Introduction

To begin with the end in mind means to start with a clear understanding of your destination. It means to know where you're going so that you better understand where you are now so that the steps you take are always in the right direction.

—Stephen R. Covey, *The 7 Habits of Highly Effective People*, 1989, p. 98

That's what I find so exciting about this process: it is so much better for me and the students to be in the middle of a UbD. Everything seems so relaxed, I'm more confident, and the students are very excited. They seem to sense something more at the core of what we're doing. I suppose they sense the goal: the goal is usually not revealed as completely and clearly. I know what my students know, I know what they don't know, and I know what I need to do. How liberating.

—A teacher reflecting on using UbD

Consider the following four vignettes and what they suggest about understanding and the design of curriculum and assessments. Two are true. Two are fictionalized accounts of familiar practice.

1. As part of a workshop on "understanding," a veteran high school English teacher entered the following reflection in a learning log about her own experience as a high school student:

   *I felt then that my brain was a way station for material going in one ear and (after the test) out the other. I could memorize very easily and so became valedictorian, but I was embarrassed even then that I understood much less than some other students who cared less about grades.*

2. For two weeks every fall, all the 3rd grade classes participate in a unit on apples. The 3rd graders engage in a variety of activities related to the topic. In language arts, they read about Johnny Appleseed and view an illustrated filmstrip of the story. They each write a creative story involving an apple and then illustrate their stories using tempera paints. In art, students collect leaves from nearby crab apple trees and make a giant leaf-print collage that hangs on
the hallway bulletin board adjacent to the 3rd grade classrooms. The music teacher teaches the children songs about apples. In science, they use their senses to carefully observe and describe the characteristics of different types of apples. During mathematics, the teacher demonstrates how to scale up an applesauce recipe to make enough for all the 3rd graders.

A highlight of the unit is the field trip to a local apple orchard, where students watch cider being made and go on a hayride. The culminating unit activity is the 3rd grade apple fest, a celebration in which parents dress in apple costumes and the children rotate through various activities at stations—making applesauce, competing in an apple word-search contest, bobbing for apples, and completing a math skill sheet containing word problems involving apples. The fest concludes with selected students reading their apple stories while the entire group enjoys candy apples prepared by the cafeteria staff.

3. A test item on a National Assessment of Educational Progress (NAEP) mathematics assessment presented the following question to 8th grade students, as an open-ended prompt demanding a written answer: “How many buses does the army need to transport 1,128 soldiers if each bus holds 36 soldiers?” Almost one-third of the 8th graders gave the following answer: “31 remainder 12” (Schoenfeld, 1988, p. 84).

4. It’s late April and the panic is beginning to set in. A quick calculation reveals to the world history teacher that he will not finish the textbook unless he covers an average of 40 pages per day until the end of school. He decides, with some regret, to eliminate a short unit on Latin America and several time-consuming activities, such as a mock UN debate and voice and discussions of current international events in relation to the world history topics they’ve studied. To prepare his students for the departmental final exam, it will be necessary to switch into a fast-forward lecture mode.

Each of these vignettes reveals some troubling aspect of understanding and design. (By the way, the odd-numbered vignettes are true; the others might as well be, given common practice.)

The reflection of the high school English teacher reveals a familiar truth—even “good” students don’t always have deep understanding of what’s been taught despite the fact that conventional measures (course grades and cumulative GPA) certify success. In her case, testing focused predominantly on the recall of information from textbooks and class presentations. She reported that she was rarely given assessments that called for her to demonstrate deeper understanding.

The fictitious unit on apples presents a familiar scene—the activity-oriented curriculum—in which students participate in a variety of hands-on activities. Such units are often engaging for students. They may be organized, as in this case, around a theme and provide interdisciplinary connections. But questions about the value of the work remain. To what ends is the teaching directed? What are the big ideas and important skills to be developed during the unit? Do the students understand what the learning targets are? To what
extent does the evidence of learning from the unit (e.g., the leaf-print collage, the creative-writing stories, the completed word searches) reflect worthwhile content standards? What understandings will emerge from all this and endure?

The NAEP mathematics test item reveals another aspect of understanding, or lack thereof. Although the students computed accurately, they had not grasped the meaning of the question, nor had they apparently understood how to use what they knew to reach an answer of 32 buses. Could it be that these students had mastered the out-of-context drill problems in the math book and on worksheets, but had been given little opportunity to apply mathematics in the context of real-world applications? Should we conclude that the students who answered “remainder 12” really understand division and its use?

Nearly every teacher can empathize with the world history teacher’s struggle, given the pressures to “cover” material. The challenge is exacerbated by the natural increase of knowledge in fields such as science and history, not to mention external testing obligations and additions to the curriculum in recent years (e.g., computer studies and drug education). But at its worst, a coverage orientation—marching through the textbook irrespective of priorities, desired results, learner needs and interests, or apt assessment evidence—may defeat its own aims. For what do students remember, much less understand, when there is only teaching with no opportunity to really learn—to work with, play with, investigate, use—the key ideas and points of connection? Such an approach might correctly be labeled, “Teach, test, and hope for the best.”

The twin sins of design

Interestingly enough, we think, both the apples unit and the world history class suffer from the same general problem, though what is taking place in both classrooms clearly looks very different. Though in the elementary classroom the students are doing loads of hands-on activity and in the history classroom a teacher is lecturing to students, both cases reveal no clear intellectual goals. We call the two versions of the problem the “twin sins” of typical instructional design in schools: activity-focused teaching and coverage-focused teaching. Neither case provides an adequate answer to the key questions at the heart of effective learning: What is important here? What is the point? How will this experience enable me as a learner to meet my obligations? Put simply, in a phrase to be considered throughout this book, the problem in both cases is that there are no explicit big ideas guiding the teaching and no plan for ensuring the learning.

What this book is about

As the title suggests, this book is about good design—of curriculum, assessment, and instruction—focused on developing and deepening understanding of important ideas. Posed as a question, considered throughout the book and
from many perspectives, the essence of this book is this: How do we make it more likely—by our design—that more students really understand what they are asked to learn? So often, by contrast, those who "get it" are learners who come to us already able and articulate—understanding by good fortune. What must our planning entail to have an intellectual impact on everyone: the less experienced; the highly able, but unmotivated; the less able; those with varied interests and styles?

To explore such questions we must surely investigate the purpose of the designs—in our case, understanding. So what do we mean when we say that we want students to understand as opposed to merely take in and recall? How is it possible for a student to know lots of important things but not understand what they mean—something we have all seen as teachers? And vice versa: How can another student make lots of mistakes about the facts—and not even do all the assigned work—but nonetheless penetrate to the key ideas? Thus, although the book is about the design of curriculum to engage students in exploring big ideas, it is also an attempt to better understand understanding, especially for purposes of assessment.

As you shall see, we propose that a helpful way to think about what understanding is, how to design for it, and how to find evidence of it in student work is to realize that understanding has various facets. Everyday language reveals the variety of connotations, hence the need to clarify them. Think about the difference, for example, between saying, "He didn't understand the French speaker" and "She didn't understand what the primary source documents meant." There are different kinds of understanding; we need to be clear about which ones we are after. Understanding, we argue, is not a single goal but a family of interrelated abilities—six different facets of transfer—and an education for understanding would more deliberately develop them all.

This dual purpose—clarifying the goal called "student understanding" while exploring the means called "good design"—raises a host of vital questions in the real world of teaching, of course. What is the best way to design for both content mastery and understanding? How can we accomplish the goal of understanding if the textbooks we use dispense volumes of out-of-context knowledge? How realistic is teaching for understanding in a world of content standards and high-stakes tests? Thus, in the book, we do the following in an attempt to answer these and other questions:

- Propose an approach to curriculum and instruction designed to engage students in inquiry, promote transfer of learning, provide a conceptual framework for helping students make sense of discrete facts and skills, and uncover the big ideas of content.
- Examine an array of methods for appropriately assessing the degree of student understanding, knowledge, and skill.
- Consider the role that predictable student misunderstandings should play in the design of curricula, assessments, and instruction.
- Explore common curriculum, assessment, and instruction practices that may interfere with the cultivation of student understanding, and propose a
backward design approach to planning that helps us meet standards without sacrificing goals related to understanding.

- Present a theory of six facets of understanding and explore its theoretical and practical implications for curriculum, assessment, and teaching.
- Present a unit template to assist in the design of curricula and assessments that focus on student understanding.
- Show how such individual units should be nested in a larger, more coherent framework of courses and programs also framed around big ideas, essential questions, and core assessment tasks.
- Propose a set of design standards for achieving quality control in curriculum and assessment designs.
- Argue that designers need to work smarter, not harder, by sharing curriculum designs worldwide via a searchable Internet database.

The book's audience

This book is intended for educators, new or veteran, interested in enhancing student understanding and in designing more effective curricula and assessments to achieve that end. The audience includes teachers at all levels (elementary through university), subject matter and assessment specialists, curriculum directors, preservice and inservice trainers, school-based and central office administrators and supervisors. We provide numerous examples, from all levels of schooling, throughout the book, but never enough to suit any one audience at any one time, alas. Further examples from all subjects and levels can be found in the Understanding by Design Professional Development Workbook (McTighe & Wiggins, 2004) and on the UbD Web site (http://ubdexchange.org).

Key terms

A few words about terminology are in order. We talk a good deal in the book about big ideas that should be the focus of education for understanding. A big idea is a concept, theme, or issue that gives meaning and connection to discrete facts and skills. Here are some examples: adaptation; how form and function are related in systems; the distributive property in mathematics (whereby we can use any number of groupings and subgroupings to yield the “same” numbers); problem solving as the finding of useful models; the challenge of defining justice; and the need to focus on audience and purpose as a writer or speaker. In an education for understanding, a vital challenge is to highlight the big ideas, show how they prioritize the learning, and help students understand their value for making sense of all the “stuff” of content.

Educators involved in reform know that the words curriculum and assessment have almost as many meanings as there are people using the terms. In this book, curriculum refers to the specific blueprint for learning that is derived
from desired results—that is, content and performance standards (be they state-determined or locally developed). Curriculum takes content (from external standards and local goals) and shapes it into a plan for how to conduct effective and engaging teaching and learning. It is thus more than a list of topics and lists of key facts and skills (the “inputs”). It is a map for how to achieve the “outputs” of desired student performance, in which appropriate learning activities and assessments are suggested to make it more likely that students achieve the desired results.

The etymology of the word suggests this: Curriculum is the particular “course to be run,” given a desired end point. A curriculum is more than a traditional program guide, therefore; beyond mapping out the topics and materials, it specifies the most appropriate experiences, assignments, and assessments that might be used for achieving goals. The best curricula (and syllabi), in other words, are written from the point of view of the desired learnings, not merely what will be covered. They specify what the learner should have achieved upon leaving, what the learner needs to do to achieve, and what the teacher needs to do to achieve the results sought. In sum, they specify the desired output and means of achieving it, not just a list of content and activities.

By assessment we mean the act of determining the extent to which the desired results are on the way to being achieved and to what extent they have been achieved. Assessment is the umbrella term for the deliberate use of many methods of gathering evidence of meeting desired results, whether those results are state content standards or local curricular objectives. The collected evidence we seek may well include observations and dialogues, traditional quizzes and tests, performance tasks and projects, as well as students’ self-assessments gathered over time. Assessment is thus a more learning-focused term than evaluation, and the two should not be viewed as synonymous. Assessment is the giving and using of feedback against standards to enable improvement and the meeting of goals. Evaluation, by contrast, is more summative and credential-related. In other words, we need not give a grade—an evaluation—to everything we give feedback to. In fact, a central premise of our argument is that understanding can be developed and evoked only through multiple methods of ongoing assessment, with far greater attention paid to formative (and performance) assessment than is typical.

By desired results we mean what has often been termed intended outcomes, achievement targets, or performance standards. All four terms are meant to shift our focus away from the inputs to the output: what the student should be able to know, do, and understand upon leaving, expressed in performance and product terms. Desired result reminds us also that, as “coaches,” we will likely have to adjust our design and performance en route, if feedback shows that we are in danger of not achieving the successes sought.

The word understanding turns out to be a complex and confusing target despite the fact that we aim for it all the time. The word naturally deserves clarification and elaboration, which is the challenge for the rest of the book. For now, though, consider our initial working definition of the term: To
**Introduction**

*understand* is to make connections and bind together our knowledge into something that makes sense of things (whereas without understanding we might see only unclear, isolated, or unhelpful facts). But the word also implies doing, not just a mental act: A performance ability lies at the heart of understanding, as Bloom (1956) noted in his Taxonomy in discussing application and synthesis. To understand is to be able to wisely and effectively *use*—transfer—what we know, in context; to *apply* knowledge and skill effectively, in realistic tasks and settings. To have understood means that we show evidence of being able to transfer what we know. When we understand, we have a fluent and fluid grasp, not a rigid, formulaic grasp based only on recall and “plugging in.”

When we speak of the product of this achievement—an understanding, as a noun—we are describing particular (often hard-won) insights. For example, we talk about scientists’ current understanding that the universe is expanding or the postmodern understanding of authors as not being privileged commentators on the meaning of their books. The great challenge in teaching is to enable such subtle adult understandings to become student understandings—without reducing the understanding to a mere simplistic statement for recall. If the student gains a genuine understanding, we typically say they “really get it.” With our help as designers and coaches, they “come to an understanding.”

Yet, for years, curriculum guides have argued against framing objectives in terms of understandings. Bloom (1956) argued that the word is too ambiguous to use as a foundation for teaching goals and their assessments; hence, the writing of the Taxonomy. But an important conceptual distinction remains and needs pondering: the difference between *knowing* and *understanding*. Pinning this distinction down in theory and in practice has not been easy. We propose in the book that insufficient attention has been paid to the fact that there are different kinds of understandings, that knowledge and skill do not automatically lead to understanding, that student misunderstanding is a far bigger problem than we may realize, and that assessment of understanding therefore requires evidence that cannot be gained from traditional fact-focused testing alone.

**What this book isn’t about**

1. *Understanding by Design* is not a prescriptive program. It is a way of thinking more purposefully and carefully about the nature of any design that has understanding as the goal. Rather than offering a step-by-step guide to follow—something that is antithetical to good design, whether in education or architecture—the book provides a conceptual framework, many entry points, a design template, various tools and methods, and an accompanying set of design standards. We offer no specific guidance about what the content of curriculum should be—except that its priorities should center on the big ideas and important performance tasks of the chosen topic. What we provide, rather, is a way to design or redesign any curriculum to make student understanding (and desired results generally) more likely.
2. *Understanding by Design* is not a philosophy of education, nor does it require a belief in any single pedagogical system or approach. We offer guidance on how to tackle any educational design problem related to the goal of student understanding. Nowhere do we specify which "big ideas" you should embrace. Instead, we help you better focus your design work on how to achieve understanding of the important ideas that you (or established standards) target. (We do offer many examples of big ideas in various disciplines.) The book should not be seen as competing with other programs or approaches, therefore. In fact, the proposed view of understanding and the backward design process are compatible with a full range of prominent educational initiatives, including *Problem-Based Learning Across the Curriculum* (Stephen & Gallagher, 1997), Socratic seminar, *4MAT* (McCarthy, 1981), *Dimensions of Learning* (Marzano & Pickering, 1997), teaching to state content standards, Core Knowledge, the *Skillful Teacher* (Saphier & Gower, 1997), and the materials from the Project Zero team at the Harvard Graduate School of Education entitled *Teaching for Understanding* (Wiske, 1998; Blythe & Associates, 1998). In fact, over the past five years, college professors using the lecture format, Montessori teachers, and educators working in schools using the International Baccalaureate, *Success for All*, the advanced placement program, and the Coalition of Essential Schools philosophy have all used our work to improve their designs.

3. The book presents a robust approach to planning. We say little about teaching strategies per se, even though we believe that a variety of instructional approaches can develop and deepen student understanding. Regardless of particular techniques, we assume that all purposeful and effective teachers follow a cycle of plan-revise-teach-assess-reflect-adjust many times. This is a noteworthy caution because crucial redesign information will necessarily be derived from an analysis of student work and from preassessment. (See Chapter 11 on the design process.)

4. This book is primarily focused on the design of curricular units (as opposed to individual lessons or broader programs). Although we strongly recommend that individual units be grounded in the broader context of programs and courses (as discussed in Chapter 12), we deliberately restrict our attention in this book to the more nitty-gritty and teacher-friendly work of unit design. In working with thousands of teachers over the years, we have found that the unit provides a comfortable and practical entry point for this design process. Although it may seem natural to apply the UbD approach to a system of daily lesson planning, we discourage it. Individual lessons are simply too short to allow for in-depth development of big ideas, exploration of essential questions, and authentic applications. In other words, a single lesson provides too short a time frame for meeting complex goals. Of course, lesson plans should logically flow from unit plans: Lessons are typically more purposeful and connected when informed by larger unit and course designs.

5. Although teaching for in-depth understanding is a vital aim of schooling, it is, of course, only one of many. We are thus not suggesting that all teaching
and assessment be geared *at all times* toward deep and sophisticated understanding. There are clearly circumstances when this is neither feasible nor desirable: Learning the alphabet; acquiring certain technical skills, such as keyboarding; or developing the basics in foreign language do not call for in-depth understanding. In some cases, the developmental level of students will determine the extent to which conceptualization is appropriate; at other times the goals of a course or program will make in-depth understanding a lesser or tangential goal. Sometimes “familiarity” is an appropriate and sufficient goal for certain topics at certain points in time. There is neither the time nor the need to go into depth on everything, and it would be counterproductive when the goal is to convey a sense of the larger whole. The book is thus built upon a conditional premise: *If* you wish to develop greater in-depth understanding in your students, *then* the ideas and processes of *Understanding by Design* apply.

**A few helpful cautions and comments**

We offer three warnings, though, for readers willing and ready to plan and teach for understanding. First, although educators often talk about wanting to get beyond mere coverage to ensure that students really understand what they learn, you may find that what you previously thought was effective teaching for understanding really wasn’t. You may also discover that you aren’t quite as clear as you might be about what, specifically, your students should leave understanding. In fact, we predict that you will be somewhat disturbed by how hard it is to specify the understandings and what they look like in assessment, and how easy it is to lose sight of goals related to understanding in the midst of planning, teaching, and evaluating student work.

Second, though many courses of study appropriately focus on skills (such as reading, algebra, physical education, and introductory Spanish), teacher-designers may well find after reading this book that there are, indeed, big ideas essential for learning key skills with fluency—namely, understanding how to use skills *wisely*—that need greater attention in their plans. For example, a big idea in literacy development is that the meaning of the text is not in the text but between the lines, in the interaction between the active reader and the text. Getting students to understand this is not only difficult but requires a very different design and presents a very different teaching problem than that of focusing only on discrete reading strategies. The challenge is, at its core, to help students overcome the misunderstanding that reading is only decoding, and to help them know what to do when decoding alone does not yield meaning.

Third, though many teachers believe that to design for understanding is incompatible with established content standards and state testing, we think that by the time you have read the entire book, you will consider this to be false. Most state standards identify or at least imply big ideas that are meant to be understood, not merely covered. Consider these examples from Ohio’s standards for 11th grade social studies and California’s standards for physics:
Trace key Supreme Court decisions related to a provision of the Constitution (e.g., cases related to reapportionment of legislative districts, free speech, or separation of church and state).

Energy cannot be created or destroyed, although in many processes energy is transferred to the environment as heat. As a basis for understanding this concept:

a. Students know heat flow and work are two forms of energy transfer between systems.

MISCONCEPTION ALERT!

1. Only alternative or progressive methods of teaching and assessing can yield understanding. This is all about process as opposed to content. Nothing could be further from the truth. You cannot understand without subject matter knowledge. All so-called traditional approaches to learning at the college level, for example, aim at and often succeed in yielding in-depth understanding. The challenge is not to choose this or that tactic to the exclusion of others, but to expand and better target our teaching repertoire, based on a more careful consideration of what our learning goals imply. In practice, we find that all teachers, regardless of educational philosophy, are typically hemmed in by a too-limited set of design options. A challenge is to make sure that teachers use a greater variety of appropriate methods of instruction than they typically do now, regardless of their philosophy. (See Chapters 9 and 10.)

2. We are against traditional testing. Not so. Here, too, we seek to expand the normal repertoire to make sure that more appropriate diversity and validity is found in classroom assessment, based on the diversity of goals typically found in most programs. The challenge is to know which method to use when and why, and to better understand the strengths and weaknesses of each form of assessment. (See Chapters 7 and 8.)

3. We are against letter grades. Why would we be, if the grades correspond to a valid assessment of understanding? Letter grades are here to stay, by and large, and nothing in this book is incompatible with grades, transcripts, report cards, and college admission standards. On the contrary, the book should help teachers (especially those at the secondary and collegiate levels) better articulate and justify their grading system, providing students with more fair assessments, improved feedback, and greater clarity about what the grades stand for.

More generally, once you understand the elements we propose as central to good design, we expect that your approach to all your design obligations will change.

We predict that you will experience two quite different feelings as you read. At times you will say to yourself, “Well, of course, this is just common sense! This merely makes explicit what good planners have always done.” At other times you will feel that we are proposing provocative and counterintuitive ideas about teaching, learning, assessment, and planning. To help you in the latter case, we will offer sidebars about potential misunderstandings—we call them “Misconception Alerts”—in which we try to anticipate reader confusion in the lines of argument and ideas being proposed.

The presence of these particular sidebars conveys a vital message: Teaching for understanding must successfully predict potential misunderstandings and rough spots in learning if it is to be effective. Indeed, central to the design approach we propose is that we need to design lessons and assessments that anticipate, evoke, and overcome the most likely student misconceptions. The first such sidebar appears on this page.

You will also find a few sidebars entitled “Design Tips.” These will help you see how to begin to translate the theories of UbD to the practical work of planning, teaching, and assessing. We have also provided a Glossary to help you
navigate the language used throughout the book. To give you some sense of how the designer's thought process works, we follow a fictional teacher, Bob James, as he designs (and redesigns) his unit on nutrition. (The companion UbD Professional Development Workbook provides an extensive set of design tools, exercises, and examples to assist designers.)

So, reader, brace thyself! We are asking you to explore key ideas and to rethink many time-honored habits about curriculum, assessment, and instruction. Such rethinking practices what we preach. Because, as you will see, teaching for understanding requires the learner to rethink what appeared settled or obvious—whether learner refers to a young student or a veteran educator. We believe that you will find much food for thought, as well as many practical tips about how to achieve student understanding by design.
Chapter 1

Backward Design

Design, v.—To have purposes and intentions; to plan and execute

—Oxford English Dictionary

The complexity of design work is often underestimated. Many people believe they know a good deal about design. What they do not realize is how much more they need to know to do design well, with distinction, refinement, and grace.

—John McClean, "20 Considerations That Help a Project Run Smoothly," 2003

Teachers are designers. An essential act of our profession is the crafting of curriculum and learning experiences to meet specified purposes. We are also designers of assessments to diagnose student needs to guide our teaching and to enable us, our students, and others (parents and administrators) to determine whether we have achieved our goals.

Like people in other design professions, such as architecture, engineering, or graphic arts, designers in education must be mindful of their audiences. Professionals in these fields are strongly client-centered. The effectiveness of their designs corresponds to whether they have accomplished explicit goals for specific end-users. Clearly, students are our primary clients, given that the effectiveness of curriculum, assessment, and instructional designs is ultimately determined by their achievement of desired learnings. We can think of our designs, then, as software. Our courseware is designed to make learning more effective, just as computer software is intended to make its users more productive.

As in all the design professions, standards inform and shape our work. The software developer works to maximize user-friendliness and to reduce bugs that impede results. The architect is guided by building codes, customer budget, and neighborhood aesthetics. The teacher as designer is similarly constrained. We are not free to teach any topic we choose by any means. Rather, we are guided by national, state, district, or institutional standards that specify what students should know and be able to do. These standards provide a
useful framework to help us identify teaching and learning priorities and guide our design of curriculum and assessments. In addition to external standards, we must also factor in the needs of our many and varied students when designing learning experiences. For example, diverse student interests, developmental levels, large classes, and previous achievements must always shape our thinking about the learning activities, assignments, and assessments.

Yet, as the old adage reminds us, in the best designs form follows function. In other words, all the methods and materials we use are shaped by a clear conception of the vision of desired results. That means that we must be able to state with clarity what the student should understand and be able to do as a result of any plan and irrespective of any constraints we face.

You probably know the saying, “If you don’t know exactly where you are headed, then any road will get you there.” Alas, the point is a serious one in education. We are quick to say what things we like to teach, what activities we will do, and what kinds of resources we will use; but without clarifying the desired results of our teaching, how will we ever know whether our designs are appropriate or arbitrary? How will we distinguish merely interesting learning from effective learning? More pointedly, how will we ever meet content standards or arrive at hard-won student understandings unless we think through what those goals imply for the learner’s activities and achievements?

Good design, then, is not so much about gaining a few new technical skills as it is about learning to be more thoughtful and specific about our purposes and what they imply.

**Why “backward” is best**

How do these general design considerations apply to curriculum planning? Deliberate and focused instructional design requires us as teachers and curriculum writers to make an important shift in our thinking about the nature of our job. The shift involves thinking a great deal, first, about the specific learnings sought, and the evidence of such learnings, before thinking about what we, as the teacher, will do or provide in teaching and learning activities. Though considerations about what to teach and how to teach it may dominate our thinking as a matter of habit, the challenge is to focus first on the desired learnings from which appropriate teaching will logically follow.

Our lessons, units, and courses should be logically inferred from the results sought, not derived from the methods, books, and activities with which we are most comfortable. Curriculum should lay out the most effective ways of achieving specific results. It is analogous to travel planning. Our frameworks should provide a set of itineraries deliberately designed to meet cultural goals rather than a purposeless tour of all the major sites in a foreign country. In short, the best designs derive backward from the learnings sought.

The appropriateness of this approach becomes clearer when we consider the educational purpose that is the focus of this book: understanding. We cannot say how to teach for understanding or which material and activities to use
until we are quite clear about which specific understandings we are after and what such understandings look like in practice. We can best decide, as guides, what “sites” to have our student “tourists” visit and what specific “cultural” they should experience in their brief time there only if we are clear about the particular understandings about the culture we want them to take home. Only by having specified the desired results can we focus on the content, methods, and activities most likely to achieve those results.

But many teachers begin with and remain focused on textbooks, favored lessons, and time-honored activities—the inputs—rather than deriving those means from what is implied in the desired results—the output. To put it in an odd way, too many teachers focus on the teaching and not the learning. They spend most of their time thinking, first, about what they will do, what materials they will use, and what they will ask students to do rather than first considering what the learner will need in order to accomplish the learning goals.

Consider a typical episode of what might be called content-focused design instead of results-focused design. The teacher might base a lesson on a particular topic (e.g., racial prejudice), select a resource (e.g., To Kill a Mockingbird), choose specific instructional methods based on the resource and topic (e.g., Socratic seminar to discuss the book and cooperative groups to analyze stereotypical images in films and on television), and hope thereby to cause learning (and meet a few English/language arts standards). Finally, the teacher might think up a few essay questions and quizzes for assessing student understanding of the book.

This approach is so common that we may well be tempted to reply, What could be wrong with such an approach? The short answer lies in the basic questions of purpose: Why are we asking students to read this particular novel—in other words, what learnings will we seek from their having read it? Do the students grasp why and how the purpose should influence their studying? What should students be expected to understand and do upon reading the book, related to our goals beyond the book? Unless we begin our design work with a clear insight into larger purposes—whereby the book is properly thought of as a means to an educational end, not an end unto itself—It is unlikely that all students will understand the book (and their performance obligations). Without being self-conscious of the specific understandings about prejudice we seek, and how reading and discussing the book will help develop such insights, the goal is far too vague: The approach is more “by hope” than “by design.” Such an approach ends up unwittingly being one that could be described like this: Throw some content and activities against the wall and hope some of it sticks.

Answering the “why?” and “so what?” questions that older students always ask (or want to), and doing so in concrete terms as the focus of curriculum

Design Tip

Consider these questions that arise in the minds of all readers, the answers to which will frame the priorities of coached learning: How should I read the book? What am I looking for? What will we discuss? How should I prepare for those discussions? How do I know if my reading and discussions are effective? Toward what performance goals do this reading and these discussions head, so that I might focus and prioritize my studies and note taking? What big ideas, linked to other readings, are in play here? These are the students’ proper questions about the learning, not the teaching, and any good educational design answers them from the start and throughout a course of study with the use of tools and strategies such as graphic organizers and written guidelines.
planning, is thus the essence of understanding by design. What is difficult for many teachers to see (but easier for students to feel) is that, without such explicit and transparent priorities, many students find day-to-day work confusing and frustrating.

**The twin sins of traditional design**

More generally, weak educational design involves two kinds of purposelessness, visible throughout the educational world from kindergarten through graduate school, as noted in the Introduction. We call these the “twin sins” of traditional design. The error of activity-oriented design might be called “hands-on without being minds-on”—engaging experiences that lead only accidentally, if at all, to insight or achievement. The activities, though fun and interesting, do not lead anywhere intellectually. As typified by the apples vignette in the Introduction, such activity-oriented curricula lack an explicit focus on important ideas and appropriate evidence of learning, especially in the minds of the learners. They think their job is merely to engage; they are led to think the learning is the activity instead of seeing that the learning comes from being asked to consider the meaning of the activity.

A second form of aimlessness goes by the name of “coverage,” an approach in which students march through a textbook, page by page (or teachers through lecture notes) in a valiant attempt to traverse all the factual material within a prescribed time (as in the world history vignette in the Introduction). Coverage is thus like a whirlwind tour of Europe, perfectly summarized by the old movie title *If It's Tuesday, This Must Be Belgium*, which properly suggests that no overarching goals inform the tour.

As a broad generalization, the activity focus is more typical at the elementary and lower middle school levels, whereas coverage is a prevalent secondary school and college problem. Yet, though the apples and world history classrooms look quite different with lots of physical activity and chatter in the former versus lecturing and quiet note taking in the latter, the design result is the same in both cases: No guiding intellectual purpose or clear priorities frame the learning experience. In neither case can students see and answer such questions as these: What’s the point? What’s the big idea here? What does this help us understand or be able to do? To what does this relate? Why should we learn this? Hence, the students try to engage and follow as best they can, hoping that meaning will emerge.
Students will be unable to give satisfactory responses when the design does not provide them with clear purposes and explicit performance goals highlighted throughout their work. Similarly, teachers with an activity or coverage orientation are less likely to have acceptable answers to the key design questions: What should students understand as a result of the activities or the content covered? What should the experiences or lectures equip them to do? How, then, should the activities or class discussions be shaped and processed to achieve the desired results? What would be evidence that learners are on route to the desired abilities and insights? How, then, should all activities and resources be chosen and used to ensure that the learning goals are met and the most appropriate evidence produced? How, in other words, will students be helped to see by design the purpose of the activity or resource and its helpfulness in meeting specific performance goals?

We are advocating the reverse of common practice, then. We ask designers to start with a much more careful statement of the desired results—the priority learnings—and to derive the curriculum from the performances called for or implied in the goals. Then, contrary to much common practice, we ask designers to consider the following questions after framing the goals: What would count as evidence of such achievement? What does it look like to meet these goals? What, then, are the implied performances that should make up the assessment, toward which all teaching and learning should point? Only after answering these questions can we logically derive the appropriate teaching and learning experiences so that students might perform successfully to meet the standard. The shift, therefore, is away from starting with such questions as “What book will we read?” or “What activities will we do?” or “What will we discuss?” to “What should they walk out the door able to understand, regardless of what activities or texts we use?” and “What is evidence of such ability?” and, therefore, “What texts, activities, and methods will best enable such a result?” In teaching students for understanding, we must grasp the key idea that we are coaches of their ability to play the “game” of performing with understanding, not tellers of our understanding to them on the sidelines.

The three stages of backward design

We call this three-stage approach to planning “backward design.” Figure 1.1 depicts the three stages in the simplest terms.

Stage 1: Identify desired results

What should students know, understand, and be able to do? What content is worthy of understanding? What enduring understandings are desired?
In Stage 1 we consider our goals, examine established content standards (national, state, district), and review curriculum expectations. Because typically we have more content than we can reasonably address within the available time, we must make choices. This first stage in the design process calls for clarity about priorities.

**Stage 2: Determine acceptable evidence**

How will we know if students have achieved the desired results? What will we accept as evidence of student understanding and proficiency? The backward design orientation suggests that we think about a unit or course in terms of the collected assessment evidence needed to document and validate that the desired learning has been achieved, not simply as content to be covered or as a series of learning activities. This approach encourages teachers and curriculum planners to first “think like an assessor” before designing specific units and lessons, and thus to consider up front how they will determine if students have attained the desired understandings.

**Stage 3: Plan learning experiences and instruction**

With clearly identified results and appropriate evidence of understanding in mind, it is now the time to fully think through the most appropriate instructional activities. Several key questions must be considered at this stage of backward design: What enabling knowledge (facts, concepts, principles) and
skills (processes, procedures, strategies) will students need in order to perform effectively and achieve desired results? What activities will equip students with the needed knowledge and skills? What will need to be taught and coached, and how should it best be taught, in light of performance goals? What materials and resources are best suited to accomplish these goals?

Note that the specifics of instructional planning—choices about teaching methods, sequence of lessons, and resource materials—can be successfully completed only after we identify desired results and assessments and consider what they imply. Teaching is a means to an end. Having a clear goal helps to focus our planning and guide purposeful action toward the intended results.

Backward design may be thought of, in other words, as purposeful task analysis: Given a worthy task to be accomplished, how do we best get everyone equipped? Or we might think of it as building a wise itinerary, using a map: Given a destination, what’s the most effective and efficient route? Or we might think of it as planning for coaching, as suggested earlier: What must learners master if they are to effectively perform? What will count as evidence on the field, not merely in drills, that they really get it and are ready to perform with understanding, knowledge, and skill on their own? How will the learning be designed so that learners’ capacities are developed through use and feedback?

This is all quite logical when you come to understand it, but “backward” from the perspective of much habit and tradition in our field. A major change from common practice occurs as designers must begin to think about assessment before deciding what and how they will teach. Rather than creating assessments near the conclusion of a unit of study (or relying on the tests provided by textbook publishers, which may not completely or appropriately assess our standards and goals), backward design calls for us to make our goals or standards specific and concrete, in terms of assessment evidence, as we begin to plan a unit or course.

The logic of backward design applies regardless of the learning goals. For example, when starting from a state content standard, curriculum designers need to determine the appropriate assessment evidence stated or implied in the standard. Likewise, a staff developer should determine what evidence will indicate that the adults have learned the intended knowledge or skill before planning the various workshop activities.

The rubber meets the road with assessment. Three different teachers may all be working toward the same content standards, but if their assessments vary considerably, how are we to know which students have achieved what? Agreement on needed evidence of learning leads to greater curricular coherence and
more reliable evaluation by teachers. Equally important is the long-term gain in teacher, student, and parent insight about what does and does not count as evidence of meeting complex standards.

This view of focusing intently on the desired learning is hardly radical or new. Tyler (1949) described the logic of backward design clearly and succinctly more than 50 years ago:

*Educational objectives become the criteria by which materials are selected, content is outlined, instructional procedures are developed, and tests and examinations are prepared. . . .*

*The purpose of a statement of objectives is to indicate the kinds of changes in the student to be brought about so that instructional activities can be planned and developed in a way likely to attain these objectives. (pp. 1, 45)*

And in his famous book, *How to Solve It*, originally published in 1945, Polya specifically discusses “thinking backward” as a strategy in problem solving going back to the Greeks:

*There is a certain psychological difficulty in turning around, in going away from the goal, in working backwards. . . . Yet, it does not take a genius to solve a concrete problem working backwards; anyone can do it with a little common sense. We concentrate on the desired end, we visualize the final position in which we would like to be. From what foregoing position could we get there? (p. 230)*

These remarks are old. What is perhaps new is that we offer herein a helpful process, a template, a set of tools, and design standards to make the plan and resultant student performance more likely to be successful by design than by good fortune. As a 4th grade teacher from Alberta, Canada, put it, “Once I had a way of clearly defining the end in mind, the rest of the unit ‘fell into place.’”

The twin sins of activity-based and coverage-based design reflect a failure to think through purpose in this backward-design way. With this in mind, let’s revisit the two fictitious vignettes from the Introduction. In the apples vignette, the unit seems to focus on a particular theme (harvest time), through a specific and familiar object (apples). But as the depiction reveals, the unit has no real depth because there is no enduring learning for the students to derive. The work is *hands-on* without being *minds-on*, because students do not need to (and are not really challenged to) extract sophisticated ideas or connections. They don’t have to work at understanding; they need only engage in the activity. (Alas, it is common to reward students for mere engagement as opposed to understanding; engagement is necessary, but not sufficient, as an end result.)

Moreover, when you examine the apples unit it becomes clear that it has no overt priorities—the activities appear to be of equal value. The students’ role is merely to participate in mostly enjoyable activities, without having to demonstrate that they understand any big ideas at the core of the subject (excuse the pun). All activity-based—as opposed to results-based—teaching shares the weakness of the apples unit: Little in the design asks students to derive
intellectual fruit from the unit (sorry). One might characterize this activity-oriented approach as "faith in learning by osmosis." Is it likely that individual students will learn a few interesting things about apples? Of course. But, in the absence of a learning plan with clear goals, how likely is it that students will develop shared understandings on which future lessons might build? Not very.

In the world history vignette, the teacher covers vast amounts of content during the last quarter of the year. However, in his harried march to get through a textbook, he apparently does not consider what the students will understand and apply from the material. What kind of intellectual scaffolding is provided to guide students through the important ideas? How are students expected to use those ideas to make meaning of the many facts? What performance goals would help students know how to take notes for maximal effective use by the course's end? Coverage-based instruction amounts to the teacher merely talking, checking off topics, and moving on, irrespective of whether students understand or are confused. This approach might be termed "teaching by mentioning it." Coverage-oriented teaching typically relies on a textbook, allowing it to define the content and sequence of instruction. In contrast, we propose that results-oriented teaching employ the textbook as a resource but not the syllabus.

A backward design template

Having described the backward design process, we now put it together in a useful format—a template for teachers to use in the design of units that focus on understanding.

Many educators have observed that backward design is common sense. Yet when they first start to apply it, they discover that it feels unnatural. Working this way may seem a bit awkward and time-consuming until you get the hang of it. But the effort is worth it—just as the learning curve on good software is worth it. We think of Understanding by Design as software, in fact: a set of tools for making you ultimately more productive. Thus, a practical cornerstone of Understanding by Design is a design template that is meant to reinforce the appropriate habits of mind needed to complete designs for student understanding and to avoid the habits that are at the heart of the twin sins of activity-based and coverage-based design.

Figure 1.2 provides a preliminary look at the UbD Template in the form of a one-page version with key planning questions included in the various fields. This format guides the teacher to the various UbD elements while visually conveying the idea of backward design. Later chapters present a more complete account of the template and each of its fields.

Although this one-page version of the template does not allow for great detail, it has several virtues. First, it provides a gestalt, an overall view of backward design, without appearing overwhelming. Second, it enables a quick check of alignment—the extent to which the assessments (Stage 2) and learning activities (Stage 3) align with identified goals (Stage 1). Third, the template
Figure 1.2
1-Page Template with Design Questions for Teachers

### Stage 1—Desired Results

<table>
<thead>
<tr>
<th>Established Goals:</th>
</tr>
</thead>
<tbody>
<tr>
<td>What relevant goals (e.g., content standards, course or program objectives, learning outcomes) will this design address?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Understandings:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students will understand that...</td>
</tr>
<tr>
<td>What are the big ideas?</td>
</tr>
<tr>
<td>What specific understandings about them are desired?</td>
</tr>
<tr>
<td>What misunderstandings are predictable?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Essential Questions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>What provocative questions will foster inquiry, understanding, and transfer of learning?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Students will know...</th>
</tr>
</thead>
<tbody>
<tr>
<td>What key knowledge and skills will students acquire as a result of this unit?</td>
</tr>
<tr>
<td>What should they eventually be able to do as a result of such knowledge and skills?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Students will be able to...</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

### Stage 2—Assessment Evidence

<table>
<thead>
<tr>
<th>Performance Tasks:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Through what authentic performance tasks will students demonstrate the desired understandings?</td>
</tr>
<tr>
<td>By what criteria will performances of understanding be judged?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other Evidence:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Through what other evidence (e.g., quizzes, tests, academic prompts, observations, homework, journals) will students demonstrate achievement of the desired results?</td>
</tr>
<tr>
<td>How will students reflect upon and self-assess their learning?</td>
</tr>
</tbody>
</table>

### Stage 3—Learning Plan

<table>
<thead>
<tr>
<th>Learning Activities:</th>
</tr>
</thead>
<tbody>
<tr>
<td>What learning experiences and instruction will enable students to achieve the desired results? How will the design...</td>
</tr>
<tr>
<td>W = Help the students know Where the unit is going and What is expected? Help the teacher know Where the students are coming from (prior knowledge, interests)?</td>
</tr>
<tr>
<td>H = Hook all students and Hold their interest?</td>
</tr>
<tr>
<td>E = Equip students, help them Experience the key ideas and Explore the issues?</td>
</tr>
<tr>
<td>R = Provide opportunities to Rethink and Revise their understandings and work?</td>
</tr>
<tr>
<td>E = Allow students to Evaluate their work and its implications?</td>
</tr>
<tr>
<td>T = Be Tailored (personalized) to the different needs, interests, and abilities of learners?</td>
</tr>
<tr>
<td>O = Be Organized to maximize initial and sustained engagement as well as effective learning?</td>
</tr>
</tbody>
</table>

22
can be used to review existing units that teachers or districts have developed. Finally, the one-page template provides an initial design frame. We also have a multipage version that allows for more detailed planning, including, for example, a Performance Task Blueprint and a day-by-day calendar for listing and sequencing key learning events. The Understanding by Design Professional Development Workbook (McTighe & Wiggins, 2004, pp. 46–51) includes a six-page template that allows for more detailed planning.

We regularly observe that teachers begin to internalize the backward design process as they work with the UbD Template. Stage 1 asks designers to consider what they want students to understand and then to frame those understandings in terms of questions. In completing the top two sections of the Stage 1 portion of the template, users are prompted to identify the Understandings and Essential Questions to establish a larger context into which a particular unit is nested.

Stage 2 prompts the designer to consider a variety of assessment methods for gathering evidence of the desired Understandings. The two-box graphic organizer then provides spaces for specifying the particular assessments to be used during the unit. Designers need to think in terms of collected evidence, not a single test or performance task.

Stage 3 calls for a listing of the major learning activities and lessons. When it is filled in, the designer (and others) should be able to discern what we call the “WHERE TO” elements.

The form of the template offers a means to succinctly present the design unit; its function is to guide the design process. When completed, the template can be used for self-assessment, peer review, and sharing of the completed unit design with others.

To better understand the template’s benefits for the teacher-designer, let’s take a look at a completed template. Figure 1.3 shows a completed three-page version of the template for a unit on nutrition.

Notice that the template in Figure 1.3 supports backward design thinking by making the longer-term goals far more explicit than is typical in lesson planning, and we can follow those goals through Stages 2 and 3 to ensure that the design is coherent. The focus on big ideas in Stage 1 is transparent, without sacrificing the more discrete elements of knowledge and skill. Finally, by calling for appropriately different types of assessment, the template reminds us that we typically need varied evidence and assessments grounded in performance to show transfer, if understanding is our aim.

**Design standards**

Accompanying the UbD Template is a set of Design Standards corresponding to each stage of backward design. The standards offer criteria to use during development and for quality control of completed unit designs. Framed as questions, the UbD Design Standards serve curriculum designers in the same
Stage 1—Identify Desired Results

Established Goals:

Standard G—Students will understand essential concepts about nutrition and diet.
6a—Students will use an understanding of nutrition to plan appropriate diets for themselves and others.
6b—Students will understand their own individual eating patterns and ways in which those patterns may be improved.

What essential questions will be considered?

- What is healthful eating?
- Are you a healthful eater? How would you know?
- How could a healthy diet for one person be unhealthy for another?
- Why are there so many health problems in the United States caused by poor nutrition despite all the available information?

What understandings are desired?

Students will understand that...

- A balanced diet contributes to physical and mental health.
- The USDA food pyramid presents relative guidelines for nutrition.
- Dietary requirements vary for individuals based on age, activity level, weight, and overall health.
- Healthful living requires an individual to act on available information about good nutrition even if it means breaking comfortable habits.

What key knowledge and skills will students acquire as a result of this unit?

Students will know...

- Key terms—protein, fat, calorie, carbohydrate, cholesterol.
- Types of foods in each food group and their nutritional values.
- The USDA food pyramid guidelines.
- Variables influencing nutritional needs.
- General health problems caused by poor nutrition.

Students will be able to...

- Read and interpret nutrition information on food labels.
- Analyze diets for nutritional value.
- Plan balanced diets for themselves and others.
Stage 2—Determine Acceptable Evidence

What evidence will show that students understand?

Performance Tasks:

You Are What You Eat—Students create an illustrated brochure to teach younger children about the importance of good nutrition for healthful living. They offer younger students ideas for breaking bad eating habits.

Chow Down—Students develop a three-day menu for meals and snacks for an upcoming Outdoor Education camp experience. They write a letter to the camp director to explain why their menu should be selected (by showing that it meets the USDA food pyramid recommendations, yet it is tasty enough for the students). They include at least one modification for a specific dietary condition (diabetic or vegetarian) or religious consideration.

What other evidence needs to be collected in light of Stage 1 Desired Results?

Other Evidence: (e.g., tests, quizzes, prompts, work samples, observations)

Quiz—The food groups and the USDA food pyramid

Prompt—Describe two health problems that could arise as a result of poor nutrition and explain how these could be avoided.

Skill Check—Interpret nutritional information on food labels.

Student Self-Assessment and Reflection:

1. Self-assess the brochure, You Are What You Eat.
2. Self-assess the camp menu, Chow Down.
3. Reflect on the extent to which you eat healthfully at the end of unit (compared with the beginning).
Stage 3—Plan Learning Experiences

What sequence of teaching and learning experiences will equip students to engage with, develop, and demonstrate the desired understandings? Use the following sheet to list the key teaching and learning activities in sequence. Code each entry with the appropriate initials of the WHERE TO elements.

1. Begin with an entry question (Can the foods you eat cause zits?) to hook students into considering the effects of nutrition on their lives.  

2. Introduce the Essential Questions and discuss the culminating unit performance tasks (Chow Down and Eating Action Plan).  

3. Note: Key vocabulary terms are introduced as needed by the various learning activities and performance tasks. Students read and discuss relevant selections from the Health textbook to support the learning activities and tasks. As an ongoing activity, students keep a chart of their daily eating and drinking for later review and evaluation.  

4. Present concept attainment lesson on the food groups. Then have students practice categorizing pictures of foods accordingly.  

5. Introduce the Food Pyramid and identify foods in each group. Students work in groups to develop a poster of the Food Pyramid containing cut-out pictures of foods in each group. Display the posters in the classroom or hallway.  

6. Give quiz on the food groups and Food Pyramid (matching format).  

7. Review and discuss the nutrition brochure from the USDA. Discussion question: Must everyone follow the same diet to be healthy?  

8. Working in cooperative groups, students analyze a hypothetical family’s diet (deliberately unbalanced) and make recommendations for improved nutrition. Teacher observes and coaches students as they work.  

9. Have groups share their diet analyses and discuss as a class. (Note: Teacher collects and reviews the diet analyses to look for misunderstandings needing instructional attention.)  

10. Each student designs an illustrated nutrition brochure to teach younger children about the importance of good nutrition for healthy living and the problems associated with poor eating. This activity is completed outside of class.  

11. Students exchange brochures with members of their group for a peer assessment based on a criteria list. Allow students to make revisions based on feedback.  

12. Show and discuss the video, “Nutrition and You.” Discuss the health problems linked to poor eating.  

13. Students listen to, and question, a guest speaker (nutritionist from the local hospital) about health problems caused by poor nutrition.  

14. Students respond to written prompt: Describe two health problems that could arise as a result of poor nutrition and explain what changes in eating could help to avoid them. (These are collected and graded by teacher.)  

15. Teacher models how to read and interpret food label information on nutritional values. Then have students practice using donated boxes, cans, and bottles (empty).  

16. Students work independently to develop the three-day camp menu. Evaluate and give feedback on the camp menu project. Students self- and peer-assess their projects using rubrics.  

17. At the conclusion of the unit, students review their completed daily eating chart and self-assess the healthfulness of their eating. Have they noticed changes? Improvements? Do they notice changes in how they feel and their appearance?  

18. Students develop a personal “eating action plan” for healthful eating. These are saved and presented at upcoming student-involved parent conferences.  

19. Conclude the unit with student self-evaluation regarding their personal eating habits. Have each student develop a personal action plan for their “healthful eating” goal.
way that a scoring rubric serves students. When presented to students before they begin their work, the rubric provides them with a performance target by identifying the important qualities toward which they should strive. Similarly, the Design Standards specify the qualities of effective units according to the Understanding by Design framework. Figure 1.4 (p. 28) presents the four UbD Design Standards with accompanying indicators.

The standards contribute to design work in three ways:

- **As a reference point during design**—Teachers can periodically check to see, for example, if the identified understandings are truly big and enduring, or if the assessment evidence is sufficient. Like a rubric, the questions serve as reminders of important design elements to include, such as a focus on Essential Questions.

- **For use in self-assessment and peer reviews of draft designs**—Teachers and peers can use the criteria to examine their draft units to identify needed refinements, such as using the facets to dig deeper into an abstract idea.

- **For quality control of completed designs**—The standards can then be applied by independent reviewers (e.g., curriculum committees) to validate the designs before their distribution to other teachers.

Our profession rarely subjects teacher-designed units and assessments to this level of critical review. Nonetheless, we have found structured peer reviews, guided by design standards, to be enormously beneficial—both to teachers and their designs (Wiggins, 1996, 1997). Participants in peer review sessions regularly comment on the value of sharing and discussing curriculum and assessment designs with colleagues. We believe that such sessions are a powerful approach to professional development, because the conversations focus on the heart of teaching and learning.

We cannot stress enough the importance of using design standards to regularly review curriculum—existing units and courses as well as new ones being developed. It is often difficult for educators, both novice and veteran, to get in the habit of self-assessing their designs against appropriate criteria. A prevailing norm in our profession seems to be, "If I work hard on planning, it must be good." The UbD Design Standards help to break that norm by providing a means for quality control. They help us validate our curriculum's strengths, while revealing aspects that need improvement.

In addition to using the UbD Design Standards for self-assessment, the quality of the curriculum product (unit plan, performance assessment, course design) is invariably enhanced when teachers participate in a structured peer review in which they examine one another's unit designs and share feedback and suggestions for improvement. Such "critical friend" reviews provide feedback to designers, help teachers internalize the qualities of good design, and offer opportunities to see alternate design models. ("Gee, I never thought about beginning a unit with a problem. I think I'll try that in my next unit.")
Stage 1—To what extent does the design focus on the big ideas of targeted content?

Consider: Are . . .

- The targeted understandings enduring, based on transposable, big ideas at the heart of the discipline and in need of uncovery?
- The targeted understandings framed by questions that spark meaningful connections, provoke genuine inquiry and deep thought, and encourage transfer?
- The essential questions provocative, arguable, and likely to generate inquiry around the central ideas (rather than a “pat” answer)?
- Appropriate goals (e.g., content standards, benchmarks, curriculum objectives) identified?
- Valid and unit-relevant knowledge and skills identified?

Stage 2—To what extent do the assessments provide fair, valid, reliable, and sufficient measures of the desired results?

Consider: Are . . .

- Students asked to exhibit their understanding through authentic performance tasks?
- Appropriate criterion-based scoring tools used to evaluate student products and performances?
- Various appropriate assessment formats used to provide additional evidence of learning?
- The assessments used as feedback for students and teachers, as well as for evaluation?
- Students encouraged to self-assess?

Stage 3—To what extent is the learning plan effective and engaging?

Consider: Will the students . . .

- Know where they’re going (the learning goals), why the material is important (reason for learning the content), and what is required of them (unit goal, performance requirements, and evaluative criteria)?
- Be hooked—engaged in digging into the big ideas (e.g., through inquiry, research, problem solving, and experimentation)?
- Have adequate opportunities to explore and experience big ideas and receive instruction to equip them for the required performances?
- Have sufficient opportunities to rethink, rehearse, revise, and refine their work based upon timely feedback?
- Have an opportunity to evaluate their work, reflect on their learning, and set goals?

Consider: Is the learning plan . . .

- Tailored and flexible to address the interests and learning styles of all students?
- Organized and sequenced to maximize engagement and effectiveness?

Overall Design—to what extent is the entire unit coherent, with the elements of all three stages aligned?
Design tools

In addition to the design standards, we have developed and refined a comprehensive set of design tools to support teachers and curriculum developers. This is hard work. We have found that an array of scaffolds—prompts, organizers, idea sheets, and examples—help educators produce higher-quality designs. A full set of these resources is available in the *UbD Professional Development Workbook*.

We think that a good template serves as an intelligent tool. It provides more than a place to write in ideas. It focuses and guides the designer's thinking throughout the design process to make high-quality work more likely. In practice, curriculum designers work from a copy of the template, supported by specific design tools and numerous filled-in examples of good unit designs. In this way, we practice what we preach with students; models and design standards are provided up front to focus designer performance from the start.¹

But why do we refer to the template, design standards, and corresponding design tools as “intelligent”? Just as a physical tool (e.g., a telescope, an automobile, or a hearing aid) extends human capabilities, an intelligent tool enhances performance on cognitive tasks, such as the design of learning units. For example, an effective graphic organizer, such as a story map, helps students internalize the elements of a story in ways that enhance their reading and writing of stories. Likewise, by routinely using the template and design tools, users will likely develop a mental template of the key ideas presented in this book: the logic of backward design, thinking like an assessor, the facets of understanding, WHERETO, and design standards.

By embodying the Understanding by Design elements in tangible forms (i.e., the template and design tools), we seek to support educators in learning and applying these ideas. Thus, the design tools are like training wheels, providing a steadying influence during those periods of disequilibrium brought on by new ideas that may challenge established and comfortable habits. Once the key ideas of Understanding by Design are internalized, however, and regularly applied, the explicit use of the tools becomes unnecessary, just as the young bicycle rider sheds the training wheels after achieving balance and confidence.

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**MISCONCEPTION ALERT!**

Though the three stages present a logic of design, it does not follow that this is a step-by-step process in actuality. As we argue in Chapter 11, don't confuse the logic of the final product with the messy process of design work. It doesn't matter exactly where you start or how you proceed, as long as you end up with a coherent design reflecting the logic of the three stages. The final outline of a smoothly flowing college lecture rarely reflects the back-and-forth (iterative) thought process that went into its creation.

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*Backward design in action with Bob James*

**Setting:** We are inside the head of Bob James, a 6th grade teacher at Newtown Middle School, as he begins to design a three-week unit on nutrition. His ultimate
design will be the unit provided above in Figure 1.3. But Bob is new to UbD, so his design will unfold and be revised over time. Throughout the book we'll show his thinking—and rethinking—as he considers the full meaning of the template elements.

Stage 1: Identify desired results

The template asks me to highlight the goals of the unit, and for me that means drawing upon our state standards. In reviewing our standards in health, I found three content standards on nutrition that are benchmarked to this age level:

- Students will understand essential concepts about nutrition.
- Students will understand elements of a balanced diet.
- Students will understand their own eating patterns and ways in which these patterns may be improved.

Using these standards as the starting point, I need to decide what I want my students to take away from the unit. Knowledge and skill are what I have always focused on: knowledge of the food pyramid, the ability to read labels in the store and at home, and so on. Although I've never deliberately thought about understandings, per se, I like the concept and think that it will help me focus my teaching and limited class time on the truly important aspects of this unit.

As I think about it, I guess what I'm really after has something to do with an understanding of the elements of good nutrition so students can plan a balanced diet for themselves and others. The big ideas have to do with nutrition and planning meals in a feasible way. Then, the important questions are, So, what is good for you? What isn't? How do you know? What makes it difficult to know and to eat right? (The good taste of junk food makes it difficult!)

This idea is clearly important, because planning nutritious menus is an authentic, lifelong need and a way to apply this knowledge. I'm still a little unclear about what "an understanding" means, though, in this context. I'll need to reflect further on what an understanding is and how it goes beyond specific knowledge and its use. The basic concepts of nutrition are fairly straightforward, after all, as are the skills of menu planning. Does anything in the unit require, then, any in-depth and deliberate uncoverage? Are there typical misunderstandings, for example, that I should more deliberately focus on?

Well, as I think about it, I have found that many students harbor the two misconceptions that if food is good for you, it must taste bad; and if it is sold in famous and popular places, it must be okay. One of my goals in this unit is to dispel these myths so that the students won't have an automatic aversion to healthy food and unwittingly eat too much unhealthy stuff. In terms of the potential for engagement—no problem there. Anything having to do with food is a winner with 10- and 11-year-olds. And there are some points to menu planning (such as balancing cost, variety, taste, and dietary needs) that are not at all obvious. This way of thinking about the unit will enable me to better focus on these points.
Stage 2: Determine acceptable evidence

This will be a bit of a stretch for me. Typically in a three- or four-week unit like this one, I give one or two quizzes; have a project, which I grade; and conclude with a unit test (generally multiple choice or matching). Even though this approach to assessment makes grading and justifying the grades fairly easy, I have always felt a bit uneasy that these assessments don’t reflect the point of the unit and that the project grade sometimes has less to do with the key ideas and more to do with effort. I think I tend to test what is easy to test instead of assessing for my deeper goals, above and beyond nutritional facts. In fact, one thing that has always disturbed me is that the kids tend to focus on their grades rather than on their learning. Perhaps the way I’ve used the assessments—more for grading purposes than to help shape and document learning—has contributed somewhat to their attitude.

Now I need to think about what would serve as evidence of the ideas I’m focusing on. After reviewing some examples of performance tasks and discussing “application” ideas with my colleagues, I have decided tentatively on the following task:

Because we have been learning about nutrition, the camp director at the outdoor education center has asked us to propose a nutritionally balanced menu for our three-day trip to the center later this year. Using the food pyramid guidelines and the nutrition facts on food labels, design a plan for three days, including three meals and three snacks (a.m., p.m., and campfire). Your goal: a tasty and nutritionally balanced menu.

I’m excited about this idea because it asks students to demonstrate what I really want them to take away from the unit. This task also links well with one of our unit projects: to analyze a hypothetical family’s diet for a week and propose ways to improve their nutrition. With this task and project in mind, I can now use my quizzes to check students’ knowledge of the food groups and food pyramid recommendations, and a lengthier test to check for their understanding of how a nutritionally deficient diet contributes to health problems. Hey! This is one of the better assessment plans I have designed for a unit, and I think that the task will motivate students as well as provide evidence of their understanding.

Stage 3: Plan learning experiences and instruction

This is my favorite part of planning—deciding what activities the students will do during the unit and what resources and materials we’ll need for those activities. But according to what I’m learning about backward design, I’ll need to think first about what essential knowledge and skills my students will need if they’re going to be able to demonstrate in performance the understandings I’m after.

Well, they’ll need to know about the different food groups and the types of foods found in each group so that they’ll understand the USDA food pyramid
recommendations. They'll also need to know about human nutritional needs for carbohydrates, protein, sugar, fat, salt, vitamins, and minerals, and about the various foods that provide them. They'll have to learn about the minimum daily requirements for these nutritional elements and about various health problems that arise from poor nutrition. In terms of skills, they'll have to learn how to read and interpret the nutrition-fact labels on foods and how to scale a recipe up or down, because these skills are necessary for their culminating project—planning healthy menus for camp.

Now for the learning experiences, I'll use resources that I've collected during the past several years—a pamphlet from the USDA on the food groups and the food pyramid recommendations; a wonderful video, "Nutrition for You"; and, of course, our health textbook (which I now plan to use selectively). As I have for the past three years, I'll invite the nutritionist from the local hospital to talk about diet and health and how to plan healthy menus. I've noticed that the kids really pay attention to a real-life user of information they're learning.

My teaching methods will follow my basic pattern—a blend of direct instruction, inductive methods, cooperative-learning group work, and individual activities.

Planning backward to produce this new draft has been helpful. I now can more clearly see and state what knowledge and skills are essential, given my goals for the unit. I'll be able to concentrate on the more important aspects of the topic (and relieve some guilt that I'm not covering everything). It's also interesting to realize that even though some sections of the textbook chapters on nutrition will be especially useful (for instance, the descriptions of health problems arising from poor nutrition), other sections are not as informative as other resources I'll now use (the brochure and the video). In terms of assessment, I now know more clearly what I need to assess using traditional quizzes and tests, and why the performance task and project are needed—to have students demonstrate their understanding. I'm getting a feel for backward design.

**Comments on the design process**

Notice that the process of developing this draft nutrition unit reveals four key aspects of backward design:

1. The assessments—the performance tasks and related sources of evidence—are thought through prior to the lessons being fully developed. The assessments serve as teaching targets for sharpening the focus of instruction and editing the past lesson plans, because they define in very specific terms what we want students to understand and be able to do. The teaching is then thought of as enabling performance. These assessments also guide decisions about what content needs to be emphasized versus that which is not really essential.
2. It is likely that familiar and favorite activities and projects will have to be further modified in light of the evidence needed for assessing targeted standards. For instance, if the apples unit described in the Introduction were planned using this backward design process, we would expect to see revisions in some of the activities to better support the desired results.

3. The teaching methods and resource materials are chosen last, with the teacher keeping in mind the work that students must produce to meet the standards. For example, rather than focusing on cooperative learning because it’s a popular strategy, the question from a backward-design perspective becomes: What instructional strategies will be most effective in helping us reach our targets? Cooperative learning may or may not be the best approach, given the particular students and standards.

4. The role of the textbook may shift from being the primary resource to being a support. Indeed, the 6th grade teacher planning the nutrition unit realized the limitations of relying on the text if he is to meet his goals. Given other valuable resources (the USDA materials, the video, and the nutritionist), he no longer felt compelled to cover the book word for word.

This introductory look is intended to present a preliminary sketch of the big picture of a design approach. Bob James will be refining his unit plan (and changing his thinking a few times) as he gains greater insight into understanding, essential questions, valid assessment, and the related learning activities.

**A preview**

Figure 1.5 presents the key elements of the UbD approach and thus an outline of points to come in the book. In the following chapters we “uncover” this design process, examining its implications for the development and use of assessments, the planning and organization of curriculum, and the selection of powerful methods of teaching. But a few explanatory points about each column in Figure 1.5 are appropriate to prepare you for what is to come throughout the book.

The chart is best read from left to right, one row at a time, to see how the three stages of design might look in practice. An outline of the three-stage design process for each of the three basic elements (the desired results, the assessment evidence, and the learning plan) is highlighted in the column headings. Begin with a key design question; ponder how to narrow the possibilities through intelligent priorities (Design Considerations); self-assess, self-adjust, and finally critique each element of design against appropriate criteria (Filters); and end up with a product that meets appropriate design standards in light of the achievement target (What the Final Design Accomplishes).

In summary, backward design yields greater coherence among desired results, key performances, and teaching and learning experiences, resulting in better student performance—the purpose of design.
### Figure 1.5

#### The UbD Design Matrix

<table>
<thead>
<tr>
<th>Key Design Questions</th>
<th>Chapters of the Book</th>
<th>Design Considerations</th>
<th>Filters (Design Criteria)</th>
<th>What the Final Design Accomplishes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stage 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What are worthy and</td>
<td>Chapter 3—Gaining</td>
<td>National standards</td>
<td>Focused on big ideas and</td>
<td>Unit framed around enduring</td>
</tr>
<tr>
<td>appropriate results?</td>
<td>clarity on our goals</td>
<td>State standards</td>
<td>core challenges</td>
<td>understandings and essential</td>
</tr>
<tr>
<td>What are the key</td>
<td>Chapter 4—the six</td>
<td>Local standards</td>
<td></td>
<td>questions, in relation to clear</td>
</tr>
<tr>
<td>desired learnings?</td>
<td>facets of</td>
<td>Regional topic</td>
<td></td>
<td>goals and standards</td>
</tr>
<tr>
<td></td>
<td>understanding</td>
<td>opportunities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>What should students</td>
<td>Chapter 5—essential</td>
<td>Teacher expertise</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>questions: doorways</td>
<td>and interest</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>to understanding</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Chapter 6—crafting</td>
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<td></td>
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<tr>
<td></td>
<td>understandings</td>
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<tr>
<td><strong>Stage 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What is evidence of</td>
<td>Chapter 7—thinking</td>
<td>Six facets of</td>
<td>Valid</td>
<td>Unit anchored in credible and</td>
</tr>
<tr>
<td>the desired results?</td>
<td>like an assessor</td>
<td>understanding</td>
<td>Reliable</td>
<td>useful evidence of the</td>
</tr>
<tr>
<td></td>
<td>Chapter 8—criteria</td>
<td>Continuum of</td>
<td>Sufficient</td>
<td>desired results</td>
</tr>
<tr>
<td></td>
<td>and validity</td>
<td>assessment types</td>
<td></td>
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<tr>
<td><strong>Stage 3</strong></td>
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<td>Engaging and effective,</td>
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<td>What learning</td>
<td>Chapter 9—planning</td>
<td>Research-based</td>
<td>using the elements of</td>
<td>Coherent learning activities</td>
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<td>activities and</td>
<td>for learning</td>
<td>repertoire of learning</td>
<td>WHERE TO:</td>
<td>and teaching that will</td>
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<td>teaching promote</td>
<td>Chapter 10—teaching</td>
<td>and teaching</td>
<td>Where is it going?</td>
<td>evoke and develop the</td>
</tr>
<tr>
<td>understanding,</td>
<td>for understanding</td>
<td>strategies</td>
<td>Hook the students</td>
<td>desired understandings,</td>
</tr>
<tr>
<td>knowledge, skill,</td>
<td></td>
<td></td>
<td>Explore and equip</td>
<td>knowledge, and skill;</td>
</tr>
<tr>
<td>student interest,</td>
<td></td>
<td></td>
<td>Rethink and revise</td>
<td>promote interest; and</td>
</tr>
<tr>
<td>and excellence?</td>
<td></td>
<td></td>
<td>Exhibit and evaluate</td>
<td>make excellent</td>
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<td></td>
<td></td>
<td></td>
<td>Tailor to student needs,</td>
<td>performance more likely</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>interests, and styles</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Organize for maximum</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>engagement and effectiveness</td>
<td></td>
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</tbody>
</table>
Chapter 2

Understanding Understanding

The most characteristic thing about mental life, over and beyond the fact that one apprehends the events of the world around one, is that one constantly goes beyond the information given.
—Jerome Bruner, Beyond the Information Given, 1957, p. 218

*Education*, That which discloses to the wise and disguises from the foolish their lack of understanding.

This book explores two different but related ideas: design and understanding. In the previous chapter we explored good design in general and what the template specifically calls for. But before we can go into depth about the template, we need to step back and consider the other strand of the book—understanding. Bob James was a bit confused about “understandings.” His confusion turns out to be a fairly common problem. When we ask designers in workshops to identify desired understandings and thus to distinguish between desired “knowledge” and “understanding,” they are often puzzled. What’s the difference? What is understanding? And so we pause to consider a question that turns out to be essential: How well do we understand understanding? What is it we are after when we say we want students to understand this or that? Until now, we have written about understanding as if we fully understood what we were after. But as we shall see, the irony is that though we all claim as teachers to seek student understanding of the content, we may not adequately understand this goal. This may seem like an odd claim. Teachers knowingly aim for understanding every day, don’t they? How can we not know what we are aiming for? Yet plenty of evidence suggests that “to understand” and “to teach for understanding” are ambiguous and slippery terms.

We see some of this conceptual uncertainty in the *Taxonomy of Educational Objectives: Cognitive Domain*. The book was written in 1956 by Benjamin Bloom and his colleagues to classify and clarify the range of possible intellectual objectives, from the cognitively easy to the difficult; it was meant to classify
degrees of understanding, in effect. As the authors often note, the writing of the book was driven by persistent problems in testing: Just how should educational objectives or teacher goals be measured in light of the fact that there was (and is) no clear meaning of, or agreement about the meaning of, objectives such as “critical grasp of” and “thorough knowledge of”—phrases that have to be used by test developers?

In the introduction to the Taxonomy, Bloom (1956) and his colleagues refer to understanding as a commonly sought but ill-defined objective:

For example, some teachers believe their students should “really understand,” others desire their students to “internalize knowledge,” still others want their students to “grasp the core or essence.” Do they all mean the same thing? Specifically, what does a student do who “really understands” which he does not do when he does not understand? Through reference to the Taxonomy . . . teachers should be able to define such nebulous terms. (p. 1)

Recall that when our health teacher, Bob James, was thinking about his nutrition unit (see Chapter 1), he seemed unsure about what an understanding was and how it differed from knowledge. In fact, two generations of curriculum writers have been warned to avoid the term understand in their frameworks as a result of the cautions in the Taxonomy. For example, in the Benchmarks for Science Literacy from the American Association for the Advancement of Science (AAAS), the authors succinctly describe the problem they faced in framing benchmarks for science teaching and assessing:

Benchmarks uses “know” and “know how” to lead into each set of benchmarks. The alternative would have been to use a finely graded series of verbs, including “recognize, be familiar with, appreciate, grasp, know, comprehend, understand,” and others, each implying a somewhat greater degree of sophistication and completeness than the one before. The problem with the graded series is that different readers have different opinions of what the proper order is. (1993, p. 312)

Yet the idea of understanding is surely distinct from the idea of knowing something. We frequently say things like, “Well, he knows a lot of math, but he doesn’t really understand its basis,” or, “She knows the meaning of the words but doesn’t understand the sentence.” A further indication is that, 50 years after Bloom, many state standards now specify understandings separate from knowledge. Consider these examples from the California standards in science, which make the distinction explicit, with knowledge subsumed under the broader understanding:

Newton’s laws predict the motion of most objects. As a basis for understanding this concept:

a. Students know how to solve problems that involve constant speed and average speed.

b. Students know that when forces are balanced, no acceleration occurs; thus an object continues to move at a constant speed or stays at rest (Newton’s first law).
c. Students know how to apply the law \( F = ma \) to solve one-dimensional motion problems that involve constant forces (Newton’s second law).

d. Students know that when one object exerts a force on a second object, the second object always exerts a force of equal magnitude and in the opposite direction (Newton’s third law). . . .

Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop their own questions and perform investigations. Students will:

a. Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.

b. Identify and communicate sources of unavoidable experimental error.

c. Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions. . . .

Although we might quibble as to whether the statement “Scientific progress is made by asking meaningful questions and conducting careful investigations” is a concept, the implication of the standard is clear enough: An understanding is a mental construct, an abstraction made by the human mind to make sense of many distinct pieces of knowledge. The standard further suggests that if students understand, then they can provide evidence of that understanding by showing that they know and can do certain specific things.

**Understanding as meaningful inferences**

But how are understanding and knowledge related? The standard still leaves the relationship murky in the phrase “As a basis for understanding this concept . . .” Is understanding simply a more complex form of knowledge, or is it something separate from but related to content knowledge?

Making matters worse is our tendency to use the terms know, know how, and understand interchangeably in everyday speech. Many of us would say that we “know” that Newton’s Laws predict the motion of objects. And we may say we “know how” to fix our car and “understand” how to fix our car as if the two statements expressed the same idea. Our usage has a developmental aspect, too: What we once struggled to “understand” we say we now “know.” The implication is that something that once required a chain of reasoning to grasp hold of no longer does: We just “see it.”

Mindful of our tendency to use the words understand and know interchangeably, what worthy conceptual distinctions should we safeguard in talking about the difference between knowledge and understanding? Figure 2.1 presents some useful distinctions between the terms.

John Dewey (1933) summarized the idea most clearly in *How We Think*. Understanding is the result of facts acquiring meaning for the learner:
Figure 2.1
Knowledge Versus Understanding

<table>
<thead>
<tr>
<th>Knowledge</th>
<th>Understanding</th>
</tr>
</thead>
<tbody>
<tr>
<td>The facts</td>
<td>The meaning of the facts</td>
</tr>
<tr>
<td>A body of coherent facts</td>
<td>The “theory” that provides coherence and meaning to those facts</td>
</tr>
<tr>
<td>Verifiable claims</td>
<td>Fallible, in-process theories</td>
</tr>
<tr>
<td>Right or wrong</td>
<td>A matter of degree or sophistication</td>
</tr>
<tr>
<td>I know something to be true</td>
<td>I understand why it is, what makes it knowledge</td>
</tr>
<tr>
<td>I respond on cue with what I know</td>
<td>I judge when to and when not to use what I know</td>
</tr>
</tbody>
</table>

To grasp the meaning of a thing, an event, or a situation is to see it in its relations to other things: to see how it operates or functions, what consequences follow from it, what causes it, what uses it can be put to. In contrast, what we have called the brute thing, the thing without meaning to us, is something whose relations are not grasped. . . . The relation of means-consequence is the center and heart of all understanding. (pp. 137, 146)

Consider an analogy to highlight these similarities and differences: tiling a floor with only black and white tiles. All our factual knowledge is found in the tiles. Each tile has definite traits that can be identified with relative precision and without much argument. Each tile is a fact. An understanding is a pattern visible across many tiles. There are many different patterns, some of them encompassing many or few tiles. Aha! Suddenly we see that small patterns can be grouped into sets of larger patterns—that was not apparent to us at first. And you may see the patterns differently than we do, so we argue about which is the “best” way to describe what we see. The pattern is not really “there” in an important sense, then. We infer it; we project it onto the tiles. The person laying the tiles merely positioned a black one next to a white one; he need not have had any pattern in mind: We may be the first to have seen it.

Let’s move the analogy closer to intellectual life. The words on the page are the “facts” of a story. We can look up each word in the dictionary and say we know it. But the meaning of the story remains open for discussion and argument. The “facts” of any story are the agreed-upon details; the understanding of the story is what we mean by the phrase “reading between the lines.” (The author may not have “meant” what we can insightfully “infer”—just as in the tiling example; this is one of the debates in modern literary criticism—which view, if any, is privileged.) A well-known example from literacy studies makes the point elegantly:

First you arrange things into groups. Of course one pile may be enough, depending on how much there is to do; but some things definitely need to be
separated from the others. A mistake here can be expensive; it is better to do too few things at once than too many. The procedure does not take long: when it is finished, you arrange the things into different groups again, so that they can be put away where they belong. (Bransford & Johnson, 1972, in Chapman, 1993, p. 6)

As a writer referring to this passage notes in a book on critical reading skills, There is a point which varies depending on the individual reader, at which readers who monitor their own understanding realize that they are not “getting it” even though they know the meanings of all the words, the individual sentences make sense, and there is a coherent sequence of events. . . . At that point, critical readers who want to understand typically slow down, sharpen their attention, and try different reading strategies. (Chapman, 1993, p. 7)

The first passage is a vague account of doing laundry. More generally, the goal in understanding is to take whatever you are given to produce or find something of significance—to use what we have in memory but to go beyond the facts and approaches to use them mindfully. By contrast, when we want students to “know” the key events of medieval history, to be effective touch typists, or to be competent players of specific musical pieces, the focus is on a set of facts, skills, and procedures that must be “learned by heart”—a revealing phrase!

Understanding thus involves meeting a challenge for thought. We encounter a mental problem, an experience with puzzling or no meaning. We use judgment to draw upon our repertoire of skill and knowledge to solve it. As Bloom (1956) put it, understanding is the ability to marshal skills and facts wisely and appropriately, through effective application, analysis, synthesis, and evaluation. Doing something correctly, therefore, is not, by itself, evidence of understanding. It might have been an accident or done by rote. To understand is to have done it in the right way, often reflected in being able to explain why a particular skill, approach, or body of knowledge is or is not appropriate in a particular situation.

**Understanding as transferability**

It would be impossible to over-estimate the educational importance of arriving at conceptions: that is, meanings that are general because applicable in a great variety of different instances in spite of their difference. . . . They are known points of reference by which we get our bearings when we are plunged into the strange and unknown. . . . Without this conceptualizing, nothing is gained that can be carried over to the better understanding of new experiences.


Baking without an understanding of the ingredients and how they work is like baking blindfold[ed] . . . sometimes everything works. But when it doesn’t you have to guess at how to change it. . . . It is this understanding which enables me to both creative and successful.

To know *which* fact to use *when* requires more than another fact. It requires understanding—insight into essentials, purpose, audience, strategy, and tactics. Drill and direct instruction can develop discrete skills and facts into automaticity (knowing "by heart"), but they cannot make us truly able.

Understanding is about *transfer*, in other words. To be truly able requires the ability to transfer what we have learned to new and sometimes confusing settings. The ability to transfer our knowledge and skill effectively involves the capacity to take what we know and use it creatively, flexibly, fluently, in different settings or problems, on our own. Transferability is not mere plugging in of previously learned knowledge and skill. In Bruner's famous phrase, understanding is about "going beyond the information given"; we can create new knowledge and arrive at further understandings if we have learned with understanding some key ideas and strategies.

What is transfer, and why does it matter? We are expected to take what we learned in one lesson and be able to apply it to other, related but different situations. Developing the ability to transfer one's learning is key to a good education (see Bransford, Brown, & Cocking, 2000, pp. 51ff). It is an essential ability because teachers can only help students learn a relatively small number of ideas, examples, facts, and skills in the entire field of study; so we need to help them transfer their inherently limited learning to many other settings, issues, and problems.

Consider a simple example from sports. When we grasp the idea that on defense we need to close up available space for the offense, we can use that understanding to adapt to almost any move members of the other team make, not just be limited to the one or two positionings we were taught in a three-on-three drill. We can handle entire classes of offensive problems, not just familiar instances. Failure to grasp and apply this idea in context is costly:

"When I got the ball in midfield and I started dribbling," said Lavrinenko, the [NCAA men's soccer] championship tournament's outstanding offensive player, "I was looking to pass right away. But my teammates opened up space, and I continued running. When I played the ball to Alexei, 2 players went to him and opened up more space for me." (New York Times, December 13, 1999, sec. D, p. 2)

And because the big idea of "constraining offensive space" *transfers* across sports, it is equally applicable in soccer, basketball, hockey, water polo, football, and lacrosse. The same is true in math or reading: To get beyond mere rote learning and recall, we have to be taught and be assessed on an ability to see patterns, so that we come to see many "new" problems we encounter as variants of problems and techniques we are familiar with. That requires an education in how to problem solve using big ideas and transferable strategies, not merely how to plug in specific facts or formulas.

Big ideas are essential because they provide the basis for the transfer. You must learn that a single strategy underlies all possible combinations of specific moves and settings, for example. The strategy is to get someone on your team open, using various moves and fakes—regardless of what the other team does
or whether it looks exactly like what you did in practice. In academics, you must learn to transfer intellectual knowledge and skill:

Transfer is affected by the degree to which people learn with understanding rather than merely memorize sets of facts or follow a fixed set of procedures. . . . Attempts to cover too many topics too quickly may hinder learning and subsequent transfer. (Transtford, Brown, & Cocking, 2000, pp. 55, 58)

This is an old idea, famously framed by Whitehead (1929) almost 100 years ago in his complaint about “inert ideas” in education:

In training a child to activity of thought, above all things we must beware of what I will call “inert ideas”—that is to say, ideas that are merely received into the mind without being utilized or tested, or thrown into fresh combinations. . . . Education with inert ideas is not only useless: it is above all things, harmful. . . . Let the main ideas which are introduced be few and important, and let them be thrown into every combination possible. (pp. 1–2)

In reading, we may not have previously read this book by this author, but if we understand “reading” and “romantic poetry,” we transfer our prior knowledge and skill without much difficulty. If we learned to read by repeated drill and memorization only, and by thinking of reading as only decoding, making sense of a new book can be a monumental challenge. The same is true for advanced readers at the college level, by the way. If we learned to “read” a philosophy text by a literal reading, supplemented by what the professor said about it, and if we have not learned to actively ask and answer questions of meaning as we read, reading the next book will be no easier. (For more on this topic, see Adler and Van Doren, 1940.)

Transfer is the essence of what Bloom and his colleagues meant by application. The challenge is not to “plug in” what was learned, from memory, but modify, adjust, and adapt an (inherently general) idea to the particulars of a situation:

Students should not be able to solve the new problems and situations merely by remembering the solution to or the precise method of solving a similar problem in class. It is not a new problem or situation if it is exactly like the others solved in class except that new quantities or symbols are used. . . . It is a new problem or situation if the student has not been given instruction or help on a given problem and must do some of the following: . . . 1. The statement of the problem must be modified in some way before it can be attacked. . . . 2. The statement of the problem must be put in the form of some model before the student can bring the generalizations previously learned to bear on it. . . . 3. The statement of the problem requires the student to search through memory for relevant generalizations. (Bloom, Madaus, & Hastings, 1981, p. 233)

Knowledge and skill, then, are necessary elements of understanding, but not sufficient in themselves. Understanding requires more: the ability to thoughtfully and actively “do” the work with discernment, as well as the ability to self-assess, justify, and critique such “doings.” Transfer involves figuring out which knowledge and skill matters here and often adapting what we know to address the challenge at hand.
Here's an amusing transfer task to illustrate the point one more time. See if you can use your knowledge of French pronunciation and English rhymes to “translate” the following song. Say it out loud, at a normal speaking speed:

Oh, Anne, doux
But, Cueilles ma chou.

Trille fort,
Chatte dort.

Faveux Sikhs,
Pie coupe Styx.

Sève nette,
Les dèmes se traitent.

N'a ne d'haine,
Écoute, lée daine!

All of the cases we’ve discussed here illustrate the importance of confronting students with a real problem for thought if understanding is to be called for and awakened. This is very different from giving students lessons and tests that merely require taking in and recalling from memory, based on highly cued exercises in which learners simply plug in what is unambiguously required. (See Chapters 6 through 8 for further discussions on crafting understandings and meaningful assessments.)

The failure of even our best students to transfer their learning is evident in many areas but is most striking in mathematics. Consider the following examples of test items, all of which are testing the same idea (in each case, approximately two-thirds of the tested students did not correctly answer the question):

From the New York State Regents Exam:
To get from his high school to his home, Jamal travels 5.0 miles east and then 4.0 miles north. When Sheila goes to her home from the same high school, she travels 8.0 miles east and 2.0 miles south. What is the measure of the shortest distance, to the nearest tenth of a mile, between Jamal's home and Sheila's home? (The use of the accompanying grid is optional.)

From the NAEP 12th grade mathematics test:
What is the distance between the points (2,10) and (-4, 2) in the xy plane?

- [ ] 6
- [ ] 8
- [ ] 10
- [ ] 14
- [ ] 18

From a Boston Globe article on the Massachusetts MCAS 10th grade math scores:
The hardest question on the math section, which just 33 percent got right, asked students to calculate the distance between two points. It was a cinch—if students knew that they could plot the points and use the Pythagorean
theorem, a well-known formula to calculate the hypotenuse of a right triangle if the lengths of two legs are given. The sixth-hardest math question, which only 41 percent of students got right, also required use of the Pythagorean theorem. "It seems applying the Pythagorean theorem was a weakness for kids," said William Kendall, director of math for the Braintree public schools. "These weren't straightforward Pythagorean theorem questions. They had to do a little bit more." (Vaishnav, 2003)

All three problems require students to transfer their understanding of the Pythagorean theorem to a new situation. It is likely that most students in the United States could not do it, despite the fact that every set of state standards identifies a grasp of the Pythagorean theorem as a key desired result.

We can apply our understanding to this news without too much difficulty, based on what has been said thus far. We surmise that the \( A^2 + B^2 = C^2 \) theorem is taught as a fact, a rule for making certain calculations when confronted with a known right triangle and simple tasks. Remove a few blatant cues, however, and students cannot transfer their learning to perform with understanding. Is it any wonder, then, that students do not understand what they supposedly know? And what few educators seem to realize, therefore, is that drilling students for state tests is a failing strategy.

**Understanding as a noun**

Note again that the word understand(ing) has a verb meaning and a noun meaning. To understand a topic or subject is to be able to use (or "apply," in Bloom's sense) knowledge and skill wisely and effectively. An understanding is the successful result of trying to understand—the resultant grasp of an unobvious idea, an inference that makes meaning of many discrete (and perhaps seemingly insignificant) elements of knowledge.

A genuine understanding involves another kind of transfer. We go beyond what we see, using big ideas, to make meaning of it, as Dewey noted in the quotation from *How We Think* cited earlier. "Oh, that's just like what we saw when the pioneers headed west!" a student excitedly realizes, when considering 20th-century immigration. That's the kind of transfer we seek! The challenge is to make it more likely by design rather than by luck or by natural disposition. With deliberate and explicit instruction in how to transfer (and assessments that constantly demand such transfer), the learner must take what were initially bits of knowledge with no clear structure or power and come to see them as part of a larger, more meaningful, and more useful system. Without lessons designed to bring ideas to life, concepts such as honor, manifest destiny, or the water cycle remain empty phrases to be memorized, depriving learners of the realization that ideas have power.

Here is a link, then, between the discussion in Chapter 1 on priorities in design and the specific goal of student understanding. Designing around big
ideas makes learning more effective and efficient. As the authors of *How People Learn* note,

*Teaching specific topics or skills without making clear their context in the broader fundamental structure of a field of knowledge is uneconomical. . . . An understanding of fundamental principles and ideas appears to be the main road to adequate transfer of training. To understand something as a specific instance of a more general case—which is what understanding a more fundamental structure means—is to have learned not only a specific thing but also a model for understanding other things like it that one may encounter.* (Bransford, Brown, & Cocking, 2000, pp. 25, 31)

Transfer must be the aim of all teaching in school—it is not an option—because when we teach, we can address only a relatively small sample of the entire subject matter. All teachers have said to themselves after a lesson, “Oh, if we only had more time! This is just a drop in the bucket.” We can never have enough time. Transfer is our great and difficult mission because we need to put students in a position to learn far more, on their own, than they can ever learn from us.

Paradoxically, transfer heads in the opposite direction from “new” knowledge. An education for understanding asks us to more closely examine prior knowledge and the assumptions by which we claim something to be knowledge. Socrates is the model here. He questioned knowledge claims in order to understand and learn far more. When we are helped to ask certain questions—Why is that so? Why do we think that? What justifies such a view? What’s the evidence? What’s the argument? What is being assumed?—we learn a different kind of powerful transfer: the ability to grasp what makes knowledge knowledge rather than mere belief, hence putting us in a far better position to increase our knowledge and understanding.

**The Expert Blind Spot**

*Teaching specific topics or skills without making clear their context in the broader fundamental structure of a field of knowledge is uneconomical.*


Understanding the importance of transfer can help us make sense, then, of those educators, like Bruner, who claim that typical coverage is “uneconomical.” How can he say this? It seems so manifestly false: Teaching for understanding is perhaps more effective, but how can it possibly be more efficient? Can’t we address far more content through didactic teaching and textbook coverage than we can by setting up inquiry-based work to help students come to deeper understanding of the material on their own?

But this confuses the *teaching* with the *learning*. Consider Bruner’s three reasons for why a traditional coverage approach is uneconomical in the long run:
Such teaching makes it exceedingly difficult for the student to generalize from what he has learned to what he will encounter later. In the second place, such learning . . . has little reward in terms of intellectual excitement. . . . Third, knowledge one has acquired without sufficient structure to tie it together is knowledge that is likely to be forgotten. An unconnected set of facts has a pitifully short half-life in memory. (Bruner, 1960, p. 31)

In other words, we as educators fail to understand understanding when we think that coverage works. What we call the Expert Blind Spot is hard at work, causing us to confuse what we (or textbook authors) talk about with the active meaning-making required by the learner to grasp and use meaning. This habitual response by so many of us amounts to saying, “If I cover it clearly, they will ‘get it’ and be able to call upon it in the future. The more I cover, therefore, the more they will learn, and the better they’ll do on the tests.”

What we hope you see by the book’s end, however, is that this widely held assumption is false; the “yield” from coverage is quite low for most students:

More than 30 years ago, medical educators conducted a study on what first-year medical students remembered of the thousands of new terms that they’d memorized in their first-year gross anatomy course. They were tested and retested over time. The curve that matched most closely to their forgetting of gross anatomy was the same shape as discovered in Ebbinghaus’s classic study of memory for nonsense syllables a century ago. The publication of data like these made a mark in the world of medical education. The teaching of anatomy has since changed radically in schools of medicine. (Shulman, 1999, p. 13 [emphasis added])

To cover everything is like quickly talking through a connect-the-dots puzzle in which the teacher further confuses students into thinking that understandings are merely more dots to be added to the page, thereby causing the picture to be even less clear and more confusing than it might be. Coverage leaves students with no sense of the whole that seems so obvious to the expert—all but the few most able students will get lost, and perhaps alienated.

Teachers do not optimize performance, even on external tests, by covering everything superficially. Students end up forgetting or misunderstanding far more than is necessary, so that reteaching is needed throughout the school experience. (How often have you said to your students, “My goodness, didn’t they teach you that in grade X?”) So we end up with what we see in so many schools (as verified by NAEP test results): Students in general can do low-level tasks but are universally weak in higher-order work that requires transfer.

The research on learning (considered in greater detail in Chapter 13) merely supports the sobering truth of common sense: If learning is to endure in a flexible, adaptable way for future use, coverage cannot work. It leaves us with only easily confused or easily forgotten facts, definitions, and formulas to plug into rigid questions that look just like the ones covered. Furthermore, we have thereby made it far more difficult for students to learn the “same” things in more sophisticated and fluent ways later. They will be completely puzzled by and often resistant to the need to rethink earlier knowledge. In short, as Lee
Shulman, president of the Carnegie Center for the Advancement of Teaching, put it so well, conventional teaching abets the three “pathologies of mislearning: we forget, we don’t understand that we misunderstand, and we are unable to use what we learned. I have dubbed these conditions amnesia, fantasia, and inertia” (Shulman, 1999, p. 12).

Our analysis thus far suggests, then, the need for three types of “uncover- age” in designing and teaching for understanding to avoid forgetfulness, misconceptions, and lack of transfer:

- Uncovering students’ potential misunderstandings (through focused questions, feedback, diagnostic assessment)
- Uncovering the questions, issues, assumptions, and gray areas lurking underneath the black and white of surface accounts
- Uncovering the core ideas at the heart of understanding a subject, ideas that are not obvious—and perhaps are counterintuitive or baffling—to the novice

**The evidence of understanding**

What differentiates revolutionary thinkers from non-revolutionary ones is almost never a greater knowledge of the facts. Darwin knew far less about the various species he collected on the Beagle voyage than did experts back in England who classified these organisms for him. Yet expert after expert missed the revolutionary significance of what Darwin had collected. Darwin, who knew less, somehow understood more.


If understanding is about making meaning of facts and transferring knowledge to other problems, tasks, and domains, what does such understanding (or lack of it) look like? What should we be seeing if our students are getting better at understanding what they are learning? To pose this question is to shift from talking about our aims to talking about the evidence of whether our aims have been met.

The Sulloway comment about Darwin suggests one line of inquiry. Consider the words we use in describing understanding at the highest levels of research. We often describe understanding as “deep” or “in depth” as opposed to superficial knowledge. You have to “dig” below the “surface” (i.e., the “cover”) to “uncover” unobvious “core” insights. Understanding “takes time and practice.” Understandings are “hard won,” not immediate—maybe even overlooked or unseen by those with lots of knowledge, as Sulloway suggests. The emphasis in all these connotations is on getting below the surface, to the hidden gems of insight. We cannot cover concepts and expect them thereby to be understood; we have to uncover their value—the fact that concepts are the results of inquiry and argument.
Notice, then, the difference in the two questions at the heart of grappling with goals related to understanding (and all educational goals more generally) via backward design—the questions for the first two of the three stages:

Stage 1: What should students come away understanding?

Stage 2: What will count as evidence of that understanding?

The first question concerns important ideas about content and what should be learned. It asks the designer to be specific about what the student should take away, given the ideas, facts, and skills encountered. (Specifying the understandings we seek is surprisingly difficult, as we discuss in Chapter 6.) The second question is different. It doesn’t speak to what should be learned; it concerns acceptable embodiment of those goals: What constitutes appropriate performance and products—output—from students of that learning, determined through assessment.

The second question actually encompasses distinct questions that make up the second stage of backward design:

- Where should we look for evidence? What is the type of student work we need to see done well, given the stated standard?
- What should we look for specifically in student performance, regardless of the particular approach, for us to judge the degree to which the student understands?

Loosely speaking, the first question about the evidence involves a design standard for assessment of the work (i.e., what are valid tasks, tests, observations?), and the second question about the evidence concerns the actual evaluation of the work produced, via rubrics or other criteria-related guidelines.

The argument for backward design is predicated on the view that we are not likely to achieve our target of understanding—however we define the term—unless we are clear about what counts as evidence of that understanding. And the more we ask that nitty-gritty assessment question, the more many teachers come to understand that they may not have adequately understood understanding.

Why might we be unsure about what constitutes good evidence of understanding? Because the evidence we tend to focus on or that stands out more readily can easily mislead us if we are not careful. When students provide the answer we seek, it is easy to conflate such recall with understanding. Bloom and his colleagues (1956) remind us of the distinction when they recount a famous story about John Dewey:

Almost everyone has had the experience of being unable to answer a question involving recall when the question is stated in one form, and then having

### MISCONCEPTION ALERT!

A standard is different from a performance indicator. A standard represents a goal and belongs in Stage 1. A performance indicator, such as those found often in bulleted lists under state content standards, represents possible assessment evidence. Making matters more confusing, sometimes the standards also refer to learning activities like those we would put in Stage 3. (See standard in the Glossary.)
little difficulty . . . when the question is stated in another form. This is well illustrated by John Dewey’s story in which he asked a class, “What would you find if you dug a hole in the earth?” Getting no response, he repeated the question; again he obtained nothing but silence. The teacher chided Dr. Dewey, “You’re asking the wrong question.” Turning to the class, she asked, “What is the state of the center of the earth?” The class replied in unison, “Igneous fusion.” (p. 29)

The story beautifully illustrates the need to distinguish the content goal from the evidence, as well as the need to stress transferability in the requirements for evidence. Children cannot be said to understand their own answer, even though it is correct, if they can only answer a question phrased just so. Furthermore, they will not be able to use what they “know” on any test or challenge that frames the same question differently, as apparently happened in the state tests mentioned earlier.

Getting evidence of understanding means crafting assessments to evoke transferability: finding out if students can take their learning and use it wisely, flexibly, creatively. The authors of the Taxonomy note, for example, that “real” knowledge involves using learning in new ways. They call this “intellectual ability” and distinguish it from “knowledge” based on recall and scripted use. Similarly, David Perkins in the book Teaching for Understanding defines understanding as “the ability to think and act flexibly with what one knows . . . a flexible performance capability,” as opposed to rote recall or “plugging in” of answers (Wiske, 1998, p. 40). A person who has understanding can cope far better than others with ambiguous—that is, real-world—challenges in which what is required does not come packaged as a straightforward cue to stimulate a single response. (Recall the vignette in the Introduction about the class valedictorian who admitted a lack of understanding despite high marks on tests of recall.)

Evidence of understanding that is transferable involves assessing for students’ capacity to use their knowledge thoughtfully and to apply it effectively in diverse settings—that is, to do the subject. As the authors of How People Learn (Bransford, Brown, & Cocking, 2000) write,

_Students’ abilities to transfer what they have learned to new situations provides an important index of adaptive, flexible learning . . . Many approaches to instruction look equivalent when the only measure of learning is memory. . . . Instructional differences become more apparent when evaluated from the perspective of how well the learning transfers to new problems and settings._ (p. 235)

_Students develop flexible understanding of when, where, why, and how to use their knowledge to solve new problems if they learn how to extract underlying principles and themes from their learning exercises._ (p. 224 [emphasis added])

The point is nothing new. Bloom and his colleagues (1956) made the same point about “application” in the Taxonomy 50 years ago. An assessment of
application had to involve a novel task, requiring transfer; and it ideally involved contextualized and practical use of ideas:

If the situations . . . are to involve application as we are defining it here, then they must either be situations new to the student or situations containing new elements . . . Ideally we are seeking a problem which will test the extent to which an individual has learned to apply the abstraction in a practical way.

(p. 125)

Evidence of understanding requires that we test quite differently, then. We need to see evidence of students’ ability to “extract” understandings and apply them in situated problems, in performance—something quite different from merely seeing if they can recall and plug in the underlying principles the teacher or textbook gave them.

This requires us to anchor our assessments in prototypical performances in each area, success at which indicates understanding; for example, the ability to design a science experiment, debug it, and revise it in order to determine the chemical content of a substance; the ability to use the facts and skills learned in history to write a credible narrative about a period in local history. (We refer to these two examples as two of many “core tasks” in a field of study, and we propose that curriculum frameworks and programs be designed around such core tasks, along with the big ideas. For a more detailed discussion of core tasks, see Chapters 7 and 12.) We need to see if students with understandably limited ability can nonetheless transfer—that is, recognize what in their repertoire might be useful here, in this novel situation, and use it effectively. Thus, we would use far fewer narrow prompts that are intended to elicit the “correct” answer to a familiar question.

The “igneous fusion” example is extreme, but the problem strikes home more than most of us may see or care to admit. We are often too ready to attribute understanding when we see correct and intelligent-sounding answers on our own tests. What may trip us up more than we realize is apparent understanding, in other words. And that difficulty is likely exacerbated in a world of high-stakes testing and grading. For as long as education promotes a cat-and-mouse game whereby students have incentive to both please us and appear to understand what they are supposed to learn (irrespective of whether they do or not), the challenge of assessing for real understanding becomes greater.

In short, we must be careful: It doesn’t matter how we term the difference between knowing and understanding as long as we safeguard the real difference. What we call understanding is not a matter of mere semantics. It is a matter of conceptual clarity whereby we distinguish between a borrowed expert opinion and an internalized flexible idea. If our assessments are too superficial and fact-centered, we may miss the distinction in the evidence we collect. It does not matter in the end what we call understanding-related targets, but it matters greatly that we safeguard the distinction between “understand” and “know the right answer when prompted.” What matters is that we grasp the challenge of assessing for transfer.
We have to be sharper at specifying what kinds of student work and assessment evidence are required if we are to judge a student as really understanding. The authors of the AAAS Benchmarks for Science Literacy (1993) cited earlier say that they decided against specifying action verbs or observable behaviors to clarify what kinds of evidence were required to reveal understanding, because “the choice among them is arbitrary” and using particular verbs “would be limiting and might imply a unique performance that was not intended” (pp. 312–313).

Although we concede that there is no unique or inherently perfect assessment task for an understanding target, certain kinds of challenges are more appropriate than others. Knowing what kinds of assessments embody the standards is precisely what many teachers need. Recall that this is why Bloom’s Taxonomy was written in the first place. Without specificity concerning what counts as appropriate evidence for meeting the standards, a teacher might well be satisfied by a factual test of knowledge, whereas only a complex piece of inquiry and defense of methods and result will truly do justice to the standard.

If “correct” answers may yield inadequate evidence of understanding, what should we do to make our assessments better distinguish between real and apparent understanding? Before we answer that question, we must deal with another problem first: Sometimes a correct answer hides misunderstanding. How is that possible? And what are the implications for assessment of understanding? The irony is that we can gain significant insight into designing, assessing, and teaching for understanding by considering the phenomenon of misunderstanding.

Student misunderstanding and what we can learn from it

Somehow, well-intentioned, able, and attentive students can take away lessons that we never intended. What are we complaining about when we say of students, “They know all the facts, but they put them together all wrong” or, “They just aren’t thinking about what they are saying”? The Catcher in the Rye is a fixture of high school English courses in the United States, for example, yet many students come away believing the book to be about Holden’s “excellent adventure” (to borrow from a recent movie title), the larklike days in the life of a hooky-playing prep school student. Somehow, the fact that Holden is in great emotional pain—and tells the story from his psychiatric hospital bed—is unseen by many students. Similarly, in mathematics, many elementary students struggle mightily with the multiplication of fractions, given the oddity of the answers being smaller than the numbers they started with. Or consider the great challenge of reading: Simple decoding is not so simple. We pronounce “lose” as “loze” and the teacher tells us we are mistaken. But we thought we
understood the rule! Why isn’t the pronunciation of “lose” consistent with the long-vowel rule about words that end in a consonant and e (e.g., close, doze, home)?

Misunderstanding is not ignorance, therefore. It is the mapping of a working idea in a plausible but incorrect way in a new situation. Here are some examples:

- One of our children asked: “Dad, are Spanish and English using the same words, but just pronouncing them differently?”
- The same child complained a few years later, “How can 4.28 + 2.72 = 7? Seven isn’t a decimal!”
- A high school history student asked her teacher quietly at the end of a unit, “So just what did Louisiana purchase?”
- An elementary teacher reported the irritation of one of her 4th grade students at not ever seeing lines of longitude and latitude as she flew cross-country with her family.
- A very bright and learned boy, with advanced placement science courses in his background, thought “error” in science was a function of avoidable mistakes, rather than a principle inherent in the enterprise of induction.

Paradoxically, you have to have knowledge and the ability to transfer in order to misunderstand things.

Thus evidence of misunderstanding is incredibly valuable to teachers, not a mere mistake to be corrected. It signifies an attempted and plausible but unsuccessful transfer. The challenge is to reward the try without reinforcing the mistake or dampening future transfer attempts. In fact, many teachers not only fail to see the value in the feedback of student misunderstanding, they are somewhat threatened or irritated by it. A teacher who loses patience with students who don’t “get” the lesson is, ironically, failing to understand—the Expert Blind Spot again. For attentive students not to “get it” is to show us that what we thought was clear was really not so. For some teachers, perpetual student misunderstanding is therefore threatening, understandably, because it seems to call into question our methods and implied goals. What the naïve teacher may be overlooking, of course, is that the big ideas are rarely obvious. Indeed, they are often counterintuitive, as we noted in Chapter 1. A word to the wise, then: If you hear yourself saying to a class, “But it’s so obvious!” you are most likely falling prey to the Expert Blind Spot! Take time to ponder: Hmmmm, what is not obvious to the novices here? What am I taking for granted that is easily misunderstood? Why did they draw the conclusion they did?

Making the matter of greater urgency is the fact that research over the past 20 years confirms the surprising depth and breadth of the phenomenon. Many students, even the best and most advanced, can seem to understand their work (as revealed by tests and in-class discussion) only to later reveal significant misunderstanding of what they “learned” when follow-up questions to probe understanding are asked or application of learning is required. Indeed, it is not only our view but also the view of leading cognitive researchers that ferreting
out student conceptions and misconceptions and being mindful of them when designing learning is key to better results. (A summary of the research on learning and teaching for understanding is presented in Chapter 13.) Howard Gardner, David Perkins, and their Harvard colleagues at Project Zero have summarized these findings eloquently and thoroughly in the past decade, though the misconception research goes back to work done in science education in the 1970s. As Gardner (1991) explains in summing up the research,

> [What] an extensive research literature now documents is that an ordinary degree of understanding is routinely missing in many, perhaps most students. It is reasonable to expect a college student to be able to apply in new context a law of physics, or a proof in geometry, or the concept in history of which she has just demonstrated acceptable mastery in her class. If, when the circumstances of testing are slightly altered, the sought-after competence can no longer be documented, then understanding—in any reasonable sense of the term—has simply not been achieved. (p. 6)

Testing of even a conventional kind can provide evidence of such failures to understand if the tests are designed with misunderstanding in mind. In the Introduction we noted the NAEP math example in which a large minority of students answered “32, remainder 12” buses. Consider this result more generally. Most U.S. teenagers study Algebra I and get passing grades. Yet NAEP (1988) results show that only 5 percent of U.S. adolescents perform well at tasks requiring higher-order use of Algebra I knowledge. The Third International Mathematics and Science Study (TIMSS, 1998) reached a similar conclusion for science in one of the most exhaustive studies to date (Trenton Times, 1997). And so did NAEP’s recent test, showing “a stark gap between the ability of students in general to learn basic principles, and their ability to apply knowledge or explain what they learned” (New York Times, 1997). (The test was a mixture of multiple-choice, constructed response, and performance-task questions.)

For more than a decade in physics, specific tests have been developed and used as assessments targeting key misconceptions. The most widely used test, the Force Concept Inventory, provides a pre- and post-test instrument for measuring progress in overcoming the most common (and surprisingly persistent) misconceptions.

AAAS, in its Benchmarks (1993) and Atlas of Science Literacy (2001), has provided a rich account of desired understandings in the sciences, coupled with key misunderstandings connected with them:

> When a relationship is represented in symbols, numbers can be substituted for all but one of the symbols, and the possible value of the remaining symbol computed. Sometimes the relationship may be satisfied by one value, sometimes more than one, and sometimes not at all.

- Students have difficulty understanding how symbols are used in algebra. They are often unaware of the arbitrariness of the letters chosen. These difficulties persist even after instruction in algebra and into college.
Students of all ages often do not view the equal sign of equations as a symbol of equivalence but rather interpret it as a sign to begin calculating—the right side should show the "answer."

*Comparison of data from two groups should involve comparing both their middles and the spreads around them.*

*The middle of a data distribution may be misleading—when the data are not distributed symmetrically, or when there are extreme high or low values, or when the distribution is not reasonably smooth.*

- The concept of the mean is quite difficult for students of all ages to understand even after years of formal instruction. . . . Research suggests that a good notion of "representativeness" may be a prerequisite to grasping the definitions of mean, median and mode. . . . Premature introduction of the algorithm for computing the mean divorced from a meaningful context may block students from understanding what averages are. (AAAS, 2001, pp. 122–123)

To see how easy it is to misunderstand things we think we all know, consider this more basic science question: Why is it colder in winter and warmer in summer? Just about every student in the United States has been taught basic astronomy. We "know" that the Earth travels around the sun, that the orbit is elliptical, and that the Earth tilts at about 20 degrees off its north-south axis. But when graduating Harvard seniors were asked the question (as documented in a video on the misunderstanding phenomenon produced by the Harvard-Smithsonian Center for Astrophysics), few could correctly explain why (Schneps, 1994). They either had no adequate explanation for what they claimed to know or they provided a plausible but erroneous view (such as, the weather changes are due to the earth being closer or farther from the sun).

Similar findings occur when we ask adults to explain the phases of the moon: Many well-educated people describe the phases as lunar eclipses. In a follow-up video series on misconceptions in science entitled Minds of Their Own, the Harvard astrophysics group documented how a physics student who can do the same electric circuit problems we give to 4th graders, and describe what is occurring, has a flawed understanding when the question is cast in a novel way (can you light the bulb with only batteries and wires?).

The recognition of inevitable learner misunderstanding in even the best minds, in disciplines as seemingly straightforward and logical as science and mathematics, is actually quite old. Plato's dialogues vividly portray the interplay between the quest for understanding and the habits of mind and misconceptions that may be subconsciously shaping or inhibiting our thinking. Francis Bacon (1620/1960) provided a sobering account of the misunderstandings unwittingly introduced by our own intellectual tendencies operating unawares in the Organon 400 years ago. He noted that we project categories, assumptions, rules, priorities, attitudes, and matters of style onto our "reality" and then develop countless ways of "proving" our instinctive ideas to be true: "The human understanding . . . when it has once adopted an opinion draws all
things else to support and agree with it” (pp. 45–49). Philosophers and psychologists from Kant and Wittgenstein to Piaget and other modern cognitive researchers have attempted to figure out the puzzle of persistent misunderstanding and the naïve conviction that typically accompanies it—and the self-assessment and self-discipline needed to move beyond both.

Practically speaking, we must begin to design assessments in recognition of the need for conceptual benchmarks, not just performance abilities. We need to design assessments mindful of not only the big ideas but also the likelihood that those ideas will be misconceived—and will resist being overcome, as in this biology example cited by Shulman (1999):

*Biology teachers must wrestle with the durability of student misconceptions of evolution and natural selection. Most students in courses that emphasize evolution and natural selection enter these courses as intuitive Lamarckians. They are convinced that any characteristics acquired by one generation are then transmitted to the next generation. The formal instruction emphasizes the Darwinian refutation of that position. These students may earn A’s and B’s in the course, demonstrating that they now understand the Darwinian perspective, but quiz them three months later and they’re once again dedicated intuitive Lamarckians—as indeed are many of the rest of us. I suspect that forms of fantasía are endemic among students and graduates of higher education, many lying in wait for years before manifesting themselves at critical moments. (p. 12)*

Here are some examples of common misunderstandings for some important ideas, and misunderstandings that reflect the overcoming of them:

- **Impressionism is art in which the painter offers a subjective impression or feeling evoked by the scene.** The opposite is the case: Impressionism was an attempt to paint scenes realistically, not abstractly or by feeling. Impressionism refers to a technical term in philosophy whereby direct sensory impressions are distinguished from the mind’s placing of those impressions into ideas.

- **Each month there is a lunar eclipse when the moon is not visible.** The phases of the moon depend on the relative position of the earth, the sun, and the moon, so that we see the part of the moon that is lit by the sun. Ongoing lunar eclipses are not the cause of the phases.

- **Science is about finding causes.** Scientists find correlations; talk of “causes” is viewed as too philosophical and unscientific. Modern science, economics, and medicine search for statistical patterns. That’s why asking “What caused it?” is not necessarily a question doctors can answer, even as they prescribe effective medicines.

- **When you multiply two numbers, the answer is bigger.** Multiplication is not repeated addition. Fractions when multiplied yield a smaller answer, and when divided, a larger answer. How can that be? Students often see fractions and decimals as separate number systems; learning to see them as alternate means of representing the “same” quantities is the understanding.
• **History is about the facts, what happened.** A historian is a storyteller, not a mere gatherer and purveyor of facts. Why, then, do so few students realize that there can be and are very different stories of the same important history?

- **You should cup your hands when swimming in order to “catch the water” to move faster.** The greater the surface area, the greater the force. Thus, you should swim with a flat palm to maximize the amount of water being pulled and pushed.

- **Light is light and dark is dark.** Not true. Two light beams intersecting at crest and trough can cancel each other out and cause darkness! Noise-canceling headphones use sound to produce silence. Similarly, mirror-image waves of light or sound cancel each other out.

- **Negative and imaginary numbers are unreal.** Negative and imaginary numbers are no less and no more real than ordinary numbers. They exist to provide the symmetry and continuity needed for essential arithmetic and algebraic laws.

- **Evolution is a controversial idea.** No, the theory of natural selection as the engine of evolution is what is controversial. Theories of evolution predated Darwin by centuries and were not seen as being in conflict with religious doctrine.

- **Our founders were liberals.** The American revolutionaries held that individuals, not governments, had natural rights applied through labor (based on John Locke’s views about property). Thus, in one sense, they were “conservatives” (i.e., the right to personal property is fundamental).

- **Irony is coincidence.** Irony is not mere coincidence, though almost every sportscaster misuses the word! Irony is what the wiser person sees that another seemingly wise person does not. The audience sees what Oedipus does not, and the tension between the latter’s pride and what we know is the truth is the source of the drama’s power.

Given the likelihood of deeply rooted misconceptions and the potential for misunderstanding, a proactive and, for most of us, unfamiliar approach to assessment design is required. To successfully engineer understanding, we have to think backward: What does understanding look like when it is there or not there? We have to be able to describe what it looks like, how it manifests itself, how apparent understanding (or misunderstanding) differs from genuine understanding, which misunderstandings are most likely to arise (thus interfering with our goal), and whether we are making headway in ferreting out and eradicating the key impediments to future understanding. In other words, we have to think through our assessments before we think through our teaching and learning.

Any design depends upon clear purposes, as we have said. Yet the matter is complicated by the mixture of many externally imposed goals (e.g., state content standards) and self-selected goals. How should we prioritize? How do we select wisely from so many obligations to ensure an effective and coherent design? How can we design coherent units while remaining constantly mindful of the many and overlapping course and program goals? We now turn to these questions.