

ISSUE 7



Should Schools Adopt a Constructivist Approach to Education?

YES: Mark Windschitl, from "The Challenges of Sustaining a Constructivist Classroom Culture," *Phi Delta Kappan* (June 1999)

NO: E. D. Hirsch, Jr., from "Reality's Revenge: Research and Ideology," *American Educator* (Fall 1996)

ISSUE SUMMARY

YES: Mark Windschitl, a member of the faculty in the department of curriculum and instruction at the University of Washington, argues in favor of constructivism, a child-centered approach to education that is defined by student participation in hands-on activities and extended projects that are allowed to "evolve" in accordance with the students' interests and initial beliefs.

NO: E. D. Hirsch, Jr., a professor in the School of Education at the University of Virginia, Charlottesville, argues that child-centered approaches have failed and points to research demonstrating the superiority of fact-based, teacher-centered approaches.

Observation of any school classroom in the United States at any point in history would reveal, to no one's surprise, a teacher (or teachers) and a varying number of students. In fact, although many other people, including administrators, parents, and even politicians, participate directly or indirectly in the educational process, most people view the teacher-student relationship as the primary determinant of what students accomplish in school. But the relationship between teachers and students has changed dramatically over the past few decades. In the 1950s, for example, the relationship was very much dominated by the teacher. He or she exerted a high degree of control over what students did at nearly every point throughout the day. In this teacher-centered approach, the teacher disseminated the "facts" to be learned to the students, typically within the context of a lecture. The teacher ensured that students would learn the facts by requiring that they listen carefully and engage in various highly structured, drill-and-practice activities. In recent years, however,

students have come to exert considerably more control over the educational process and the teacher-student relationship. In many classrooms today, students are much more likely to be "doing" rather than "listening." This doing is often in the form of participation in an extended project of some form, such as building a Civil War-era town or collecting and cataloging insects. The teacher may assign these projects, but it is the students who shape the projects to suit their own interests as well as the discoveries that they make along the way. Although labeled in different ways (e.g., project-based, discovery learning, hands-on learning), the hallmark of this constructivist approach is a high degree of self-directed student activity.

Concerns about student achievement, especially as compared to student achievement in other industrialized nations, have led some scholars and administrators to begin calling for a return to a more teacher-centered, fact-based approach to education. Critics have argued that the constructivist approach is inefficient; that is, because children "waste time" with incorrect "discoveries" before arriving at the correct one, there often is not enough time to teach them all of the content that should be mastered. Other critics assert that some children never make the correct discoveries on their own and thus require greater teacher control and a more systematic introduction of the skills to be mastered. Finally, critics argue that acquisition of higher-order modes of thought applicable to a broad range of problems will not emerge without mastery of the rich networks of facts that constitute the domains of mathematics, physics, chemistry, and the like.

Supporters of the constructivist approach, however, are not without responses to these criticisms. They counter that a fact-based, teacher-centered approach is itself inefficient because of the sheer number of facts that compose any meaningful domain and because the "facts" change with new discoveries. This means, they argue, that the only lasting education is one that promotes higher modes of thought and action rather than storage of facts. Supporters also suggest that many attempts to implement a constructivist approach fail only because they do not go far enough; they merely insert a few student-initiated projects into an otherwise teacher-centered system. Finally, supporters argue that the well-documented decline in student interest in academic tasks that occurs throughout the school years is the result of a teacher-centered orientation. They point to numerous examples of constructivist classrooms in which students appear to be highly engaged in the academic life of the classroom.

In the following selection, Mark Windschitl argues for constructivism over a fact-based, teacher-centered approach to education. He also argues that constructivism is not merely a set of instructional practices but a way of thinking about the nature of child development and schooling. Successfully implementing this approach, he says, requires a fundamental change in the "culture" of the school, a change that affects not only how children are taught but how they are assessed, how classrooms are physically organized, how activities are scheduled, and how teaching is evaluated. In the second selection, E. D. Hirsch, Jr., argues that supporters of constructivist and other child-centered approaches have ignored empirical research, which, he argues, favors the use of a fact-based, teacher-centered approach.

The Challenges of Sustaining a Constructivist Classroom Culture

Ms. Hughes' sixth-grade classroom is a noisy place, and if you come to visit you may have a hard time finding her. Today, students are clustered in small groups, bent over note cards and diagrams they have assembled in order to determine whether they can design a habitat that can support Australian dingoes and marmosets.

The students have just participated in three days of discussion and reading about interrelationships among mammals. They are divided into four groups, each of which has negotiated with Ms. Hughes to devise a complex problem to work on that reflects their interests and abilities. One group chose a design problem: creating a habitat for a local zoo that will support at least three kinds of mammals naturally found in the same geographic area.

The students are now engaged for the next two weeks on this project. They find and share dozens of resources, many of which are spread out on tables and on the floor around the room. Allen brings to class a video he shot at the zoo last week so that everyone can see what different habitats look like. Michelle loads a CD-ROM on mammals that she brought from home, and James donates one of his mother's landscape architecture books for ideas on how to diagram spaces and buildings.

During the next two weeks, these students will develop an understanding of how mammal species interact with one another, cope with the environment, and follow the natural cycles of reproduction. Concepts such as "competition for resources" and "reproductive capacity"—whose definitions in other classes might have been memorized—arise instead from a meaningful and multifaceted context. These concepts are built on the experiences of the students and are essential, interconnected considerations in the success of the habitat design. This is one of the many faces of the constructivist classroom.

A growing number of teachers are embracing the fundamental ideas of constructivist learning—that their students' background knowledge profoundly affects how they interpret subject matter and that students learn best when they apply their knowledge to solve authentic problems, engage in "sense-making" dialogue with peers, and strive for deep understanding of core ideas rather than recall of a laundry list of facts. Unfortunately, much of the public conversation about constructivism has been stalled on its philosophical contrasts with more traditional approaches to instruction. Constructivists

have offered varying descriptions of how classrooms can be transformed, usually framed in terms of these contrasts. And although these descriptions have prompted educators to reexamine the roles of teachers, the ways in which students learn best, and even what it means to learn, the image of what is possible in constructivist classrooms remains too idealized.

To all the talk about theory, educators must add layers of dialogue about real classroom experiences and concerns about those experiences. An essential part of this dialogue is the articulation of the pedagogical, logistical, and political challenges that face educators who are willing to integrate constructivism into their classroom practice. The new discourse shifts the emphasis from comparisons between constructivism and traditional instruction to the refinement of constructivist practices in real classrooms. This frank conversation about challenges is equally valuable for sympathetic administrators—being informed and reflective about these issues is a necessary prerequisite to offering support for the classroom teacher.

In this article, I characterize and categorize these challenges and describe the kinds of administrative support necessary to create and sustain a culture of constructivist teaching in schools. First, however, it is necessary to examine constructivism as a philosophy on which a systemic classroom culture can be based rather than to view it as a set of discrete instructional practices that may be inserted into the learning environment whenever necessary. The challenges I describe here are challenges precisely because they cause us to reconsider and dare us to change the comfortable (and often unstated) norms, beliefs, and practices of the classroom culture we are so familiar with. Constructivism is more than a set of teaching techniques; it is a coherent pattern of expectations that underlie new relationships between students, teachers, and the world of ideas.

Constructivism as Culture

Constructivism is premised on the belief that learners actively create, interpret, and reorganize knowledge in individual ways. These fluid intellectual transformations occur when students reconcile formal instructional experiences with their existing knowledge, with the cultural and social contexts in which ideas occur, and with a host of other influences that serve to mediate understanding. With respect to instruction, this belief suggests that students should participate in experiences that accommodate these ways of learning. Such experiences include problem-based learning, inquiry activities, dialogues with peers and teachers that encourage making sense of the subject matter, exposure to multiple sources of information, and opportunities for students to demonstrate their understanding in diverse ways.

However, before teachers and administrators adopt such practices, they should understand that constructivism cannot make its appearance in the classroom as a set of isolated instructional methods grafted on to otherwise traditional teaching techniques. Rather, it is a culture—a set of beliefs, norms, and practices that constitute the fabric of school life. This culture, like all other cultures, affects the way learners can interact with peers, relate to the teacher,

and experience the subject matter. The children's relationships with teachers, their patterns of communication, how they are assessed, and even their notion of "what learning is good for" must all be connected, or the culture risks becoming a fragmented collection of practices that fail to reinforce one another. For example, the constructivist belief that learners are capable of intellectual autonomy must coincide with the belief that students possess a large knowledge base of life experiences and have made sense out of much of what they have experienced. These beliefs are linked with the practice of problem-based learning within relevant and authentic contexts and with the norm of showing mutual respect for one another's ideas in the classroom.

Portraying the constructivist classroom as a culture is important because many challenges for the teacher emerge when new rituals take root or when familiar norms of behavior are transformed into new patterns of teacher/student interaction.¹ By contrast, if discrete practices that have been associated with constructivism (cooperative learning, performance assessments, hands-on experiences) are simply inserted as special activities into the regular school day, then it remains business as usual for the students. Teachers and students do not question their vision of learning, no one takes risks, and hardly a ripple is felt.

Throughout this article then, challenges become apparent when we question the fundamental norms of the classroom—the images and beliefs we hold of teachers and students, the kinds of discourse encouraged in the classroom, the way authority and decision making are controlled, and even what "counts" as learning. I begin with a subtle but powerful influence on classroom instruction.

Images of Teaching: The Chains That Bind Us

Most of us are products of traditional instruction, as learners, we were exposed to teacher-centered instruction, fact-based subject matter, and a steady diet of drill and practice.² Our personal histories furnish us with mental models of teaching, and these models of how we were taught shape our behavior in powerful ways. Teachers use these models to imagine lessons in their classrooms, develop innovations, and plan for learning.³ These images serve to organize sets of beliefs and guide curricular actions.⁴ Teachers are more likely to be guided not by instructional theories but by the familiar images of what is "proper and possible" in classroom settings.⁵

Unfortunately, the signs and symbols of teacher-centered education and learning by transmission, which are likely to be a part of teachers' personal histories, persist in classrooms today.⁶ In this environment, it is assumed that the more quiet and orderly the classrooms are, the more likely it is that learning is taking place. Individual desks face the front of the room, where the teacher occupies a privileged space of knowing authority; students work individually on identical, skill-based assignments to ensure uniformity of learning. Value statements are embedded everywhere in this environment.

Constructivist teachers envision themselves emerging boldly from the confines of this traditional classroom culture, but the vision first requires critical reflection. Teachers must ask themselves, "Is my role to dispense

knowledge or to nurture independent thinkers? How do I show respect for the ideas of the students? Am I here to learn from the students?" Teachers must struggle to develop a new, well-articulated rationale for instructional decisions and cannot depend on their previous teaching or learning experiences for much help in shaping their choice of methods; shifting the centers of authority and activity in accordance with this rationale requires persistence. For example, teachers can be uncomfortable with their apparent lack of control as students engage with their peers during learning activities and may be unwilling to allow supervisors who visit the classroom to observe this kind of environment. Teachers may reconsider their ideas of student-centered learning in favor of conforming to the more traditional images of the teacher as the hub of classroom discourse and attention.⁷

New Demands on the Teacher

Constructivist instruction, especially that which is based on design tasks or problem solving, places high demands on the teacher's subject-matter understanding. The teacher must not only be familiar with the principles underlying a topic of study but must also be prepared for the variety of ways these principles can be explored.

For example, if students are studying density in science class, the teacher must support the understanding of one group of students who want to approach the concept from a purely abstract, mathematical perspective as they construct tables, equations, and graphs to develop their knowledge. In this case, the teacher must understand these different representations of information and how they are interrelated. Another group of students may plan to recount the story of the *Titanic*, emphasizing the role that density played in the visibility of the iceberg, the ballast of the ship, and the sinking itself. Here, the teacher must be intellectually agile, able to apply his or her mathematical understanding of density to a real-life, inevitably more complex situation.

Teachers in different subject areas may allow students varying degrees of latitude in exploring content and will differ in how they accept student "constructions" of core curricular ideas. Mathematics is characterized by rule-based propositions and skills that may be open to discovery via many experiential pathways. Most forms of mathematics problems, however, have only one right answer. And if students are allowed to explore problems by their own methods, teachers may find it difficult to see exactly how the students are making sense of the problem-solving process—not all constructions are created equal. Science and social studies present the same challenges, although science is less axiomatic than mathematics, and the issues explored in social studies are open to wider interpretation. Dealing with the "correctness" of student constructions is an ongoing concern, and the arguments have barely been introduced here, but reflection on these issues helps teachers develop a critical awareness of disciplinary "truths" and the viability of various ways of knowing the world.

In addition to the necessity for flexible subject-matter knowledge, constructivism places greater demands on teachers' pedagogical skill. Crafting

instruction based on constructivism is not as straightforward as it seems. Educators struggle with how specific instructional techniques (e.g., lecture, discussion, cooperative learning, problem-based learning, inquiry learning) fit into the constructivist model of instruction. Regardless of the particular techniques used in instruction, students will always construct and reorganize knowledge rather than simply assimilate information from teachers or textbooks. The question is not whether to use lecture or discussion, but how to use these techniques to complement rather than dominate student thinking. For example, constructivist principles suggest that students should experience the ideas, phenomena, and artifacts of a discipline before being exposed to formal explanations of them. Students might begin units of instruction in science class by manipulating a pendulum, in math class by constructing polygons, or in social studies by reading letters from Civil War battlefields. Only after these experiences do teachers and students together suggest terminology, explanations, and conceptual organization.

Even though designing instruction is important, constructivist teaching is less about the sequencing of events and more about responding to the needs of a situation.⁸ Teachers must employ a sophisticated range of strategies to support individual students' understandings as they engage in the problem-based activities that characterize constructivist classrooms. These strategies include scaffolding, in which the task required of the learner is strategically reduced in complexity; modeling, in which the teacher either thinks aloud about or acts out how she would approach a problem; and coaching, guiding, and advising, which are loosely defined as providing learners with suggestions of varying degrees of explicitness.⁹ The teacher is challenged to select the proper strategy and implement it with skill.

Problem-based activities exemplify another core value of the constructivist culture—collaboration. Students are witness to and participate in one another's thinking. Learners are exposed to the clear, cogent thinking of some peers as well as to the inevitable meandering, unreflective thought of others. Students do require training to function effectively in these groups.¹⁰ However, even with training, many capable students are simply not interested in helping their peers, and negative consequences of group work—such as bickering, exclusion, and academic freeloading—are common.¹¹ These consequences can be minimized if the teacher is familiar with the principles of cooperative learning. And so, having students work together requires that the teacher have additional competencies in cooperative learning strategies and management skills particular to decentralized learning environments.

A final pedagogical challenge involves independent student projects. Depending on the degree of structure the teacher imposes in a classroom, students will have some latitude in choosing problems or design projects that relate to the theme under study. Often, students determine with the teacher suitable criteria for problems and for evidence of learning. Negotiation about the criteria prompts questions such as: Is the problem meaningful? Important to the discipline? Complex enough? Does it relate to the theme under study? Does it require original thinking and interpretation, or is it simply fact finding? Will the resolution of this problem help us acquire the concepts and

principles fundamental to the theme under study? Because curricular materials are often filled with prepared questions and tasks, teachers seldom have occasion to introduce their students to this idea of "problems about problems." Clearly, teachers must develop their own ability to analyze problems by reflecting on the nature of the discipline and refining their ideas through extended dialogue with colleagues and experiences with students.

Logistical and Political Challenges

Effective forms of constructivist instruction call for major changes in the curriculum, in scheduling, and in assessment.¹² When students are engaged in problem solving and are allowed to help guide their own learning, teachers quickly find that this approach outgrows the 50-minute class period. This situation often means that the teacher will have to negotiate with administrators and other teachers about the possibilities of block scheduling and integrating curricula. If teachers can team with partners from other subject areas, they can extend the length of their class periods and develop more comprehensive themes for study that bridge the worlds of science, social studies, math, and the arts.

The purpose of integrated curricula and extended class periods is to allow students to engage in learning activities that will help them develop deep and elaborate understandings of subject matter. These understandings may be quite different in nature from student to student. Thus there is a need for forms of assessment that allow students to demonstrate what they know and that connect with rigorous criteria of excellence. These are not the paper-and-pencil, objective tests in which learners recognize rather than generate answers or create brief responses to questions in which they have little personal investment. Rather, students are required to produce journals, research reports, physical models, or performances in the forms of plays, debates, dances, or other artistic representations. Assessing these products and performances requires well-designed, flexible rubrics to maintain a link between course objectives and student learning. Designing these rubrics (through negotiation with students) builds consensus about what "purpose" means in a learning activity, about the nature of meaningful criteria, and about how assessments reflect the efficacy of the teacher as a promoter of understanding.

The final and perhaps most politically sensitive issue confronting teachers is that the diversity of understandings emerging from constructivist instruction does not always seem compatible with state and local standards. For example, student groups engaged in science projects on photosynthesis may have radically different approaches to developing their understanding of this phenomenon. One group may choose to focus on chemical reactions at the molecular level while another group may examine how oxygen and carbon dioxide are exchanged between animals and plants on a global scale. These two groups will take disconcertingly divergent paths to understanding photosynthesis.

This kind of project-based learning must be skillfully orchestrated so that, however students choose to investigate and seek resolutions to problems,

they will acquire an understanding of key principles and concepts as well as the critical thinking skills that are assessed on standardized tests. Proponents of project-based learning have demonstrated that these kinds of learning outcomes are entirely possible.¹³ Artful guidance by the teacher notwithstanding, it can be unsettling for teachers to reconcile the language of "objectives, standards, and benchmarks" with the diversity of understandings that emerge in a constructivist classroom.

Conclusions and Recommendations

How does a school community support the instructional expertise, academic freedom, and professional collaboration necessary to sustain a constructivist culture? First, a core group of committed teachers must systematically investigate constructivism in order to understand its principles and its limitations. The ideas behind constructivism seem intuitive and sensible, but teachers and administrators must go beyond the hyperbole and the one-shot-workshop acquaintance with constructivism. Interested faculty members should conduct a thorough reading campaign, and at least one or two teachers should extend their experience by participating in advanced workshops, attending classes, and witnessing how constructivist cultures operate in other schools. Stipends and released time can be provided for a cadre of lead teachers to attend classes, do extra reading, adapt curriculum, and offer their own workshops to fellow teachers. Workshop topics could include the constructivist implementation of cooperative learning, scaffolding techniques, problem-based learning, or multifaceted assessment strategies.

The faculty members must openly discuss their beliefs about learners and about their roles as teachers. If these beliefs are left unexamined or unchallenged, then individuals have feeble grounding for their personal philosophies. Just as problematically then, everyone operates on different, untested assumptions. And all decisions about curriculum, instruction, and assessment are built on such assumptions.

Personal philosophies of education are particularly important when constructivism is used to furnish underlying principles—important because constructivism means risk taking and a divergence from business as usual. Sooner or later, teachers will be asked, "Why do you teach that way?" Whatever form that question takes, teachers must be able to justify the choices they make. This task will not be as intimidating if the teacher has mindfully linked the aspects of his or her constructivist philosophy to the various dimensions of classroom experience and to the larger goals of education.

The process of making these beliefs explicit can also strengthen teachers' resolve to move beyond the traditional images of what is proper and possible in the classroom. It can make clear to them the characteristics and limitations of the system that encouraged images of teachers as dispensers of information and students as passive recipients of knowledge. Accordingly, teachers must try to arrive at a new vision of their role. This vision must include serving as a facilitator of learning who responds to students' needs with a flexible

understanding of subject matter and a sensitivity to how the student is making sense of the world.

Teachers and their principals must be prepared to go on record with these beliefs in discussions with parent groups and the school board. Educators should always have a rationale for what and how they teach, however, because constructivism is so contrary to historical norms, it is even more important in this case that the rationale be well founded, coherent, and applicable to the current school context. Community members will undoubtedly be suspicious of teaching methods that are so different from the ones they remember as students and that sound too much like a laissez-faire approach to learning.

Administrators must also take the lead in supporting a "less is more" approach. The compulsion to cover material is antithetical to the aim of constructivist instruction—the deep and elaborate understanding of selected core ideas. Textbooks, which are often the de facto curriculum, have become encyclopedic, and administrators should make teachers feel secure about using a variety of other resources. They should also provide funds to purchase alternative classroom materials. Furthermore, administrators must be open to suggestions for block scheduling and for integrating curricula, perhaps even arranging for interested teachers to be placed together in team-teaching situations that are premised on the constructivist approach.

To strengthen the school's position on accountability, assessment specialists who understand constructivism can be brought in to connect local standards with instruction and with evidence that learning is taking place. Teachers will undoubtedly appreciate assistance in investigating and evaluating a variety of assessment strategies.

The list of challenges I have described here is not exhaustive. There are certainly others, and the challenges outnumber the solutions at the moment. But articulating these challenges is a significant step in helping educators create and sustain a classroom culture that values diversity in learning and offers a new vision of the roles of teachers and learners—the culture of constructivism.

Notes

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E. D. Hirsch, Jr.

Reality's Revenge: Research and Ideology

The first step in strengthening education in America is to avoid the pre-mature polarizations that arise when educational policy is confused with political ideology. In the United States today, the hostile political split between liberals and conservatives has infected the public debate over education—to such an extent that straight thinking is made difficult.

... I would label myself a political liberal and an educational conservative, or perhaps more accurately, an educational pragmatist. Political liberals really ought to oppose progressive educational ideas because they have led to practical failure and greater social inequity. The only practical way to achieve liberalism's aim of greater social justice is to pursue conservative educational policies.

That is not a new idea. In 1932, the Communist intellectual Antonio Gramsci, writing from jail (having been imprisoned by Mussolini), was one of the first to detect the paradoxical consequences of the new "democratic" education, which stressed "life relevance" and other naturalistic approaches over hard work and the transmission of knowledge. Il Duce's educational minister, Giovanni Gentile, was, in contrast to Gramsci, an enthusiastic proponent of the new ideas emanating from Teachers College, Columbia University, in the United States.¹

Gramsci saw that to denominate such methods as phonics and memorization of the multiplication table as "conservative," while associating them with the political right, amounted to a serious intellectual error. That was the nub of the standoff between the two most distinguished educational theorists of the political Left—Gramsci and Paulo Freire. Freire, like Gramsci a hero of humanity, devoted himself to the cause of educating the oppressed, particularly in his native Brazil, but his writings also have been influential in the United States. Like other educational progressivists, Freire rejected traditional teaching methods and subject matters, objecting to the "banking theory of schooling," whereby the teacher provides the child with a lot of "rote-learned" information. The consequence of the conservative approach, according to Freire, is to numb the critical faculties of students and to preserve the oppressor class. He called for a change of both methods and content—new content

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that would celebrate the culture of the oppressed, and new methods that would encourage intellectual independence and resistance. In short, Freire, like other educational writers since the 1920s, associated political and educational progressivism.

Gramsci took the opposite view. He held that political progressivism demanded educational conservatism. The oppressed class should be taught to master the tools of power and authority—the ability to read, write, and communicate—and to gain enough traditional knowledge to understand the worlds of nature and culture surrounding them. Children, particularly the children of the poor, should not be encouraged to flourish “naturally,” which would keep them ignorant and make them slaves of emotion. They should learn the value of hard work, gain the knowledge that leads to understanding, and master the traditional culture in order to command its rhetoric, as Gramsci himself had learned to do.

In this debate, history has proved Gramsci to be the better theorist and prophet. Modern nations that have adopted Gramscian principles have bettered the condition and heightened the political, social, and economic power of oppressed classes of people. By contrast, nations (including our own) that have stuck to the principles of Freire have failed to change the social and economic status quo....

The educational standpoint from which this article is written may be accurately described as neither “traditional” nor “progressive.” It is pragmatic. Both educational traditionalists and progressivists have tended to be far too dogmatic, polemical, and theory-ridden to be reliable beacons for public policy. The pragmatist tries to avoid simplifications and facile oppositions. Thus, this article will argue that the best guide to education on a large scale is observation of practices that have worked well on a large scale, coupled with as exact an understanding as possible of the reasons why those practices have succeeded in many different contexts....

What Is Higher-Order Thinking?

The goal of present-day educational reformers is to produce students with “higher-order skills” who are able to think independently about the unfamiliar problems they will encounter in the information age, who have become “problem solvers” and have “learned how to learn,” and who are on their way to becoming “critical thinkers” and “lifelong learners.” The method advocated for achieving these “higher-order skills” is “discovery learning,” by which students solve problems and make decisions on their own through “inquiry” and “independent analysis” of “real-world” projects—what [William Heard] Kilpatrick in the 1920s called the “project method.”

The oft-repeated goal of the educational community—to inculcate general thinking skills—is not, however, soundly based in research. And that is stating the point too mildly. The idea that school can inculcate abstract, generalized skills for thinking, “accessing,” and problem solving, and that these skills can be readily applied to the real world is, bluntly, a mirage. So also is the

hope that a thinking skill in one domain can be readily and reliably transferred to other domains.

Yet broad-gauged thinking abilities do exist. Most of us know well-educated people, even some not very bright ones, who have high general competence, can think critically about diverse subjects, can communicate well, can solve a diversity of problems, and are ready to tackle unfamiliar challenges. The belief that our schools should regularly produce such people appeals to both experience and common sense. If the goal didn’t make apparent sense, it could hardly have retained its attractiveness to the educational community and the general public. Rightly understood, then, the goal of general competence does define one important aim of modern education. The task is not to change that goal but to interpret it accurately so that it corresponds to the nature of real-world competency and can actually be achieved.

Two traditions in cognitive psychology are useful for understanding the nature of the critical-thinking, problem-solving skills that we wish to develop in our students. One tradition has studied the characteristic differences between expert and novice thinking, sometimes with the practical goal of making novices think more like experts as fast as possible.² Another tradition has investigated the differences between accurate and inaccurate thinking of the everyday newspaper-reading, bargain-hunting sort that all of us must engage in as non-experts.³ Both sorts of study converge on the conclusion that, once basic underlying skills have been automated, the almost universal feature of reliable higher-order thinking about any subject or problem is the possession of a broad, well-integrated base of background knowledge relevant to the subject. This sounds suspiciously like plain common sense (i.e., accurate everyday thinking), but the findings entail certain illuminating complexities and details that are worth contemplating. Moreover, since the findings run counter to the prevailing fact-disparaging slogans of educational reform, it will be strategically useful to sketch briefly what research has disclosed about the knowledge-based character of higher-order thinking.

The argument used by educators to disparage “merely” factual knowledge and to elevate abstract, formal principles of thought consists in the claim that knowledge is changing so rapidly that specific information is outmoded almost as soon as it has been learned. This claim goes back at least as far as Kilpatrick’s *Foundations of Method* (1925). It gains its apparent plausibility from the observation that science and technology have advanced at a great rate in this century, making scientific and technological obsolescence a common feature of modern life. The argument assumes that there is an analogy between technological and intellectual obsolescence. Educators in this tradition shore up that analogy with the further claim that factual knowledge has become a futility because of the ever-growing quantity of new facts. The great cascade of information now flowing over the information highway makes it pointless to accumulate odd bits of data. How, after all, do you know which bits are going to endure? It is much more efficient for students to spend time acquiring techniques for organizing, analyzing, and accessing this perpetual Niagara of information.

Like the tool metaphor for education, the model of acquiring processing techniques that would be permanently useful—as contrasted with acquiring

mere facts that are soon obsolete—would be highly attractive if it happened to be workable and true. But the picture of higher thinking skills as consisting of all-purpose processing and accessing techniques is not just a *partly* inadequate metaphor—it is a totally misleading model of the way higher-order thinking actually works. Higher thought does not apply formal techniques to looked-up data; rather, it deploys diverse relevant cues, estimates, and analyses from pre-existing knowledge. The method of applying formal techniques to looked-up data is precisely the inept and unreliable problem-solving device used by novices. As a model of real-world higher-order thinking, the picture is not simply inaccurate—it reverses the realities. It describes the lower-order thinking of novices, not the higher-order thinking of experts.

A useful illustration of the point is presented by Jill Larkin and Ruth Chabay in a study of the ways in which novices and experts go about solving a simple physics problem.⁴ The problem Larkin and Chabay set up is (in simple terms) to find out how much friction there is between a sled and the snow-covered ground when a girl is pulling her little brother through the snow at a constant rate. The brother and the sled together weigh 50 pounds. The sister is pulling with a force of 10 pounds, and she pulls the rope at an angle of 30 degrees from the horizontal. What is the coefficient of friction? The typical novice tries to solve the problem by applying formal equations that can be looked up in a book, thus dutifully following the tool principle of problem solving. The student finds that the applicable formula is $f = \mu N$, where f is force, N is the "normal force" (which is usually equal to weight), and μ is the coefficient of friction, which is the quantity to be solved. The novice sees that $f = \mu \times 50$. The student assumes that $f = 10$, the force exerted by the girl. So $10 = \mu \times 50$ and $\mu = 10/50$, which equals .2. The answer is wrong, not because the equation or the math is wrong but because the novice doesn't know enough about real-world physics to know how to connect the formula to the problem. The novice's procedure illustrates not just the inappropriateness of the formalistic model but also the bankruptcy of the claim that students need only learn how to look things up—so-called "accessing skills." In this typical case, the skill of looking things up simply lends spurious exactitude to the student's misconceptions.

The expert physicist goes about the problem differently. He or she analyzes the critical components of the situation before looking up equations and makes two critical observations before even bothering with numbers. The first observation is that the sled is going at a constant speed, so that, in effect, there is no net residue of forces acting on the sled; there is an exact balance between the force exerted horizontally by the girl's pull and the force exerted against that pull by friction. If there had been some difference in the two forces, then the sled would speed up or slow down. So the answer has got to be that the friction is exactly equal to the horizontal component of the force exerted by the girl. The physicist also sees that since the rope is pulled at 30 degrees, part of the girl's 10 pounds of force is vertical. The answer is going to be that the friction equals the *horizontal* force of the girl's pull, which is going to be the 10 pounds minus its vertical component. The structure of the answer is solved on the basis of multiple cues and relevant knowledge, before any formulas are looked up and

applied. Larkin and Chabay make the following comment (which is much more to our purpose than the details of the physics involved):

Scientists' problem solving starts with redescribing the problem in terms of the powerful concepts of their discipline. *Because the concepts are richly connected with each other, the redescribed problem allows cross-checking among inferences to avoid errors* [author's emphasis].⁵

An important feature of higher-order thinking is this "cross-checking among inferences," based on a number of "richly connected" concepts. In higher-order thinking, we situate a problem in mental space on analogy with the way we situate ourselves in physical space—through a process of cross-checking or triangulation among relevant guideposts in our landscape of pre-existing knowledge. If we look at a problem from a couple of different angles, using a couple of different cues, and if our different estimates converge, we gain confidence in our analysis and can proceed with confidence. If, on the other hand, there is some dissonance or conflict between our cues, then warning signals go up, and we figure out which approach is more probable or fruitful. The procedure is clearly a very different and far more reliable mode of thinking than the error-prone method of applying formal techniques to looked-up data.

The example also illustrates the implausibility of the claim that school-based information quickly grows outdated. How outmoded will the knowledge used to solve the sled problem become? A philosopher of science, Nicholas Rescher, once observed that the latest science is in a sense the least reliable science, because, being on the frontier, it is always in dispute with other, rival theories—any of which may emerge victorious. Accordingly, reasoned Rescher, the most reliable physics is "stone-age-physics": If you throw the rock up, it is going to come down. For most problems that require critical thought by the ordinary person regarding ethics, politics, history, and even technology, the most needed knowledge is usually rather basic, long-lived, and slow to change. True, just as physics is under revision at the frontier, so American history before the Civil War is constantly under revision in certain details (e.g., did Abraham Lincoln have an affair with Ann Rutledge?). But behind the ever-changing front lines, there is a body of reliable knowledge that has not changed, and will not change very much, and that serves very well as a landscape to orient us in mental space. It is true that, over time, the content of the most significant and useful background knowledge for today's world does change. But I have never seen a carefully reasoned defense of the repeated assertion that, in the new age, factual knowledge is changing so fast as to make the learning of significant information useless. Probably, no carefully reasoned defense of this mindless claim could be mounted.

The physics example from Larkin and Chabay, if viewed in isolation, might be taken to show that higher-order thinking depends on abstract concepts rather than on factual details. But most research indicates that while the thinking activities through which we reach conclusions and solve problems are not crowded with literally remembered facts, neither are they made up of abstract concepts alone. The models, cues, and schemas through which we think critically are neither pure concepts nor a literal recall of data but a

complex and varied combination of concepts, estimates, and factual examples. The key trait to remember about higher-order thinking is its mixed character, consisting of operational facility and domain-specific knowledge.

Some of the most useful studies of higher-order thinking have been concerned with improving our ability to make intelligent and accurate estimates on which to base decisions in our ethical, economic, and civic lives.⁶ Since most of us cannot remember, and do not want to take the time to learn, all the details of the U.S. budget deficit and similar matters, we follow political and economic debates with a degree of impressionism that leaves many of us open to slogans and demagoguery. What kind of critical thinking can improve our ability to reach accurate conclusions on such issues? How can we protect ourselves and our students from oversimplifications, lies, and scapegoating conspiracy theories?

It is hard to see why a generalized skepticism, unsupported by accurate knowledge, is superior to a generalized credulity, similarly unsupported. Indeed, uninformed, generalized skepticism expresses itself as a form of credulity, despite our inclination to call I'm-from-Missouri postures "critical thinking." Our best hope for intelligent civic thought lies in our ability to make good ballpark estimates that are close enough to truth to make our decisions well informed and sound. But life is too short, and learning too arduous, for all citizens to memorize a lot of economic and demographic data. Our current yearly government budget deficit—is it around \$30, \$300, or \$3,000 per American family? Sure, we could look it up, but few of us will. If we can't make an intelligent estimate from the knowledge we already have, we usually won't make an intelligent estimate at all. A lot of higher-order thinking involves our ability to make these sorts of estimates, and to make them well. How do some people manage to do it? And how can we all learn how to do it? From answers to those questions, what implications can be deduced for the K-12 curriculum?

The best research on this subject shows that neither fact-filled memorization nor large conceptual generalizations are effective modes of education for higher-order thinking about the complexities of the modern world. On the other hand, it has been shown that accurate factual estimates are necessary for understanding many issues....

The breadth-depth issue will always be with us and will always require compromises and common sense. The particular compromise one makes will depend upon subject matter and goals. In practice, an appropriate compromise has been reached by self-taught, well-informed people and by the fortunate students of particularly able teachers. One well-tested teaching method, carefully followed by many good books and teachers, provides students with a meaningful web of inferences and generalizations about the larger domain. Researchers have shown that such generally selective factual instruction leads to accurate inferences not directly deducible from the literal facts that were taught. The mechanisms by which we are able to use these selective exemplifications in order to make remarkably accurate factual guesses about untaught domains are a subject of vigorous current research.

Whatever the underlying psychological mechanisms prove to be, research has demonstrated that the teaching of a generous number of carefully chosen exemplary facts within a meaningful explanatory context is a better method for inducing insightful thinking than is any proposed alternative. These alternatives include (1) the teaching of the whole factual domain, (2) the teaching of the general principles only, and (3) the teaching of a single example in great depth (the less-is-more theory). None of these methods is as effective for inducing effective real-world thinking as sampling well-selected and consistent facts in a carefully prepared explanatory context.⁷ This careful-sampling method works well even when (as usually happens) the literal details of the taught facts are not memorized by students and cannot be retrieved accurately from memory after a period of several months. Nonetheless, a strong improvement in accurate thinking persists if students have once been taught a carefully chosen sample of the factual data.

This finding has strong implications for curriculum making. The conclusion from cognitive research shows that there is an unavoidable interdependence between relational and factual knowledge and that teaching a broad range of factual knowledge is essential to effective thinking both within domains and among domains. Despite the popularity of the anti-fact motif in our progressive education tradition, and despite its faith in the power of a few "real-world" projects to educate students "holistically" for the modern world, no state board or school district has yet abandoned the principle of requiring a broad range of different subject matters in elementary school. Across the land, there are still universal requirements for mathematics, science, language arts, and social studies.

Is this curricular conservatism a mere residue of traditional thinking, or does it indicate that common sense has not been defeated by Romantic theory? I favor the latter hypothesis. Despite the vagueness of state and district guidelines, their continued parceling out of schooling into different subject matters, against continued pleas for a more "integrated" and holistic approach, shows an implicit understanding that breadth of knowledge is an essential element of higher-order thinking. School boards have rightly assumed that the mental landscape needs to be broadly surveyed and mapped in order to enable future citizens to cope with a large variety of judgments. No effective system of schooling in the world has abandoned this principle of subject-matter breadth in early schooling.

For later schooling, however, a good deal of evidence—marshaled in the superb research of John Bishop of Cornell—shows that in the last two years of high school, and later on, the balance of utility shifts in favor of deeper and more narrowly specialized training as the best education for the modern world.⁸ This finding means that breadth in earlier schooling is all the more essential to developing adequate higher-order thinking and living skills in our citizens-to-be. If schooling is going to become more and more specialized in later life, it is ever more important to map out the wider intellectual landscape accurately and well in the earlier years. Otherwise, we shall produce not critical thinkers but narrow, ignorant ones, subject to delusion and rhetoric. This danger was uppermost in Jefferson's mind when he advocated teaching

of human history in early years. In our age, the same argument holds for the domains connected with mathematics, science, technology, and communication skills. A wide range of knowledge and a broad vocabulary supply entry wedges into unfamiliar domains, thus truly enabling "lifelong learning," as well as the attainment of new knowledge and greater depth as needed. The unmistakable implication for modern education is that, instead of constantly deferring the introduction of challenging and extensive knowledge, we need to be taking the opposite tack by increasing both the challenge and the breadth of early education.

Consensus Research on Pedagogy

A consensus regarding the most effective teaching methods has emerged from three independent sources whose findings converge on the same pedagogical principles. This pattern of independent convergence (a kind of intellectual triangulation) is, along with accurate prediction, one of the most powerful confidence-building patterns in scientific research. There are few or no examples in the history of science (none that I know of) when the same result, reached by three or more truly independent means, has been overturned. . . .

The independent convergence on the fundamentals of effective pedagogy that exists today is less mathematical but nonetheless compelling. The same findings have been derived from three quite different and entirely independent sources: (1) small-scale pairings of different teaching methods; (2) basic research in cognition, learning, memory, psycholinguistics, and other areas of cognitive psychology; and (3) large-scale international comparative studies. The findings from all three sources are highly consistent with each other regarding the most effective pedagogical principles. Because real-world classroom observations are so completely affected by so many uncontrolled variables, the most persuasive aspect of the current picture is the congruence of the classroom-based observations with cognitive psychology—which is currently our best and most reliable source of insight into the processes of learning.

In presenting these findings, my strategy will be briefly to go through some of the classroom studies and summarize their points of agreement. Then, I will relate those points to findings in cognitive psychology. Finally, I will comment on their congruence with the results of international comparisons. . . .

New Zealand studies In a series of "process-outcome" studies between 1970 and 1973, researchers from the University of Canterbury in New Zealand found that time spent focused on content and the amount of content taught were more important factors than the teacher behaviors that were used to teach the content.⁹ . . .

"Follow through" studies Jane Stallings and her colleagues observed and evaluated results from 108 first-grade classes and fifty-eight third-grade classes taught by different methods. Programs having strong academic focus rather than programs using the project-method approach produced the highest gains in reading and math. Brophy and Good summarize the Stallings findings as

follows: "Almost anything connected with the classical recitation pattern of teacher questioning (particularly direct, factual questions rather than more open questions) followed by student response, followed by teacher feedback, correlated positively with achievement." As in the New Zealand studies, students who spent most of their time being instructed or guided by their teachers did much better than students who did projects or were expected to learn on their own.¹⁰

Brophy-Evertson studies Between 1973 and 1979, Brophy and his colleagues conducted a series of studies in which they first determined that some teachers got consistently good results over the years, and others consistently bad ones. They made close observations of the teacher behaviors associated, respectively, with good and bad academic outcomes. Teachers who produced the most achievement were focused on academics. They were warm but businesslike. Teachers who produced the least achievement used a "heavily affective" approach and were more concerned with the child's self-esteem and psychic well-being than with academics. They emphasized warmth, used student ideas, employed a democratic style, and encouraged student-teacher interaction. The researchers further found that learning proceeded best when the material was somewhat new and challenging, but could also be assimilated relatively easily into what students already knew. The biggest contrast was not between modes of academic instruction but between all such instruction and "learner-centered," "discovery learning," which was ineffective. Paradoxically, the students were more motivated and engaged by academic-centered instruction than by student-centered instruction.

In 1982, Brophy and his colleagues summarized some of their later findings on the effective teaching of beginning reading. These were the most salient points:

1. Sustained focus on content.
2. All students involved (whole-class instruction dominates).
3. Brisk pace, with easy enough tasks for consistent student success.
4. Students reading aloud often and getting consistent feedback.
5. Decoding skills mastered to the point of over learning (automaticity).
6. In the course of time, each child asked to perform and getting immediate, nonjudgmental feedback.¹¹

Good-Grouws studies For over a decade, Good and Grouws pursued process-outcome studies that support the Brophy-Evertson findings. Their 1977 summary contained the following points:

1. The best teachers were clearer.
2. They introduced more new concepts, engaged in less review.
3. They asked fewer questions.
4. Their feedback to the students was quick and nonevaluative.
5. They used whole-class instruction most of the time.
6. They were demanding and conveyed high expectations.¹²

The Gage studies N. L. Gage and his colleagues at Stanford University have produced a series of process-outcome studies from the 1960s to the 1980s. These results, consistent with the above, are summarized in the following points of advice to teachers:

1. Introduce material with an overview or analogy.
2. Use review and repetition.
3. Praise or repeat student answers.
4. Be patient in waiting for responses.
5. Integrate the responses into the lesson.
6. Give assignments that offer practice and variety.
7. Be sure questions and assignments are new and challenging, yet easy enough to allow success with reasonable effort.¹³

Other studies In 1986, Rosenshine and Stevens listed five other "particularly praiseworthy" studies of effective teaching modes, all of which came to similar conclusions. They summarize these conclusions as follows:

1. Review prerequisite learning.
2. Start with a brief statement of goals.
3. Introduce new material in small steps.
4. Maintain clarity and detail in presentation.
5. Achieve a high level of active practice.
6. Obtain response and check for understanding (CFU).
7. Guide student practice initially.
8. Give systematic, continual feedback.
9. Monitor and give specific advice during seatwork.¹⁴

The Brophy-Good summary In their final summation of research in this area, Brophy and Good make a comment worth quoting directly. They draw two chief conclusions from reviewing all of this research:

One is that academic learning is influenced by the amount of time students spend in appropriate academic tasks. The second is that students learn more efficiently when their teachers first structure new information for them and help them relate it to what they already know, and then monitor their performance and provide corrective feedback during recitation, drill, practice, or application activities. . . . There are no shortcuts to successful attainment of higher-level learning objectives. Such success will not be achieved with relative ease through discovery learning by the student. Instead, it will require considerable instruction from the teacher, as well as thorough mastery of basic knowledge and skills that must be integrated and applied in the process of "higher-level" performance. Development of basic knowledge and skills to the level of automatic and errorless performance will require a great deal of drill and practice. Thus drill and practice activities should not be slighted as "low level." They appear to be just as essential to complex and creative intellectual performance as they are to the performance of a virtuoso violinist.¹⁵

Before I go on to discuss correlations between these findings and research in cognitive psychology, I will digress to make an observation connecting these results to student motivation. While common sense might have predicted the *academic* superiority of structured, whole-class instruction over less academically focused, learner-centered instruction, it was unexpected that these studies should have demonstrated the *motivational* superiority of instruction centered on content rather than on students. Why is academically focused instruction more engaging and motivating to young learners than learner-centered instruction?

I know of no research that explains this finding, but I shall hazard the guess that individualized, learner-centered instruction must be extremely boring to most students most of the time, since, by mathematical necessity, they are not receiving individualized attention most of the time. It may also be the case that the slow pace and progress of less structured teaching may fail to engage and motivate students. A teacher must be extraordinarily talented to know just how to interact engagingly with each individual child. Given the strong motivation of young children to learn about the adult world, the best way to engage them is by a dramatic, interactive, and clear presentation that incidentally brings out the inherent satisfaction in skill mastery and interest in subject matter.

There is also a basis in cognitive psychology for the finding that students should be taught procedural skills to the point of "over learning." "Over learning" is a rather unfortunate term of art, since intuitively it seems a bad idea to overdo anything. But the term simply means that students should become able to supply the right answer or to follow the right procedure very fast, without hesitation. Through practice, they become so habituated to a procedure that they no longer have to think or struggle to perform it. This leaves their highly limited working memory free to focus on other aspects of the task at hand. The classroom research cited above simply reported that teachers who followed the principle of over learning produced much better results. Cognitive psychology explains why. . . .

The classroom studies also stressed the importance of teaching new content in small incremental steps. This is likewise explained by the limitations of working memory, since the mind can handle only a small number of new things at one time. A new thing has to become integrated with prior knowledge before the mind can give it meaning, store it in memory, and attend to something else. New learnings should not be introduced until feedback from students indicates that they have mastered the old learnings quite well, though not, as in the case of procedural skills, to the point of over learning. Research into long-term memory shows why this slow-but-sure method of feedback and review works best: "Once is not enough" should be the motto of long-term memory, though nonmeaningful review and boring repetition are not good techniques. The classroom research cited above indicated that the best teachers did not engage in incessant review. Memory studies suggest that the best approach to achieving retention in long-term memory is "distributed practice." Ideally, lessons should spread a topic over several days, with repetitions occurring at moderately distant intervals. . . . This feature of learning explains

the importance of a deliberate pace of instruction, as all the classroom studies showed. Whatever practical arrangements are chosen for classroom learning, the principle of content rehearsal is absolutely essential for fixing content in long-term memory. Until that fixation occurs, content learning cannot be said to have happened.

That receiving continual feedback from the students is essential to good teaching is a robust finding in all the studies, and also gets support from research into both short-term and long-term memory. Feedback indicates whether the material has been learned well enough to free short-term (i.e., working) memory for new tasks. Moreover, the process of engaging in question-answer and other feedback practices constitutes content rehearsal, which also helps achieve secure learning in memory. Good teachers seem to be implicitly aware of this double function of question asking—that is, simultaneous monitoring and rehearsing.

Finally, research in cognitive psychology supports the finding that classes should often begin with a review or an analogy that connects the new topic with knowledge students already have. Psycholinguistic studies have shown that verbal comprehension powerfully depends on students' relevant background knowledge and particularly on their ability to apply that knowledge to something new.¹⁶ Meaningful understanding seems to be equivalent to joining the new knowledge to something already known. Other psycholinguistic studies show that comprehension is enhanced when clues are offered at the beginning of a written passage indicating the overall character and direction of the passage. One needs to have a sense of the whole in order to predict the character of the parts and the way they fit with each other. Just as holistic, generic clues are important for the reader's comprehension of a written passage, such clues are similarly important for the student's understanding in the classroom. This psycholinguistic principle shows why a summary at the beginning of a class can give students the right "mindset" for assimilating the new material.¹⁷

These few principles concerning working memory, long-term memory, and the best prior conditions for meaningful learning explain the effectiveness of almost all the practices that were found to be effective in the classroom studies. Their congruence with mainstream psychology was well observed by Rosenshine and Stevens when they stated that research in cognitive psychology

helps explain why students taught with structured curricula generally do better than those taught with either more individualized or discovery learning approaches. It also explains why young students who receive their instruction from a teacher usually achieve more than those who are expected to learn new materials and skills on their own or from each other. When young children are expected to learn on their own, particularly in the early stages, the students run the danger of not attending to the right cues, or not processing important points, and of proceeding on to later points before they have done sufficient elaboration and practice.¹⁸

Now I shall turn to some data from international studies on classroom practice. The fullest such research has been conducted by Harold Stevenson

and his several colleagues in the United States, China, Japan, and Taiwan, who observed 324 Asian and American mathematics classrooms divided between first grade and fifth grade. Each classroom was studied for more than twenty hours by trained observers who took voluminous notes. . . .

In light of the contrast in outcomes, it is no surprise that the activities that typically occur in Asian classrooms follow the effective pedagogical principles deduced from small-scale American studies and from cognitive psychology. By contrast, the activities that typically occur in American classrooms run counter to those research findings. . . .

To illustrate the agreement between the small-scale intranational studies and the international studies, I shall first summarize the small-scale research findings in each category, then the corresponding findings from the international studies.

Social Atmosphere

Small-scale intranational studies In the best classrooms, the social atmosphere was warm and supportive, but at the same time businesslike and focused on the job at hand. By contrast, the worst-performing classrooms were "heavily affective," with a lot of verbal praise and self-esteem talk. In the best classes, the teacher was respectful to students but demanded good discipline as well as hard work. In the worst, the atmosphere was less ordered and disciplined.

International studies The most frequent form of evaluation used by American teachers was praise, a technique that is rarely used in either Taiwan or Japan. Praise cuts off discussion and highlights the teacher's role as the authority. It also encourages students to be satisfied with their performance rather than informing them about where they need improvement. Chinese and Japanese teachers have a low tolerance for errors, and when they occur, they seldom ignore them. Discussing errors helps to clarify misunderstandings, encourage argument and justification, and involve students in the exciting quest of assessing the strengths and weaknesses of the various alternative solutions that have been proposed.¹⁹

Initial Orientation

Small-scale intranational studies The teacher first reviews the knowledge prerequisite to the new learning and orients the class to what is in store. One good way is to introduce the material with an overview or analogy connecting it with previous knowledge and to present a brief statement of goals for the day's class.

International studies The Asian teacher stands in front of the class as a cue that the lesson will soon start. The room quiets. "Let us begin," says the teacher in Sendai. After brief reciprocal bows between pupils and teacher, the teacher opens the class with a description of what will be accomplished during the class period. From that point until the teacher summarizes the day's lesson and announces, "We are through," the Japanese elementary school class—like

those in Taiwan and China—consists of teacher and students working together toward the goals described at the beginning of the class. . . .

Pace

Small-scale intranational studies The best teachers introduce new material in small, easily mastered steps setting a deliberate but brisk pace, not moving ahead until students show that they understand. Better results come from teachers who move forward with new concepts, have higher expectations, and provide review, but not "incessant review."

International studies The pace is slow, but the outcome is impressive. Japanese teachers want their students to be reflective and to gain a deep understanding of mathematics. Each concept and skill is taught with great thoroughness, thereby eliminating the need to teach the concept again later. Covering only a few problems does not mean that the lesson turns out to be short on content. In the United States, curriculum planners, textbook publishers, and teachers themselves seem to believe that students learn more effectively if they solve a large number of problems rather than if they concentrate their attention on only a few.²⁰

Clarity

Small-scale intranational studies The most effective teachers were not just clearer but more focused on the content or skill goal, asked questions but fewer of them, and kept the focus by continually integrating student responses into the lesson. A useful tool for clarity in presentation: an end-of-class summary review indicating where the lesson went and what it did.

International studies Irrelevant interruptions often add to children's difficulty in perceiving lessons as a coherent whole. In American observations, the teacher interrupted the flow of the lesson with irrelevant comments, or the class was interrupted by someone else in 20 percent of all first-grade lessons and 47 percent of all fifth-grade lessons. In Sendai, Taipei, and Beijing, interruptions occurred less than 10 percent of the time at both grade levels. Coherence is also disrupted by frequent shifting from one topic to another within a single lesson. Twenty-one percent of the shifts within American lessons were to different topics (rather than to different materials or activities), compared with only 5 percent in the Japanese lessons. Before ending the lesson, the Asian teacher reviews what has been learned and relates it to the problem she posed at the beginning of the lesson. American teachers are much less likely than Asian teachers to end lessons in this way. . . .

Managing and Monitoring

Small-scale intranational studies In the most effective teaching, whole-class instruction is used most of the time. The teacher obtains responses and checks for understanding for each student, ensuring that each child gets some feedback and that all students stay involved. While feedback to the students

is frequent, it is not incessant. The teacher is patient in waiting for responses. Student answers are often repeated for the class. Many effective teachers make constructive, nonevaluative use of student errors, working through how they were made. Students are more engaged and motivated in these classrooms than in student-centered ones.

International studies Chinese and Japanese teachers rely on students to generate ideas and evaluate the correctness of the ideas. The possibility that they will be called upon to state their own solution keeps Asian students alert, but this technique has two other important functions. First, it engages students in the lesson, increasing their motivation by making them feel they are participants in a group process. Second, it conveys a more realistic impression of how knowledge is acquired. American teachers are less likely to give students opportunities to respond at such length. Although a great deal of interaction appears to occur in American classrooms—with students and teachers posing questions and giving answers—American teachers generally ask questions that are answerable with a yes or a no or a short phrase. They seek a correct answer and continue calling on students until one produces it.²¹

Drill and Practice

Small-scale intranational studies Two kinds of practice are needed, corresponding to two objects of learning—content and skills. For content, new concepts are discussed and reviewed until secure in the memory. Procedural skills are mastered to the point of overlearning (automaticity). Guided practice should be part of whole-class instruction before seatwork occurs. Small-group seatwork generally works better than individual seatwork, but seatwork per se is used rather sparingly for both content and skills. Supervision and feedback are provided during seatwork.

International studies When children must work alone for long periods of time without guidance or reaction from the teacher, they begin to lose focus on the purpose of their activity. Asian teachers assign less seatwork than American teachers; furthermore, they use seatwork differently. Asian teachers tend to use short, frequent periods of seatwork, alternating between discussing problems and allowing children to work problems on their own. When seatwork is embedded within the lesson, instruction and practice are tightly woven into a coherent whole. Teachers can gauge children's understanding of the preceding part of the lesson by observing how they solve practice problems. Interspersing seatwork with instruction in this way helps the teacher assess how rapidly she can proceed through the lesson. American teachers, on the other hand, tend to relegate seatwork to one long period at the end of the class, where it becomes little more than a time for repetitious practice. . . . American teachers often do not discuss the work or its connection to the goal of the lesson, or publicly evaluate its accuracy.²² . . .

... [C]onsensus [research into teacher effectiveness] among present-day reformers is well summarized by Zemelman, Daniels, and Hyde in their 1993 book, *Best Practice*.

In virtually every school subject, we now have recent summary reports, meta-analyses of instructional research, bulletins from pilot classrooms, and landmark sets of professional recommendations. Today there is a strong consensus definition of Best Practice, of state-of-the-art teaching in every critical field. . . . Whether the recommendations come from the National Council of Teachers of Mathematics, the Center for the Study of Reading, the National Writing Project, the National Council of Science, the National Council of Teachers of English, the National Association for the Education of Young Children, or the International Reading Association, the fundamental insights into teaching and learning are remarkably congruent. Indeed on many key issues, the recommendations from these diverse organizations are unanimous.

Zemelman, Daniels, and Hyde then list twenty-five "LESS" and "MORE" admonitions on which all these organizations agree. Among them are the following:

- LESS whole-class teacher-directed instruction
- LESS student passivity, sitting, listening, receiving
- LESS attempts by teachers to cover large amounts of material
- LESS rote memorization of facts and details
- LESS stress on competition and grades
- MORE experiential, inductive, hands-on learning
- MORE active learning with all the attendant noise of students doing, talking, collaborating
- MORE deep study of a smaller number of topics
- MORE responsibility transferred to students for their work: goal-setting, record-keeping, monitoring, evaluation
- MORE choice for students, e.g., picking their own books, etc.
- MORE attention to affective needs and varying cognitive styles of students
- MORE cooperative, collaborative activity.²³

The authors praise the current consensus on these "child-centered" principles for being "progressive, developmentally appropriate, research based, and eminently teachable." These claims are not, however, "research based" in the way the authors imply. Quite the contrary. No studies of children's learning in mainstream science support these generalizations. With respect to effective learning, the consensus in research is that their recommendations are worst practice, not "best practice."

This Alice in Wonderland reversal of reality has been accomplished largely by virtue of the rhetorical device that I have called "premature polarization." Discovery learning is labeled "progressive," and whole-class instruction "traditional." . . . It overlooks, for instance, the different pedagogical requirements

for procedural learning and content learning and thus neglects the different pedagogical emphases needed at the different ages and stages of learning. Effective procedural learning requires "overlearning," and hence plenty of practice. Content learning is amenable to a diversity of methods that accommodate themselves to students' prior knowledge, habits, and interests.

What the international data show very clearly is that both procedural and content learning are best achieved in a focused environment that preponderantly emphasizes whole-class instruction but that is punctuated by small-group or individualized work. Within that focused context, however, there are many good roads to Rome. The classroom observations of Stevenson and his colleagues bring home the ancient wisdom of integrating both direct and indirect methods, including inquiry learning, which encourages students to think for themselves, and direct informing, which is sometimes the most effective and efficient mode of securing knowledge and skill. A combination of show and tell, omitting neither, is generally the most effective approach in teaching, as it is in writing and speaking.

The only truly general principle that seems to emerge from process-outcome research on pedagogy is that focused and guided instruction is far more effective than naturalistic, discovery, learn-at-your-own-pace instruction. But within the context of focused and guided instruction, almost anything goes, and what works best with one group of students may not work best with another group with similar backgrounds in the very same building. Methods must vary a good deal with different age groups. Within the general context of focused and guided instruction, my own general preference, and one followed by good teachers in many lands, is for what might be called "dramatized instruction." The class period can be formed into a little drama with a beginning, middle, and end, well directed but not rigidly scripted by the teacher. The beginning sets up the question to be answered, the knowledge to be mastered, or the skill to be gained; the middle consists of a lot of back-and-forth between student and student, student and teacher; and the end consists of a feeling of closure and accomplishment. . . .

The focused narrative or drama lies midway between narrow drill and practice (which has its place) and the unguided activity of the project method (which may also occasionally have a place). Sir Philip Sidney argued (in 1583) that stories are better teachers than philosophy or history, because philosophy teaches by dull precept (guided instruction) and history teaches by uncertain example (the project method).²⁴ The story, however, joins precept and example together, thus teaching and delighting at the same time. . . .

Excellent classroom teaching has a narrative and dramatic feel even when there is a lot of interaction between the students and the teacher—it has a definite theme, and a beginning, middle, and end. This teaching principle holds even for mathematics and science. When every lesson has a well-developed plot in which the children themselves are participants, teaching is both focused and absorbing. The available research is consistent with this scheme, though it by no means says that thoughtful sequencing, plotting, and dramatizing of learning activities are the exclusive or whole key to good pedagogy. For many elementary learnings, repeated practice has to be an integral part of the plot.

That recent psychological research should yield insights that confirm what . . . Sidney said about stories should probably make us more, not less, confident in the results of this recent research. Education is as old as humanity. The breathless claim that technology and the information age have radically changed the nature of the education of young children turns out to be, like most breathless claims in education, unsupported by scholarship. Nor should current studies surprise us when they show that a naturalistic approach, lacking a definite story line and a sharp focus, has the defect Sidney saw in history as a teacher of humankind: it "draweth no necessary consequence." There is a modest place for discovery learning, just as there is for drill and practice. But research indicates that, most of the time, clearly focused, well-plotted teaching is the best means for "[holding] children from play and old men from the chimney corner."

Notes

1. For comments on Gentile's views and for basic insights into Gramsci's ideas about education, I am grateful to Ertwistle, Antonio Gramsci. Additional commentary may be found in Broccoli, Antonio Gramsci e l'educazione come egemonia; Scuderi, Antonio Gramsci e il problema pedagogico; and De Robbio, Antonio Gramsci e la pedagogia dell'impegno. For modern data showing that Gramsci is right in holding that traditional schooling greatly improves the academic competencies of low achievers, see K. R. Johnson, and Layng, "Breaking the Structuralist Barrier," 1475-90.
2. Larkin et al., "Models of Competence in Solving Physics Problems," 317-48. Schoenfeld and Hermann, "Problem Perception and Knowledge Structure in Expert and Novice Mathematical Problem Solvers," 484-94.
3. Some work in this tradition: Tversky and Kahneman, "Availability," 207-32; Collins, *Human Plausible Reasoning*; and Fischhoff, "Judgment and Decision Making," 153-87.
4. Larkin and Chabay, "Research on Teaching Scientific Thinking," 158.
5. Ibid., 150-72.
6. Kunda and Nisbett, "The Psychometrics of Everyday Life," 195-224.
7. Brown and Siegler, "Metrics and Mappings," 531. But see also Scardamalia and Bereiter, "Computer Support for Knowledge-Building Communities," 265-83; and Scardamalia, Bereiter, and Lamont, "CSILE: Trying to Bring Students into World 3," 201-28.
8. Bishop, *Expertise and Excellence*.
9. The data from the New Zealand study and most other studies cited here are taken from the excellent review by Brophy and Good, who conducted some of the most significant research into effective teaching methods. See Brophy and Good, "Teacher Behavior and Student Achievement," 328-75. Some of the New Zealand work is described in Nuttall and Church, "Experimental Studies of Teaching Behaviour." The importance of this kind of research was well argued by Gilbert T. Sewall in his *Necessary Lessons*, especially pages 131-33. Sewall cites highly similar findings from the British researcher Neville Bennett in N. Bennett, *Teaching Styles and Pupil Progress*. For an explanation why progressive methods like discovery learning have not worked well in teaching science, see Walberg, "Improving School Science in Advanced and Developing Countries," 625-99.
10. Stallings and Kasowitz, *Follow Through Classroom Evaluation*, 1972-1973.
11. Brophy and Everson, *Learning from Teaching*. Anderson, Everson, and Brophy, *Principles of Small-Group Instruction in Elementary Reading*.
12. Good and Grouws, "Teacher Effects," 49-54.
13. Gage, *The Scientific Basis of the Art of Teaching*.
14. Rosenshine and Stevens, "Teaching Functions," 376-91.
15. Brophy and Good, "Teacher Behavior and Student Achievement," 338.
16. Spiro, "Cognitive Processes in Prose Comprehension and Recall," and Anderson and Shiffrin, "The Meaning of Words in Context."
17. Bransford and Johnson, "Contextual Prerequisites for Understanding," 717-26. Spiro, "Cognitive Processes in Prose Comprehension and Recall."
18. Rosenshine and Stevens, "Teaching Functions," 379.
19. Stevenson and Stigler, *The Learning Gap*, 191.
20. Ibid., 194.
21. Ibid., 190.
22. Ibid., 183.
23. Zemelman, Daniels, and Hyde, *Best Practice*, 4-5.
24. Sidney, *An Apology for Poetry*.



POSTSCRIPT



Should Schools Adopt a Constructivist Approach to Education?

Hirsch points to dozens of studies that he believes demonstrate the superiority of a teacher-centered, fact-based approach. Why, then, do Windschitl and other constructivists adhere so firmly to their position? How can they ignore the empirical evidence amassed by Hirsch? In fact, interpreting the studies that Hirsch cites is not so straightforward. Many of these studies are correlational, involving comparisons between existing classrooms exemplifying the different approaches. In a correlational study, the researcher has no control over factors such as the assignment of students or teachers to one approach or the other or the ways in which the two approaches are implemented. This means that it is often difficult to discern whether differences in student achievement have been caused by differences in pedagogical approach or by preexisting differences that were beyond the control of the researchers. In addition, constructivists would argue that many of the so-called constructivist classrooms examined in these studies did little more than insert a few hands-on activities into an otherwise teacher-centered classroom. They would question whether the classrooms that were evaluated really provided a fair test of the impact constructivism has on student learning and achievement. An even more vexing problem in interpretation, however, is that the two approaches appear to value very different types of outcomes for students. The teacher-centered, fact-based approach values a large quantity of decontextualized skills and facts, whereas the constructivist approach values the acquisition of more particular forms of knowing and acting. In other words, the two approaches seem to be designed to teach very different things. This raises the possibility that deciding between them cannot be done solely by relying on empirical data. Instead, we must decide what outcomes are most valuable for students—large collections of facts and skills or the particular modes of thought and action described by the constructivists. Only when that is decided can empirical research be carried out to determine whether the teacher-centered approach, the constructivist approach, or some other approach is best suited to reaching those outcomes in a timely and cost-effective manner.

Complicating matters further is the fact that both the teacher-centered approach and the constructivist approach are composed of many elements, and it may turn out to be that some elements of each may be most effective. In fact, this possibility has been suggested by a number of cognitive scientists, including David Perkins, codirector of Harvard Project Zero. In an insightful paper, "Teaching for Understanding," *American Educator* (vol. 17, no. 3, 1993),

Perkins criticizes the drill-and-practice strategy for not providing students the means of knowing how to apply the facts that they have memorized to solve meaningful problems. At the same time, he acknowledges that deep understanding of any domain of knowledge demands that certain critical facts be mastered, although he stresses that real understanding ultimately requires that students recognize the relationships among these facts. Perkins is also critical of the constructivist approach for underestimating the sophistication of the cognitive capabilities of even the youngest children. This underestimation, he argues, often leads constructivists to withhold material that children could and should master early in their schooling. Perkins further criticizes constructivists for focusing so completely on the concept of hands-on activities that they ignore the possibility that verbal discourse can also be used to actively engage students in the material to be mastered. At the same time, however, he acknowledges that deep understanding of a domain—in the sense of recognizing the relationships among critical facts and being able to apply those facts to solve a range of meaningful problems—requires the active, extended engagement with tasks and materials that is characteristic of the hands-on constructivist approach. Perkins maintains that the goal for students should be deep understanding of the domains of knowledge we value and that this will require an approach that blends elements of both the teacher-centered and the constructivist approach.

Readers interested in learning more about the psychological theories underlying constructivist education should see Leonard Abbeduto and Stephen N. Elliott, *Guide to Human Development for Future Educators* (McGraw-Hill, 1998); "Constructing Scientific Knowledge in the Classroom," by R. Driver et al., *Educational Researcher* (vol. 23, no. 7, 1994); *In Search of Understanding: The Case for Constructivist Classrooms* by Jacqueline G. Brooks and Martin G. Brooks (Association for Supervision & Curriculum Development, 1993); and "Piaget's Equilibration Theory and the Young Gifted Child: A Balancing Act," by Leonora M. Cohen and Younghee M. Kim, *Roeper Review* (1999). Readers interested in reading original papers by developmental psychologist Jean Piaget, from whose work the constructivist approach has grown most directly, can turn to the collection *The Essential Piaget: An Interpretive Reference and Guide*, edited by Howard E. Gruber and Jacques J. Voneche (Jason Aronson, 1995). Articles that provide illustrations of constructivist classrooms are "How to Build a Better Mousetrap: Changing the Way Science Is Taught Through Constructivism," by Thomas R. Lord, *Contemporary Education* (Spring 1998); "Constructivist Theory in the Classroom," by Mary M. Bevevino, Joan Dengel, and Kenneth Adams, *The Clearing House* (May/June 1999); and "Constructivism: Science Education's 'Grand Unifying Theory,'" by Alan Colburn, *The Clearing House* (September/October 2000). See also "The Role of Assessment in a Learning Culture," by Lortie A. Shepard, *Educational Researcher* (October 2000) for an interesting article on the place of assessment in the constructivist classroom.