for good and for evil. A student needs to know about these topics not primarily because they may appear on an examination but rather because they help us to chart human possibilities. Ultimately, we must each synthesize our understandings for ourselves. The performances of understanding that truly matter are the ones that we carry out as human beings in a world that is imperfect but that we can affect — for good or for ill.

Acknowledgments

For support of this work, I am grateful to the Ross Family Charitable Foundation, the Louise and Claude Rosenberg, Jr. Family Foundation, and Thomas H. Lee. I thank Veronica Boix-Mansilla, David Perkins, and Charles Reigeluth for their helpful critiques of an earlier draft of this paper.

References

Gardner, H. (1991). *The unschooled mind: How children think and how schools should teach*. New York: Basic Books.

Gardner, H. (1993a). *Frames of mind: The theory of multiple intelligences* (10th anniversary ed.). New York: Basic Books.

Gardner, H. (1993b). *Multiple intelligences: The theory in practice*. New York: Basic Books.

Gardner, H. (1998). Are there additional intelligences? The Case for Naturalist, Spiritual, and Existential Intelligences. In J. Kane (Ed.), *Education, information, and transformation: Essays on learning and thinking* (pp. 111–132). Englewood Cliffs, NJ: Prentice-Hall.

Gardner, H. (1999). *The disciplined mind: What all students should understand*. New York: Simon and Schuster.

Goldhagen, D. (1996). *Hitler's willing executioners: Ordinary Germans and the Holocaust*. New York: Alfred A. Knopf.

Gould, S. J. (1993). *Wonderful life: The Burgess Shale and the nature of history*. New York: W. W. Norton.

Herrnstein, R., & Murray, C. (1994). *The bell curve: Intelligence and class structure in American life.* New York: Free Press.

Hirsch, E. D. (1996). *The schools we need and why we don't have them*. New York: Doubleday.

Sternberg, R. J. (1985). *Beyond 1Q: A triarchic theory of human intelligence*. Cambridge: Cambridge University Press.

Wiske, M. S. (Ed.). (1998). *Teaching for understanding: Linking research with practice*. San Francisco, CA: Jossey-Bass.