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What Will It Mean To Be An Educated Person in Mid-21st Century?

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What should distinguish an educated person of mid-21st century from the educated person of a century earlier? Unfortunately, the most straightforward answer consists of a number of added specifications with very little compensating elimination of older ones. New technology is downgrading certain technical skills such as penmanship, ability to do long division, and ability to thread a movie projector; but the academic content and competencies set out in the 1959 *Case for Basic Education* (Koerner, 1959) remain as important now as then, along with challenging new content and additional competencies that now demand attention. And some of the 1959 wisdom rings more tellingly now than it did back then, particularly Clifton Fadiman's words about "generative" subjects that enable future learning and about the value of education in saving students from feeling lost, in enabling them to feel "at home in the world" (Fadiman, 1959, p. 11). Rather than approaching the question with an additive mindset, however, we attempt in this paper to approach it in a way that is open to possibilities of transformation in educational ends and means.

The coming decades are likely to see the individual learner having to share space with the group as the unit of analysis in teaching and assessment. There are legitimate senses in which learning not only take places in groups but is a group phenomenon (Stahl, 2006): Group learning is something beyond the learning undergone by members of the group; it is something only definable and measurable at the group level. There are legitimate and important senses in which groups understand (or fail to understand), develop expertise, act, solve problems, and demonstrate creativity (Sawyer, 2003). While the title of this chapter indicates a focus on the individual, much of what we have to say is shaped by the larger question, "What will it mean to be an educated society in mid-21st century?"

A Different Kind of Person?

In speculating on what it will mean to be an educated person in the middle of the 21st century, the first question to consider is whether mid-21st century people will be different kinds of persons from their 20th century counterparts. There is much talk about brains being "rewired" by game playing and cell phone use. Without venturing into such speculation, we can note potentially far-reaching behavioral changes resulting from new

kinds of social communication. There is the social website phenomenon of "friending," which leads to vastly expanded circles of putative friends compared to the usual networks of direct contacts. Whether these constitute friendship in the normal sense may be questioned, but what is most evident is the extent to which communication in these social media is person-centered in contrast to being idea-centered. This shift is something of potentially major educational and perhaps cultural consequence, and we return to it briefly at the end of this chapter, in a section titled "Will Technology Facilitate Becoming an Educated Person?". Related to it, and also of potential profound consequence, is the trend toward short messages without the continuity of ordinary conversation. Short, mostly discontinuous messages also characterize text-messaging and the commenting that pervades blogs and Web news sites. As technology evolves enabling speech to play a larger role in online communication, the trend toward brevity may be reversed, but it could mean even farther distancing from the "essayist technique" that has been the medium of extended reflective thought (Olson, 1977). Extreme personalization and fragmentary communication would appear to be antithetical to what quality education has traditionally stood for. Are they really? And if they are, how should education respond to them?

The consequences of a shift toward greater person-centeredness are indefinite enough at this time that they may look favorable to some and dismal to others. A standing joke these days is Facebook denizens reporting what they (or sometimes their dog) are having for dinner. It does appear that much of the content appearing on social sites and personal blogs can only matter to people who have a personal interest in the author. A similar trend may be detected in contemporary poetry; whereas at one time you needed a classical education to understand the allusions in a poem, now you often need to know the poet. What is being lost here is the drive toward expansive meaning that characterizes the arts and scholarly disciplines. It may be that this is a good thing; it is consistent with post-modern skepticism about grand narratives. But it certainly gives a different meaning to "well-educated" from what it had a century ago.

The trend toward shorter, more fragmentary communication has more direct implications for ability to meet the intellectual challenges of this century. Can the increasingly complex problems of 21st-century societies be solved by sound bites? The

answer is surely no, yet utterances of 15 seconds or less are already taking over political discourse while, maddeningly, legislation is getting longer. Although we have not seen any systematic evidence on the matter, numerous Internet bloggers remark on the paradox of books and other media getting longer while ability to sustain attention over long stretches is getting shorter. Quite possibly these are not divergent trends but different manifestations of the same trend, which is a declining ability to do the sustained integrative thinking that can on one hand tighten prose around essential ideas and on the other hand enable readers to process complex texts. The proof will come if speech-to-text becomes the preferred medium of asynchronous communication: Will it result in more extended thought or will it tend to bury thought under transcribed babble?

Text is gradually being replaced by hypertext—coherent texts that contain abundant clickable links to related information sources. The virtues of hypertext are obvious to anyone researching a topic on the Internet, but it does pose a heightened challenge to focus. Following a link to a source that contains additional links, following one of those, and so on can quickly lead to loss of one's original purpose. Improved media design may make it easier to recover one's line of thought, but ultimately the challenge is an educational one: to heighten metacognitive awareness, to help students keep cognitive purposes in mind and to evaluate their current mental states against them. This is but one example of what promises to become a growing educational challenge: to promote *sustained work with ideas.* Society needs it, new media provide both tools and diversions from it, and schools have scarcely begun to recognize the challenge. Sustained work with ideas also poses a challenge for educational technology design, but one that has not yet come into clear focus for developers. Hopefully this will change. We are currently working on design of a new digital knowledge-building environment that has a person-oriented space for social interaction around ideas but in addition an "idea level" where ideas abstracted from the social space become objects of inquiry, development, and improvement—where what goes on may be described as ideas interacting with ideas rather than people interacting with people.

Education's Two Faces

Being an educated person has traditionally had two aspects, one representing academic knowledge and skills and the other representing personal qualities—traits of character or intellect that the educational process is supposed to develop. Recent future-oriented literature has shown a definite tilt toward the second aspect, now described by such terms as "higher-order," "21st-century," or "soft" skills, "habits of mind," and "literacies." Reasons for the tilt toward personal qualities are not difficult to discern. There is the rapid growth of knowledge, which makes mastery of any subject increasingly beyond reach and renders knowledge increasingly vulnerable to obsolescence. There is the ready availability of factual information via Web search engines, which reduces the need to store declarative knowledge in memory. And then there is the general uncertainty about what the future will demand of people, thus raising doubt about the value of specific knowledge and "hard" skills and favoring more broadly defined educational objectives such as "learning to learn," "critical thinking," "communication skills," and "creativity." These, it can be assumed, will always be useful. In practical educational terms, however, this is also a tilt away from things that teachers know how to teach with some degree of effectiveness to objectives of questionable teachability.

The scope of the term "educated" may be narrowly limited to testable knowledge and skills or expanded to include everything that constitutes being a good citizen. Real life requires that people not only have knowledge but that they be willing and able to act upon it. This has multiple implications for the kinds of life experiences that constitute growing up into active citizenship, although it is not evident that times are changing in this respect. Many educators will argue that there is increasing need for students to eschew violence, honor diversity, and free their thinking of racism, sexism, homophobia, ethnocentrism and other prejudices. They will therefore want to include these in any description of an educated person. It must be recognized, however, that throughout history there have been well-educated people who demonstrated none of these qualities and were sometimes notable for their opposites. The standard rejoinder is that such people could not have been well educated; but we do not believe it is wise to burden the term "educated" with every desirable human quality. Better to acknowledge that there is more to being a good person than being well educated. One can go to virtually any poor

village and find uneducated people who are paragons. Eliminating moral perfection from the definition of an educated person does not, however, mean eliminating emotions, beliefs, mindsets, and moral reasoning from consideration. On the contrary, it frees us to consider in a constructive way the role that these may play in cognitive processes, along with knowledge, skills, and aptitudes. A lot more is known about this interplay today than was known back when "higher-order skills" first came on the stage, and in the following discussion we attempt to draw on this recently developed knowledge.

Knowledge and Knowledgeability

The status of knowledge in what is frequently called the "Knowledge Age" is ambiguous. Everyone is of course in favor of knowledge but *knowledgeability*, the retention of knowledge in individual nervous systems, has come under scrutiny, for reasons already stated. A legitimate sub-question to *What will it mean to be an educated person in mid-21st century?* is the question, *What will it mean to be a* knowledgeable *person in mid-21st century?* An answer to this question divides into three parts, each of which poses both assessment and instructional problems.

21st century subject matter. Over the course of educational history, new subjects have from time to time been adopted as essential, and more rarely a subject may be dropped. Science made its way into the curriculum against some resistance, and now is raised close to the top. The late 20th century saw ecology and cultural studies entering the list. Computer programming came and went as an element of general education—and may be on its way back again (cf. Resnick, et al., 2009). Probability, statistics, and graphical representation of data, which were largely absent in mid-20th century schooling, are now essential for following the daily news. Not yet fully arrived in the curriculum are complex systems theory and mathematical modeling, although these are arguably essential for advanced work in virtually any discipline.

Identifying important new subject matter has been something curriculum planners have been doing energetically ever since the Sputnik era. Identifying what it will take for adequate knowledgeability in the present century calls, however, for more complex analysis. It is not enough to identify topics that are worthy of instruction. We need to identify where schooled knowledge is falling short of emerging needs. For instance,

"financial literacy" is a need brought into the spotlight by current economic problems. However, proposals currently on the table are focused on personal finance. Important as this may be, people can be knowledgeable about their personal finances—knowing how to recognize and avoid high-interest traps, for instance—and still be financially illiterate when it comes to national economic policy. In fact, using one's personal financial wisdom as a paradigm for judging governmental policies is a serious and all too common mistake; it leads to a simple-minded "thrift" approach that ignores macroeconomic effects on currency, inflation, employment, and level of consumer spending. Economics, like practically everything else of societal importance, needs to be understood systemically—and that is what most strikingly distinguishes 21st-century knowledgeability from what could serve adequately in times past.

Depth of understanding. Teaching for understanding is widely advocated. Knowledge tests are being reshaped to test for it, with less emphasis on testing factual recall. But when it comes to assessing *depth* of understanding, educational assessment does not seem to have progressed significantly beyond Bloom's *Taxonomy* (1956). The *Taxonomy* cast the problem in behavioral terms: "Specifically, what does a student do who 'really understands' which he does not do when he does not understand?" (p.1) Accordingly, depth was operationalized by a hierarchy of increasingly sophisticated things students might do with their knowledge: applying, analyzing, synthesizing, and evaluating. This approach was further developed in a revision of the *Taxonomy* (Anderson & Krathwhol, 2001) and in Perkins' "understanding performances" (Perkins, 1995; Perkins & Unger, 1999). While it is no doubt true that being able to do increasingly difficult things with knowledge requires increasing depth of understanding, this does not really get at what *depth* means, and the assessment tasks suffer from the fact that a student is liable to fail them for reasons other than a lack of understanding (Bereiter & Scardamalia, 1998).

There is another way of operationalizing depth: define it according to *what* is understood rather than *how well* the student can demonstrate understanding. Student understanding of evolution can be mapped in this way. At the lowest level, students understand that biological adaptation occurs but they treat it as something that just happens. Ohlsson (1991) found this to be a prevalent conception among university

undergraduates. At a significantly deeper level, students have the idea of "survival of the fittest" and can explain the giraffe's long neck on the basis of longer necked giraffes surviving while those with shorter necks died without reproducing. This is about as far as understanding evolution usually goes in school biology, but as advocates of Intelligent Design point out, it fails to explain the emergence of new species or the evolution of complex organs such as the eye. Explaining those things requires understanding several deeper concepts, and still deeper and more complex ones are required to explain other phenomena such as irregularities in the time course of evolution. All these understandings are testable and they form at least a partially ordered scale of depth of knowledge. Developing similar scales in other domains may require the kind of research that has been devoted to students' evolutionary concepts, but it is worth doing not only as a basis for testing but also as a basis for finer-grained learning objectives.

Defining progressions in depth of understanding is especially challenging for newer subject matter where there is not a long history of efforts to identify and teach essential concepts. Probability and statistics are being taught, but are they being taught in sufficient depth that they become useful tools for gaining insight into real-world problems? Huck (2009) has identified 52 misconceptions that indicate failures in the teaching of statistics and probability, but are the conceptual errors as miscellaneous as they appear, or are there deeper ideas of which the 52 misconceptions are a reflection—failure, for instance, to grasp and apply the idea of the set of equally likely events, which is foundational to most school-level work with probability? People's erroneous thinking about probability in real-world phenomena, however, seems to depend not so much on faulty knowledge of statistics and probability as on simplifying heuristics and biases that preempt formal knowledge (Kahneman, 2003). Another domain that cries out for a mapping of concepts according to depth is systems theory. First graders are being introduced to the concept of *system* and are being schooled in a reasonable definition of it. But where does instruction go from there? How many students, or teachers for that matter, can distinguish a systemic explanation from a mere multivariate explanation? Where does understanding of ecosystems fall short or go wrong?

Quantity of knowledge. Despite its being frequently disparaged in the education literature, sheer quantity of knowledge still matters. It matters because it increases the

likelihood of making fruitful connections and analogies; it increases one's resources for performing successful Web searches; and it provides entry to informative texts that can convey deeper information (Hirsch, 1987). We have heard informally about an experimental test tried out by the College Entrance Examination Board sometime before 1970. It tested miscellaneous world knowledge of the kind represented in mass-media news magazines, and found that scores on such a test were as good or better at predicting college grades than the familiar aptitude tests. The experiment was abandoned, reportedly, because it conveyed such a negative impression of the nature of college education. In reality, of course, schools and colleges do not teach or test miscellaneous knowledge. It is picked up informally by living an active intellectual life in an information-rich environment. The 21st century ought to be better for this than preceding centuries. Having a rich store of miscellaneous knowledge is accordingly one reasonable marker of successful mid-21st century educational growth—not the most important, but one deserving of support. Assessing quantity of miscellaneous knowledge presents a problem that occurs whenever students are not expected all to learn the same things. In a later section of this paper we will consider this problem, which takes on increasing importance as education moves increasingly toward individualization, self-directed learning, and knowledge building.

Education for Change?

The phrase "education for change" has begun to appear around the Web; several charter schools have it as their name. It is not clear what "education for change" means, and the websites we have visited do not offer explanations. One obvious implication of the accelerating rate of change is that students should be prepared to undertake substantial learning efforts later in life. Project-based learning is supposed to provide such preparation, but does it? Evidence, of course, is lacking—because of the time gap. The commonest projects consist of gathering and presenting information on some topic (Moursund, 1999). We find education graduate students who are so practiced at this that they resist any major course assignment that calls for anything different. Yet this kind of project does not bear very directly on lifelong learning needs. Seldom does practical life call for researching a topic. In adult life, studying topics of interest is avocational,

pursued for its intrinsic rewards: a worthy activity, but not an especially timely one. Instead, life's exigencies call for gaining new competencies and for obtaining information to solve problems. Some school projects involve the latter, although often the problems are given and the procedures for gathering the needed information pre-arranged. Even explicitly "problem-based" learning generally offers little experience in dealing with ill-defined, emergent problems, where it is uncertain what information will prove helpful; yet those are the kinds of problems that "education for change" ought to be preparing students for.

Acquiring new competencies is something not only "knowledge workers" but people in all lines of work may anticipate. Present day schooling provides practically no experience in doing this independently; to the extent that students gain such experience they gain it outside the curriculum—in sports, hobbies, and community or entrepreneurial work. Schooling could do more, however, and address kinds of competence that draw more directly on disciplinary knowledge. In mathematics, for instance, there are countless special applications in which students could gain some proficiency—far more than can be taught in the regular curriculum. There is mathematics of heating and air conditioning, structural engineering, the tuning of racing cars, navigation, grilling and smoking meat, finance, cosmetology, musical composition, and on and on. Working independently or in self-selected teams, students could undertake to gain proficiency in some mathematical application of interest to them and be called on to present evidence of proficiency. Replacing some topic-centered projects with competency-centered projects could probably enliven school experience considerably and be of more direct lifetime value. "Competency-based education" has been a recognized movement since the 1960s, but it emphasizes pre-specified objectives systematically taught and evaluated (Burke, et al., 1975). In competency-centered projects, by contrast, students would be responsible for all of this and the emphasis would be on gaining experience in self-directed acquisition of new competencies. The rapidly growing number of websites that award "badges"—including "expertise badges"—seems to reflect a similar interest in self-directed acquisition of competencies, although at present the earning of badges appears to be an individual rather than a collaborative effort and in most cases the badges are awarded on

the basis of activity (visiting websites, commenting, and so on) rather than on the basis of demonstrated competence.

Arguably, the young have more to teach us than we have to teach them about adapting to the famous "accelerating pace of change." Of far greater concern in the big picture is not the ability of individuals but the ability of institutions to adapt to changing conditions. Companies that fail to adapt or to adapt as rapidly and effectively as their competitors are a recurrent feature of the business news. Of course, institutions are composed of individuals, but adaptability at the individual level does not ensure adaptability at higher systemic levels. A striking case in point is the infamous "mile wide, inch deep" curriculum. Everyone is opposed to it, yet it persists despite vigorous reform efforts. But perhaps the most dramatic example of failure to adapt to changing conditions is the U.S. Congress, which at this writing appears to be almost completely dysfunctional, unable to cope with the most pressing problems of unemployment, economic stagnation, widening income inequality, access to medical care, climate change, deteriorating infrastructure, civil liberties, and more, while mired in dogma and mindsets of the past. If education can make a difference, it will not be through fussing about change per se but through equipping people with what they need to form rational judgments on issues such as those just listed. This, of course, is uncontroversial. Controversy arises—or should arise!—when it comes to defining what people need in order to form and act upon such rational judgments. Is it training in critical thinking or is it better understanding of economics, ecology, and so forth—or can education manage to provide both? And, realistically, how far can schools go in opening closed minds when there are such strong social forces opposing it?

Cosmopolitism

To be an educated person in today's world is to be a cosmopolitan (Rizvi, 2008)—someone who is a citizen of the world, at home in and able to navigate among its variety of cultures, ideas, and life styles; someone who may cherish his or her own background traditions and world view but is not bound by them. We use the term "cosmopolitism" instead of the much more common "cosmopolitanism" to refer to the

state of being cosmopolitan, because "cosmopolitanism" has acquired too much ideological baggage. The current *Wikipedia* article of that name in fact defines "cosmopolitanism" as an ideology, a one-world ideology. Although this ideology may appeal to liberal thinkers, a goodly portion of the American populace is liable to reject it as an attack on American exceptionalism.

In current curricula the goal of broadening students' outlook on the world is subsumed by "multicultural education" (Banks, 1994), knowledge goals such as "global awareness" (Partnership for 21st Century Skills, n.d.), foreign language learning, and various sorts of cross-cultural student activities. But, as with other human development objectives, breaking cosmopolitism down into knowledge, skills, attitudes, and activities seems to miss the essence, which we would define as "feeling at home in the world." This is a politically sensitive topic. Unless you are very careful about how you express yourself, cosmopolitism may come out sounding like something you might read in a luxury travel magazine or, worse yet, like cultural imperialism. Yet there can be little doubt that the kind of worldliness traditionally promoted by the "junior year abroad" needs a much fuller and richer development in the coming decades.

Media Literacy

There is no need to detail the remarkable proliferation of ways to express oneself and to represent knowledge and ideas. These are bound to become increasingly diverse and powerful, not only in terms of what people are exposed to but in terms of what they can exploit as means of communication. If information media continue to develop at the rate they did in the past 40 years, there is no telling what the situation will be like by mid-century. This suggests that media literacy, if there is anything that warrants that name, needs to be grounded in fundamentals and to rise above trendiness.

There was a time when information technology literacy meant trotting students off to a computer laboratory where they did exercises in word processing, computer graphics, and Internet searching. Although vestiges of that practice can still be found, information technology is now too various and multi-purpose for that to be helpful or even feasible. It now makes more sense simply to carry out educational activities in

which various kinds of technology play natural and useful roles. Equally obsolete, however, are the old media literacy activities that involved recognizing propaganda and persuasion techniques, using artificial or relatively trivial examples while avoiding controversial examples of major social significance.

Media literacy in this century is going to have to take a higher path. Students need to recognize the media as (a) causing social change, (b) being shaped by social change, and (c) evolving planlessly through the interaction of many factors. The consolidation of media in conglomerates is a rapidly developing fact. Former CBS news journalist Dan Rather has voiced his alarm at "the corporatization of the news, the politicization of the news and the trivialization of the news" (Rather & Diehl, 2012, p. 289). Rather traces the descent from the great independent newspapers that featured investigative journalism and worldwide news coverage to television networks that treated news as a public service, finally to arrive at the state where "we now have four talking heads in a studio shouting at one another, instead of four overseas bureaus covering real news" (p. 289).

A recent survey by Fairleigh Dickinson's PublicMind is ominous with regard to the present state of news media literacy. It indicates that people who watch Fox News know less about world events than people who do not frequent any news sources at all (Cassino & Wooley, 2011). How could this be? It can hardly be supposed that Fox News failed to report the overthrow of President Mubarak in Egypt, for instance. One explanation is that people who frequent this channel, with its heavy emphasis on right-wing domestic politics, are sufficiently imbued with American exceptionalism that they tend to disregard events in other countries. (They may be the same people who favored legislation instructing the courts not to pay attention to foreign court decisions.) What seems to be happening (and new technology is unlikely to alter the trend) is that news reporting and commentary get distributed over countless sites. More information is becoming available than in times past, along with more varied interpretations of events, but aggressive, sustained inquiry into what is behind the news (investigative journalism on socially significant issues) is being replaced by professional and amateur punditry (the "four talking heads shouting at one another").

Since it is out of the question for people to become their own investigative journalists, the best education can do is help people become their own pundits. This

means thinking critically and reflectively about information received. However, a more proactive stance than this is needed in order to deal with information overload. It means the educated citizen functioning as a theory builder rather than merely an opinionator. It means applying the hypothetico-deductive method (also known as abduction): producing a conjecture that explains the facts and then searching for information to test whether the conjecture is true. The conjecture in the preceding paragraph about why Fox News viewers would know little about world events is hypothetico-deductive. It explains the reported fact, but is it true that Fox News viewers are exceptionally imbued with belief in American exceptionalism? We have found evidence that Fox News vehemently upholds American exceptionalism and that conservatives are significantly more likely to endorse it than moderates or liberals, which is in accord with the conjecture, but we have not yet found direct evidence that Fox News viewers tend to be especially committed to exceptionalism and especially disdainful of foreign influences. So the conjecture stands, although it could be replaced by a more convincing explanation or defeated by counter-evidence. We use this example to suggest that an educational response to what might be the major "new media" issue of coming decades calls for something much more substantive than what generally passes for "media literacy." It is not just teaching critical thinking or media skills or familiarizing students with new media, it is engaging students in real theory development about real issues, using new media as a resource.

Moral Reasoning

The educated person of the mid-20th century will need to be a capable and dedicated moral reasoner. But what is new about this? Moral education by one name or other has long held a respected place in education, and a pedagogy for moral reasoning was well worked out by Lawrence Kohlberg and others in the 1960s. What is new is the globalization of moral issues and the increased complexity that goes with it. It is becoming increasingly difficult to ignore injustices in distant places or in cultures different from one's own, but reasoning about them becomes complicated by issues of cultural hegemony and differences in world views. Three moral issues prominent in the news at this writing are honor killings, female circumcision, and abortion. Honor killings

and female circumcision are established folkways in some societies. As long as they were confined to distant and poor communities, Westerners were free to disapprove but do nothing about them. With globalization, however, what was once remote has become closer and sometimes internal to Western societies, and there is a growing universalism that on one hand respects cultural diversity and eschews cultural imperialism and on the other hand espouses universal human rights and tends to bind women the world over in insistence upon the same rights. So people of a modern liberal disposition find themselves caught between one stricture that says don't intervene in the cultural practices of other societies and another that says gross violations of human rights cannot be tolerated anywhere. At this time it may be feminist thinkers who agonize most over this dilemma, but it ought to be of concern to everyone. The moral dilemma goes far beyond such Kohlbergian moral dilemmas as whether Heinz should steal to get a life-saving drug for his wife.

A moral dilemma that engages a much larger swath of citizenry in Western nations is abortion. Unlike the previous two issues, abortion has organized groups and even political parties lined up on opposing sides. Appeal to emotions is a standard technique but its role in abortion controversy dramatizes the new level of challenge it poses to moral reasoning. A few decades ago the emotional appeals available to opposing sides in abortion debates may have been about equal in persuasive power. But now anti-abortion websites can produce vivid displays of the most gruesome, bloody sights, set in contrast to the charming smiles of babies. Some states are now carrying the matter even further by passing laws that require women seeking abortions to view ultrasound video of the fetus they are carrying. Nothing that pro-choice groups can present comes anywhere near this in emotional arm-twisting. This example suggests that moral reasoning faces a more uphill struggle than it did in the past, not because of some epidemic of irrationality (although that may also be occurring) but because modern communications have greatly increased the persuasive power of visceral appeals to emotion.

Rational Thought and Emotionality

Two points about the abortion example have implications that extend beyond moral reasoning to reasoning in general. One is that new media are elevating means of expression that are alternative to words, even though words (and in particular written words) remain the principal medium of rational thought and discourse. This is probably an irreversible trend and not necessarily detrimental to rational thought. One need only consider how graphical representation of data, now pervasive in news media, has put quantitative information within the reach of people who could not have grasped it in verbal or numerical form. But if this shift is accompanied by a reduced ability to follow an extended exposition in text, we have a serious educational problem. It is bad enough that political messages are put out as sound bites, but if people's thinking about important issues is also carried out in parcels of thought equivalent to sound bites, we have a cultural problem that 21st-century education must do something about.

The other point draws upon an important advance in understanding reasoning, known among cognitive and brain scientists as "dual process theory." Dual process theory posits separate systems of response, both of which may be activated by an event or a message but that differ not only in how they work but in the speed at which they work. System 1 (Kahneman, 2011; Stanovich & West, 2000) is a system of rapid response, which works on the basis of associations (similarities, co-occurrences, etc.) and may trigger emotions of any sort, such as fear, disgust, or anger, and may precipitate immediate actions such as flight or attack. System 2 is a slower-acting system that carries out a sequential thought process. The important practical implication is that by the time System 2 kicks in, System 1 has already acted and left the thinker with an immediate judgment, impression, or action response. There is reason to believe that System 1 typically dominates moral judgment; we respond with immediate gut reactions of disapproval or approval, revulsion or admiration, and System 2 serves, when it can, to provide us with justifications for those reactions (Haidt, 2001). This seems transparent in people's opposition to same-sex marriage and to gay rights in general. Even if Biblical justifications are invoked, they have a distinctly ad hoc flavor because of the many Biblical injunctions ignored (as currently satirized by the website godhatesshrimp.com)

and because of the absurdity of the worldly arguments they bring forth to buttress their case (threat to marriage, and so on). This example illustrates that the dominance of System 1 over System 2 is not just a matter affecting personal morality but is something that can have far-reaching social consequences when the issue is one on which gut reactions are strong and widely held. New media are providing both means to provoke massive System 1 reactions and ready-made System 2 justifications for them. Of course, they can also provide stimuli for countervailing System 1 reactions as well as information and food for impartial System 2 thought. But arguably the balance of power is shifting toward System 1 arousal rather than System 2 rationality.

Affect-laden responses, triggered by associations and correlations, are as much a part of being human as deliberative thought. System 1 is educable, as in the educating of tastes and empathy. While it can be a source of stereotyped or habit-bound reactions it can also produce novel and unpredictable cognitive turns (Thagard, 2006). Being able to recognize the action of both systems in our judgments and to evaluate and possibly revise System 1 judgments with System 2 processes is a new take on what it means to be rational (Stanovich, 2004).

Thinking and Learning Skills

"Teach them to think" is an educational objective that can be traced as far back as Socrates. However, the idea of treating thinking as a skill (or set of skills) seems to have been a mid-20th-century innovation, and a questionable one. Before that "teach them to think" was treated more as a kind of character development and all-around intellectual development. "Teach them to think" might have been glossed as "teach them to be thinkers." For good or ill, meeting the 21st century's need for good thinkers is being treated by education systems around the world as a skill-learning problem rather than a human development problem.

Several groups are developing thinking skill tests with the express purpose of driving schools to teach thinking skills. Because this will predictably and perhaps intentionally lead to teaching for the test, serious attention ought to be given to issues of teachability, transfer, and fairness. There has been little such attention. A point may be

put on this skepticism by examining what has been claimed as "one of educational psychology's greatest successes" (Mayer & Wittrock, 2006, p. 298), the teaching of problem-solving strategies. What is being referred to more specifically, however, is the teaching of strategies for solving mathematical word problems. The evidence is quite clear that teaching such strategies as drawing diagrams, working backward, making a plan, and paraphrasing instructions leads to improved performance—on mathematical word problems. So teachability has been demonstrated; but what is being taught? There is no evidence that students actually use the taught strategies, and so what is being taught may only be a habit of mindfulness—a habit of thinking a bit before plunging ahead with numerical operations. As for transfer, the evidence is that the effects are rather strictly limited to word problems of the kinds used in instruction. But might this not be a valuable skill in its own right? Hardly. Where in real life does one encounter fully stated problems with all the necessary information for solution provided? On the puzzle pages of newspapers, but scarcely anywhere else. What is being taught is, thus, essentially a limited puzzle-solving skill. Evidence has been accumulating ever since Luria and Vygotsky's original research, showing that schooled people are better disposed to deal with hypotheticals than less schooled people, who are more inclined to base conclusions on real-world knowledge (Scribner, 1979). Mathematical and logical word problems are hypotheticals par excellence and solving them requires adhering to the explicit (often unrealistic) terms of the problem and not allowing common sense and world knowledge to intrude. Testing a skill that requires suppressing common sense and world knowledge thus raises questions of fairness as well as questions of relevance.

Questions may be raised about other purported thinking skills as well. How does the kind of creativity that can be demonstrated on a test relate to the kind of sustained and cumulative creative work that is valued in the real world? If one fully understands the opposing sides in a controversy, is there any need for something additional that constitutes "critical thinking" skill? More generally, what is there in the various purported thinking skills that cannot better be treated as "habits of mind" (Costa & Kallick, 2000)? Are thinking skills in the aggregate the same as fluid intelligence? Factor analytic evidence indicates that they are (Kline, 1998). If so, testing thinking skills as educational objectives means using intelligence tests as achievement tests, something

bound to cause an uproar leading to eventual abandonment of the tests. There is not even adequate empirical and theoretical basis for calling cognitive traits such as creativity, critical thinking, and problem-solving ability skills at all. The fact that people demonstrably differ in them is not sufficient proof. Learnability, teachability, and wide-ranging transfer have to be demonstrated, and evidence to support such claims turns out to be little more than evidence that teaching for the test improves test scores (Detterman, 1993). Although in the present climate it is heretical to suggest it, schools might be better off dropping thinking skills objectives altogether and turning instead to the time-honored goal of helping students develop as thinking persons.

Real 21st-Century Competencies

The Organization for Economic Co-operation and Development (2010) has begun referring to its member nations as "innovation-driven." This implies a feed-forward process characterized not only by acceleration but also by unpredictability. Is there not therefore something rather ludicrous about educationists and business representatives sitting around a table and pretending to define the skills this uncertain future will require? The likelihood ought to be acknowledged that essential skill needs have yet to come into view and that a closer look at emerging capabilities and challenges might give a foretaste of what they will be (Scardamalia, et al., 2010). There are, however, cultural changes already in motion that bespeak competency needs schools are failing to address adequately. The following are five that everyone can see but that get little recognition in "21st-century" skill lists:

1. Knowledge creation. Except in a few areas—politics, religion, and education being the principal ones—21st-century societies recognize that the route to betterment lies through creation of new knowledge. As the health sciences advance, it becomes less clear what constitutes healthy diet, and some people throw up their hands and opt for a simplistic solution. Society's collective answer, however, is to pursue further research. And so it is with environmental problems, energy problems, homeland security problems, infectious disease problems, and all the grave problems that threaten to bring on societal collapse (cf. Diamond, 2005; Homer-Dixon, 2006). Producing the necessary knowledge requires not only an increase in the number of people capable of

significant knowledge creation, but also a citizenry appreciative of and willing to support knowledge creation. A step toward meeting both needs is promoting a better understanding of the nature of knowledge and the nature of science—particularly the positive role that theory plays in the advance of knowledge. There is evidence that teachers by and large do not understand this, that they view theories as mere embodiments of the uncertainties of empirical knowledge (Windschitl, 2004). Developing students as knowledge creators involves a more radical transformation, however, one that authentically engages students as participants in a knowledge-creating culture (Bereiter & Scardamalia, 2006, 2010).

2. Working with Abstractions. Whether it is a doctor evaluating your state of health or a mechanic diagnosing a problem with your car, judgments that used to call for interacting with the object in question are now likely to be based on interaction with computerized data. This is true in an increasing range of manufacturing and service occupations. Even if technology processes the data into a realistic simulation so that you can apply skills of the old hands-on type, those data and their representation have been transformed by a theory that stands between the real phenomena and their presentation. A modern worker needs to be able to move flexibly and rationally between concrete reality and abstractions from it. Yet applying disciplinary knowledge to practical life has always involved abstraction. Information technology has only made the need to negotiate between the concrete and the abstract ubiquitous. Every time you formulate a real-world problem as a mathematical problem and then do the math, you are performing such negotiation. Schooling, however, preserves a wariness of abstractness that was explicit in Dewey (1916, 183-185) and, in the mistaken view of many educators, given a theoretical basis by Piaget. Converting the abstract into the concrete remains an honored part of the art of teaching. "Mathematical modeling" is a fancy name for an effort to go the other way, converting the concrete to the abstract. There needs to be much more of this, extending outside mathematics to other kinds of modeling that facilitate practical action.

3. Systems Thinking. Dating from Herbert Simon's original work on "bounded rationality" (1957), it has been evident that most human predicaments are too complex for our limited information-processing capacity. And problems are getting more complex (Homer-Dixon, 2006). This is partly because more is known about the problems and

partly because modern life is introducing more variables. The supermarket check-out question "Paper or plastic?" is relatively easy to answer in terms of environmental impact, as long as one considers only the environmental consequences of the grocery bag ending up in a garbage dump. But if one traces the whole path from natural resources to manufacture and on through the life history of a grocery bag, the environmental impacts become so complex that even experts find it difficult to settle on a choice. Substantial theory has developed about complexity and how it evolves, self-organization being a central concept (Kaufmann, 1995). An educated person in mid-21st century will need to understand complexity scientifically, because of its pervasive significance throughout the natural and social world, but beyond that the educated person needs ability to live with increasing complexity and turn it to advantage wherever this is possible. Most of the detrimental ideologies that block progress on societal problems involve retreats from complexity, simplistic economic ideologies being perhaps the most widespread but by no means the only examples.

4. Cognitive Persistence. Cognitive persistence includes sustained study and pursuit of understanding, comprehending long texts, following extended lines of thought, and sustained creative effort turning promising initial ideas into fully developed designs, theories, problem solutions, and so on. The point is not that requirements for this kind of competence are increasing, although this may be true if increasing numbers of jobs involve work with complex ideas. The point, rather, is that obstacles and distractions from cognitive persistence may be increasing. We have already noted concerns about the bite-sizing of discourse in modern media. Life on the internet is full of distractions, which are causing employers to be concerned about work time being lost. In schools and colleges, the heavy emphasis on examinations may be encouraging spasmodic cramming rather than cumulative intellectual work. Both motivational and cognitive issues are involved. A Canada-wide study showed a progressive decline across the school years in "intellectual engagement," which the authors distinguished from social and academic engagement (Willms, Friesen, & Milton, 2009). Conservative social critics see the problem as a more pervasive decline in work ethic, with schools being parties to this decline (cf. Malanga, 2010; Murray, 2012). Whether things are actually getting worse is

something that will not be evident without research extending over years. But that cognitive persistence is something deserving serious educational attention seems clear.

5. Collective Cognitive Responsibility. Collective responsibility characterizes expert teams of all kinds. It goes beyond the current buzzword, "collaboration," in that it means not only everyone working productively together but also everyone taking responsibility for success of the whole enterprise. Collective *cognitive* responsibility adds "collective responsibility for understanding what is happening, for staying cognitively on top of events as they unfold…. For knowing what needs to be known and for insuring that others know what needs to be known" (Scardamalia, 2002, pp. 68-69). Whereas collective responsibility for getting a job done may be as old as the species (think of hunting down a mastodon), collective cognitive responsibility has a distinct 21st century flavor. Coming decades are likely to see the spread of "massively collaborative" problem solving and idea development (Greene, Thomsen, & Michelucci, 2011, October), where cognitive responsibility will be very widely distributed and leaders may be able to facilitate but will no longer be able to manage it. Collective cognitive responsibility is already essential for design teams, research teams, planning teams, and the like, especially when there is a leveling of status hierarchies. Schools can be good places for developing the ethos and the competencies for it, although this requires teachers turning some of their traditional cognitive responsibility over to the students while ensuring that collaborative activities are rich in cognitively challenging possibilities.

Implications for Measurement and Assessment

This chapter has contained more than the usual number of question marks, which may be justified, considering that our task has been to look ahead 40 years and speculate about the effects of changes only beginning to take shape. The question marks signal research needs, but how the needed research is to be grounded itself raises additional and in some cases deeper questions. Throughout the discussion we have emphasized a developmental view of what it means to become an educated person in mid-21st century in contrast to a piecemeal skills-and-knowledge view, and this view raises a host of questions. Assessing development, which necessarily must be done over a time span and which typically considers global traits and dispositions, obviously calls for looking

beyond testing programs as we know them today. At present there are, for instance, well-established tests of so-called critical thinking, and one could imagine making a test of this sort part of a program to periodically assess progress in students' development of critical thinking. But between doing well on a test of reasoning and other abilities believed essential for critical thinking and actually being a critical thinker, there is a wide gap. In a statement of "expert consensus," the crafters of specifications for the original California Critical Thinking Skills Test recognized that critical thinking involves more than skills:

> The ideal critical thinker is habitually inquisitive, well-informed, trustful of reason, open-minded, flexible, fair-minded in evaluation, honest in facing personal biases, prudent in making judgments, willing to reconsider, clear about issues, orderly in complex matters, diligent in seeking relevant information, reasonable in the selection of criteria, focused in inquiry, and persistent in seeking results which are as precise as the circumstances of inquiry permit. (Facione, 1990, p. 2).

This could serve as a succinct description of critical thinking as a developmental goal. But how then rationalize assessing critical thinking by what is mainly a test of logical evaluation of arguments? According to Facione (1991), the reasoning was that scores on the test would reflect presence or absence of the dispositions suggested in the above description. Thus, presumably the 34-item test could act as a surrogate for a much more extensive developmental assessment. This is a huge leap of faith. Assessment of 21st-century educational outcomes should not have to depend on such leaps of faith.

What would be indicators of actually being a critical thinker? One would look for evidences of the cognitive virtues itemized in the "expert consensus," with special credit for turning critical scrutiny upon one's own cherished or conventional beliefs. Relevant observations might be few and far between, but to the extent that classroom discourse took place through online writing or through speech that could be converted to text, sufficient evidence could be available as a basis for assessment. Automated discourse analysis could even make such assessment relatively effortless (cf. Dönmez, et al., 2005). This presupposes, of course, that the classroom discourse is of such a nature that critical thinking has a chance to reveal itself. Teachers, thus, are essential to the assessment process, not only as observers or evaluators but as enablers of the kind of activity that is intended to be assessed.

What we have just said with regard to critical thinking could be extended to many other developmental objectives, whether formulated as skills, habits of mind, intellectual virtues, attitudes, or dispositions. Creativity, a favored 21st-century objective, needs to be assessed as more than a cognitive ability or a personality trait (Renzulli, 2002). Among other things, it is a life style and a career choice (Sternberg, 2003) and it may characterize not only an individual career but the life style of a community (Florida, 2002). Hence the value of treating creativity as a developmental goal rather than a skill goal, treating it as the goal of developing into a person who creates. Portfolio assessment might serve better than tests as both a measure and a motivator of creativity development.

The assessment of knowledge appears to be on much solider ground than the assessment of intellectual skills (which in some cases may have no ground at all and may only represent the mislabeling of abilities as skills). Knowledge assessment faces two mounting challenges, however, which we have already noted: the problem of assessing depth and the problem of assessing quantity of unprescribed knowledge acquisition. Assessing depth becomes a tractable problem to the extent that an ascending order of things-to-be-understood can be specified. This is a curriculum objectives problem, first and foremost, and only subsequently becomes a testing problem. The other challenge, however, is an assessment problem from the beginning. Stated most generally, how do we measure knowledge growth when students are not all expected to learn the same things? As self-directed and inquiry learning grow, this problem becomes more urgent. It is hard to get educators wholeheartedly committed to greater student agency and to questions that really matter to the students when in the end everyone is going to be evaluated on the same set of prescribed learnings. However, there is no dilemma if the list of required knowledge is really short and consists of concepts that are really important and really powerful. It is only when the required objectives suck up the whole curriculum that student agency becomes trivialized. Student agency is not stifled if students know what the big ideas are and why they are important. That becomes information even young students can factor into their knowledge building plans.

But what is to be done about learning that is free to vary, and where sheer quantity may count for something? We have a model of this kind of estimation problem from studies of vocabulary size. Estimates of a person's total vocabulary size may be

based on sampling from a large universe, such as that contained in a dictionary of between 100,000 and 200,000 words. People's scores will fall far short of the 80 percent conventionally taken to constitute mastery of a knowledge domain, but they will be sufficient to yield an estimated vocabulary size in the tens of thousands. A universe of incidental knowledge items might be generated from semantic analysis of websites, or vocabulary size itself could be a surrogate for miscellaneous knowledge. So there is methodology available for estimating knowledge "size "; whatever form it eventually takes, it will be something different from the familiar kinds of knowledge testing based on specifications of particular things that are supposed to be learned.

Finally, let us turn to the five "real 21st century competencies" discussed previously: knowledge creation, working with abstractions, systems thinking, cognitive persistence, and collective cognitive responsibility. There is nothing particularly original or controversial about listing these as core competencies, yet they remain on the margins of current educational goal setting, treated as mere adjuncts to such A-list competencies as problem solving, critical thinking, and creativity. Perhaps one reason for this sidelining is that there is no obvious way to measure them. But recent research and development provides important new possibilities.

- Assessing knowledge creation. The idea of young students actually working at knowledge creation may seem outlandish, but there are well-recognized varieties of knowledge creation that fall within demonstrable capabilities of the young (Bereiter & Scardamalia, 2010). There is testable knowledge associated with knowledge creation—especially knowledge of how knowledge progresses. This is receiving attention through work on NOS—"nature of science" (e.g., Working Group on Teaching Evolution, 1998). There are measurable dimensions of knowledge-creating dialogue, such as "scientificness" (Zhang, et al., 2007), but so far the most promising means of assessment comes from having students describe group knowledge advances and their own and other students' contributions to them (van Aalst & Chan, 2007).

- Assessing work with abstractions. Ability to work with abstractions seems like something that could be tested directly, although

research is needed to find out whether it is a teachable generic skill or merely a convenient label. Cross-cultural research suggests that ability to work with abstractions may have considerable generality and is dependent on formal education (Scribner, 1979). While people of all kinds handle reasoning tasks better when they are represented concretely than when they are represented abstractly (Johnson-Laird, 1983), the size of the performance gap between the two conditions might prove to be an individual difference variable useful in assessing ability to work with abstractions.

- Assessing systems thinking. There is a knowledge base in systems theory. The problem is how to teach it, not how to test it. Arguably this is the outstanding challenge facing instructional designers, given that systems theory is becoming essential not only for scientific literacy but also for literacy in any theoretical domain. Beyond that, there are a number of experimental efforts to foster systems thinking. Results to date are more limited than one would like, considering the importance of the objective, but we can predict that by 2050 there will be effective ways to teach and test widely generalizable systems thinking abilities. Unfortunately, we may also predict that many school curricula will be unaffected by this research and will continue to treat systems thinking as synonymous with open-mindedness and flexibility.
- Assessing cognitive persistence. Regardless of what research may eventually show about alleged declines in attention span and regardless of the educational benefits new media may provide, it would help both teaching and assessment if at least once a year students were required to read a long and comparatively complex text (or set of texts relevant to some knowledge objective) and assessed in some depth as to their understanding. These could also be used to assess knowledge building at the group level, which, as we noted at the beginning of this chapter, warrants attention in its own right and not merely as a reflection of individual learning.
- Assessing collective cognitive responsibility. This calls for assessment at both the individual and the group level. It is hard to imagine doing this without supportive technology. Elaborations of automated social

network analysis are already proving valuable in enabling both teachers and students to monitor types and levels of participation and discourse in collaborative knowledge building (Oshima, Oshima, & Matsuzawa, in press; Zhang, et al., 2007). On the horizon is automated assessment of idea evolution and of the social interactions that foster it.

Will Technology Facilitate Becoming an Educated Person?

That technology will continue to change at a dazzling rate has now become part of conventional wisdom, including conventional educational wisdom. Traditionally, educational practice has been said to lag 10 to 20 years behind the advance of knowledge. Surely this is no longer true with regard to the uptake of new technology, especially new hardware. However, there is little reason to believe that the lag in uptake of advances in pedagogy has diminished. The result is that new technology gets harnessed to old pedagogy (Reimann, P., & Markauskaite, L., 2010). Contributing to the cultural lag in education is the fact that most new information technology products are developed for business and then are adopted, often without modification, by educational institutions. The problem here is not that the products are inappropriate; technology for text production, image processing, and the like, once developed to the point of being useable in ordinary office work, can equally well be used in schools. The problem is that businesses do not generally use productivity software to educate their workers, whereas schools do, or at least aspire to do so. But the technology provides little support for educational missions, having never been designed for that purpose. Consequently we have, for instance, learning management systems with attached discussion boards that do not work very well in supporting educationally productive discussion yet have changed hardly at all in 20 years (Hewitt, 2005).

There is nothing inherently wrong with using new technology to perform old tasks, and there is truth in the cliché, “It isn’t the technology, it’s how you use it.” What is needed in order to advance on the educational challenges discussed in this chapter, however, is a dynamic relation between technological invention and social/cognitive/pedagogical invention, with each helping to ratchet up the other. We will mention two possibilities for such a dynamic relation, which are ones we happen to be

working on. One seeks to support sustained work with ideas by bringing inputs from varied media into a common digital workspace where supports are provided for explanation-building, extended problem solving, and so on. The other aims to provide feedback to students and teachers relevant to their knowledge-building efforts, for instance by mapping rates of different kinds of dialogue contributions and growth in domain vocabulary and by alerting discussants to possible misconceptions or overlooked concepts.

The kind of change that would make technology truly supportive of educating the mid-21st century person is the same change we have argued for throughout this chapter. It is a change that places human development goals as central and knowledge, skill, attitude, and other goals as subservient. There is impressive creative work going on in designing technology that puts difficult concepts and operations within reach of more students. At the same time, project-based, problem-based, and knowledge-building pedagogy are flourishing, all with the intent of giving students higher levels of agency in the learning process. But more technology is needed for bringing these strands together, especially by supporting the kind of dialogue that converts experiences acquired through games, experiments, projects, and arguments into coherent understanding (Scardamalia & Bereiter, 2006). The principal obstacles from our standpoint are not technological but reside in the absence of sophisticated consumer demand.

Conclusion

This has not been so much a forward-looking essay as one that examines the current state of our culture and its institutions and asks what education would be like if it actually addressed current needs. School reform is a thriving business for consultants. But it is proceeding on the basis of folk theories of learning, cognition, and action, largely oblivious to the past 35 years of relevant scientific and pedagogical advances. We have singled out thinking skills as an especially retrograde folk notion that seems to be deflecting educational reform from human development goals and knowledge goals that could be the focus of systemic change. Fortunately, the Partnership for 21st Century Skills (www.p21.org), which started out with its main focus being on test-driven skill objectives, has evolved toward designing intellectually-enhanced curricula in school

subjects. This is a definite step toward broader human development objectives derived from a conception of what it will mean to be an educated person in the mid-21st century. We have tried in this chapter to identify critical intellectual aspects of this educated personhood. We have seen how traditional broad concerns such as depth of understanding, literacy, and moral reasoning take on new meanings and face new challenges. More specifically, however, we have identified five competencies that call for determined educational effort, yet remain on the sidelines of assessment and teaching: knowledge creation, working with abstractions, systems thinking, cognitive persistence, and collective cognitive responsibility. We would argue that these are the real "21st century skills," the competencies needed for productive and satisfying life in an "innovation-driven society."

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