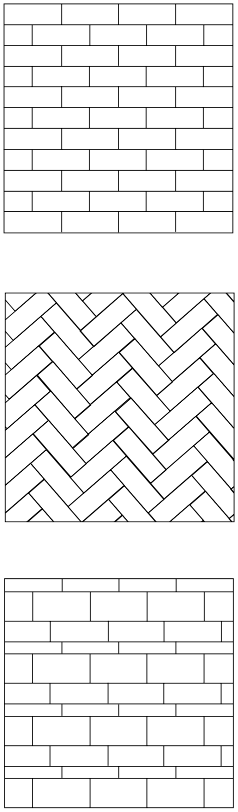
CHAPTER 4
CURRICULUM BLOCKS

For millennia, designers of plazas, walls, arches, bridges, and domes have used bricks as their basic construction units. Identical bricks can be arranged in a surprising number of different patterns, and many times more patterns can be created using only a few different kinds of brick. Some aspects of the patterns are essential to the purpose of the structure, whereas other aspects may be merely pleasing. To suit one purpose or another, the bricks can be different in material composition (marble, stone, glass, concrete, metal, plastic, clay, wood), structural properties (size, shape, strength, resilience, durability, response to temperature), appearance (color, transparency, surface texture), and inevitably cost (bare minimum to extravagant). How well the structure will do its basic job depends more on some of these properties than others, but any property may be important in motivating and selling the design. Obviously a designer needs to know what the properties of bricks really are and what features the final design must have.

In the 20th century, sad to report, curriculum designers have not been so well blessed. For most of the century, they have had only a few kinds of "bricks" available to them, and those in only two "shapes"—one period, five days a week for one semester and one period, five days a week for one year. To make matters worse, there simply is no agreed-upon set of basic properties to use to describe or talk about curriculum components. For this and other reasons, "honesty in packaging" is rare in the descriptive materials provided by publishers.

This chapter supposes that in creating the curriculum equivalent of a brick structure, educators will have access to a large variety of accurate descriptions of bricks in the form of an easily accessible database. After defining what a curriculum block is, the chapter presents a template for describing blocks, some thoughts on how and by whom suitable blocks can be developed, and a brief list of some possible curriculum blocks.



Examples of brick patterns

What Are Curriculum Blocks?

From a psychological point of view, the 13 years of learning in grades K-12 can be regarded as a single fabric of acts and thoughts, each of them occurring in the context of all the previous ones. From an administrative point of view, on the other hand, the 13 years can be described as a sequence of discrete parts—lessons that are grouped into units that are grouped into courses that are grouped into curricula. Thus, for example, a lesson on the cell wall may be found in a unit on cells that is part of a biology course that is part of a high-school curriculum (which is part of a K-12 curriculum).

How Big Is a Curriculum Block?

The lesson → unit → course → curriculum hierarchy is less rigid than it seems, since students' learning experiences are not always shaped into discrete lessons, lessons into units, or units into courses. In any case, for purposes of secondary-school curriculum design, it is best to use courses (or their equivalents) rather than lessons and units as curriculum building blocks. Dealing with smaller components is extremely difficult in view of the huge numbers involved and the myriad connections among them. Also, unlike lessons and units, courses are formally labeled, administrative blocks of learning activities for which students can receive summary credit (and usually report-card grades) with consequences for student promotion, graduation, college admission, and employment.

By the same reasoning, the subjects taught in elementary schools—not usually designated as courses—are also curriculum building blocks. And if we assume, as is done here, that other kinds of curriculum components comparable to traditional courses and subjects in magnitude and coherence are possible, then it makes good design sense to think of curriculum blocks as the large structural components for which students receive separate credit on their transcripts. By this definition, elementary-school subjects and secondary-school courses are curriculum blocks, but the units and lessons that make them up are not.

The term "curriculum block" is short for "curriculum *building* block." It reminds us (to a degree that "subject" and "course" do not) that a curriculum is *constructed* by selecting and configuring a relatively few major components, not hundreds of parts. A curriculum *design*, then, is a plan for their selection and configuration. Correspondingly, blocks must have properties that enable them to be so assembled—and those properties must be evident to curriculum designers.

A Common Block Example

As simple an idea as the curriculum block may seem, it has subtleties that require close attention. Let's consider a traditional block commonly found in the core curriculum of most school districts today. The biology course taken in 9th or 10th grade will do nicely since it is taken by virtually all students. Here is an imaginary discussion between a curious reporter and a high-school curriculum specialist:

Question: How would you describe the biology course in your school or district so that others would know what it is like? Answer: I would name the biology textbook we use.

Question: What specific knowledge and skills are all the students expected to acquire by taking the course? Answer: They will understand the key concepts of biology and what biological science is like. And they will come away with greater respect for nature. This is asserted in the preface or first chapter of every biology textbook.

Question: Those aims seem to be pretty general. Can you be more specific about exactly which key concepts the students are expected to learn and at what level of sophistication? Answer: That would be evident in the chapter and section headings of the textbook—or, better yet, in its glossary and end-of-chapter questions.

Question: Judging from biology textbooks I have seen, students have a lot of material to get through. Are *all* students expected to learn *everything* in the text? Answer: Usually not. Our teachers decide what to leave out, what to treat lightly, and what to bear down on. And of course, there are always some pet topics or activities. So I guess you could say that the textbook doesn't quite define the course content, but mostly it does.

Question: Where can one find a description of how the biology course takes account of the student learning that is expected to precede it and that which will follow? Answer: One can't. Biology is designed to stand on its own because, on the input end, teachers commonly say they cannot count on students entering the course with specified knowledge and, on the output end, many students do not go on to take chemistry, physics, and advanced biology.

Question: Does the content of the textbook you use align with national standards? Answer: Yes, there is a table in the teacher-guide version of the text that indicates which textbook sections correspond to both *Benchmarks for Science Literacy* and *National Science Education Standards*.

Question: But don't publishers routinely use such tables to make superficial connections to "topics," without attention to what the actual knowledge that students are expected to acquire? Answer: I suppose that may be true, but we haven't anything like the resources required to make a careful study of idea-by-idea alignment.

Question: If a textbook pretty much defines the course, does it describe how instruction is to be organized and the results evaluated? Answer: Yes and no. Mostly that is up to the teacher, who may change the order of topics somewhat. However, in most schools, you will find biology being taught in the traditional format involving assigned reading in the textbook, homework, class discussion, teacher demonstrations, laboratory, and periodic tests. Many teachers also have students do individual projects. Textbooks are accompanied by separate teacher's editions or guides that suggest how to organize instruction. And by tests.

Question: What "space" does biology have in the curriculum here? Answer: The same as every other science course, or any other course at all, for that matter, which is to say one period every day for one school year. It is placed in the 10th grade, where it has been stationed for as long as anyone on the faculty can remember.

Question: Finally, how many decidedly different versions of biology courses are generally available to select among? Answer: If we take textbooks to define courses, there are about three broad types on the market. Several traditional biology textbooks, and hence courses, are based on an organization of content going back to at least the 1930s; a good part of each of these is classification of organisms. But as biological knowledge has increased, more and more has been added to these textbooks until they are virtually encyclopedias, with very little on any one idea and sparse connections made among ideas. All teachers who use them have to leave out some chapters, and some supplement them with other materials for important topics. (In fact, some teachers are beginning to use the heavy, encyclopedic textbooks only as supplementary reference books.) There are also textbooks with a more modern organization—based, say, on organ systems or habitats rather than phlya, though much of the content is not very different. Then there are one or two that have greatly reduced the coverage in favor of trying to focus on a modest number of important ideas. We hope there will be more of those coming along to consider. So we feel we have a fair number of possibilities to choose from.

From the above imaginary discussion, we could conclude that biology is in relatively good shape from a curriculum-design standpoint. There are significant differences among the biology offerings, not simply cosmetic ones; the offerings have distinct conceptual approaches, and they provide or identify needed materials and procedures, yet leave room for teacher creativity. Still, there are some shortcomings from the design standpoint. It is usually too difficult to get details about alternative courses, except in rather general terms. Textbook-selection committees (the name for course-selection committees) do not have easy access to vital information, such as precisely what knowledge and skills are being targeted, what trade-offs there are among the competing courses, and what evidence there is that each course will achieve what it claims.

The advent of a national consensus on specific learning goals may make it more feasible and desirable for publishers to describe in detail and in a common language the specific goals that a course targets.

Another shortcoming deals with the variety of courses offered. In spite of the thematic differences among the specific biology courses, welcome as they are, it would be helpful to have other possibilities: semester and quarter courses that target national-level literacy goals through a focus on biotechnology or biodiversity or on medical or agricultural applications, or seminars that meet only two hours a week and are based on case studies or readings. Other interesting possibilities are courses centered on a historical episode—say, one using Jonathan Weiner's *The Beak of the Finch* (1994) as a focus for the study of Darwin and his work. Biology blocks might consist only of inquiry projects or computer-assisted independent study spanning several years. Nor is there any compelling reason why general biology in high school should be confined mostly to the 9th or 10th grades. These and similar possibilities for greater variety exist for other science, mathematics, and technology subjects.

Full-year biology courses could include these variations as components—if the total burden of topics to be covered were drastically reduced.

Properties of Curriculum Blocks

In short, the notion of curriculum blocks focuses attention on having a wide variety of "bricks" from which curricula can be assembled, and also having precise descriptions of blocks that will enable educators to make informed choices and placements of them in designing curricula. The point is not that every curriculum should have a diverse variety of blocks, but that a diversity of blocks be available so that it is *possible* to incorporate as much or as little variety into a curriculum as a school district wishes in pursuing specific learning outcomes. With that possibility in mind, we can state that

- A curriculum block is a self-contained sequence of instruction. A block is important enough to require school-board approval and to be recorded as an entry on student report cards and transcripts.
- Different curriculum blocks can have different time dimensions. They need not be restricted to one period every day for a semester or year. In principle, "courses" could have different time dimensions, but the tradition is otherwise and has proven to be stubborn.
- A curriculum block can have any of several instructional formats. There could be seminar blocks, project blocks, independent-study blocks, lecture-series blocks, and peer-teaching blocks, in addition to the traditional course blocks. Although elements of any of these formats can be included in more traditional courses, they may be more useful in their own right than they would be as occasional elements. Any one block may include a deliberate mix of formats, too.
- A curriculum block can relate to one discipline or several. The content of blocks may feature the nature and conclusions of a particular discipline or alternatively explore particular phenomena (such as lakes, explosions, transplants) or issues (pollution, space travel, biodiversity), drawing on several disciplines as needed. Mathematics courses customarily have been organized by divisions of the discipline, whereas social-studies courses often are organized around events or issues.
- A curriculum block is adequately described. A block description provides curriculum designers with sufficient information to enable them to make informed choices. Two chief items of information are a delineation of the specific learning goals that are credibly targeted by the block and an indication of the degree to which the claimed results have been validated.

A Template for Describing Curriculum Blocks

Block descriptions are needed to judge how a particular curriculum block would fit into a curriculum. The set of descriptors that follows constitutes a template for making entries in a database of block descriptions. Worked out gradually over a period of years by members of the six Project 2061 school-based teams in concert with curriculum specialists and materials developers, the descriptor set is a straightforward formulation of what any group of professional educators would want to know when selecting blocks. The template is summarized in the accompanying box, and each basic component is discussed below. (The discussion includes examples drawn from science,

A TEMPLATE FOR DESCRIBING CURRICULUM BLOCKS

Title

Overview

Intended Students: grade range and special groups that block is designed for
Subject Area: areas of study (e.g., chemistry, geometry, social studies)
Format: how instruction is organized (e.g., traditional course, seminar, independent study)
Time Frame: options for calendar duration, meetings/week, and time/meeting
Prerequisites: prior knowledge and skills needed for student success in block
Rationale: ostensible purpose for study (e.g., explain phenomena, follow a social issue, design a product)

Content

Stated Goals: specific learning outcomes that developer claims block serves
Main Topics: what will be studied (e.g., nutrition, recycling, maps)
Activities: typical student experiences (e.g., measuring rainfall, debating policy)
Options: alternative materials, activities, or organization for teachers or students
Connections: relevance to subsequent or parallel parts of the curriculum

Operation

Human Resources: professional or lay staffing needed for instruction or support
Material Resources: needed equipment, supplies, sites, and transportation
Assessment: tasks, scoring guides, and schedules for assessing student progress
Teacher Preparation: needed knowledge and skills in subject and teaching
Cost: time and money needed

Credibility

Empirical Evaluation: scientific studies of what students actually learn from block
Benchmark Analysis: evidence-based estimate of which benchmarks are served*
Reviews: published expert opinion on the quality of the block
Users: places (and contact people) where block has been implemented
Development: how, when, and by whom block was created

* Benchmark analysis is described in Chapter 6: Building Professional Capability.

mathematics, and technology, but, with minor changes in wording, the template can be made to fit any curriculum domain.)

The Project 2061 template for curriculum-block descriptions was created to serve as a standard for a national database of such descriptions. The task of building a complete and valid database needs to be national in scope, because the resources needed to acquire and evaluate a large number of curriculum blocks probably are beyond the means of local or even state groups. Although some of the description categories called for by the template are familiar and routine, others—such as empirical studies and benchmark analysis—are novel and demanding. And even some of the seemingly routine categories have subtle spins that merit fresh attention. Sometimes there will be considerable redundancy among the title, subject area, rationale, main topics, and activities of a curriculum block. A title as straightforward as “Learning about Motion through Catapult Design” pretty much covers all of these descriptions. More often, the activities in a block may not be easily inferred from its title or from any of the other description categories. For example, a template could look like this:

Title: Catapult!
Subject Area: physics of motion
Rationale: design a projectile device
Main Topics: elasticity, trajectories
Activities: sketching schematic diagrams, testing materials, piloting and revising designs, and distance contests

Different as they are, each category conveys something helpful to know about the block. The organization of information shown in the template is not meant to be the only one possible—and certainly does not imply importance or priority. From the Project 2061 point of view, the last category, Credibility—particularly Benchmark Analysis—is probably the most important, for that is where the focus is sharpest on what students are likely to learn. Which information designers would look at first in searching for blocks would, of course, depend on their search strategy—and probably on how far along in their search they were. For example, Prerequisites might not be an important concern early in selecting blocks, but will become increasingly important as the curriculum space fills up.

It should be kept in mind that the information in the database is the same information we would want about the courses making up the existing curriculum in a school district. It is sometimes an eye-opener to discover how little—if anything—is known about the components of an existing curriculum or, how little is systematically recorded and readily available.

Title

Curriculum designers need convenient labels for referring to each block they consider. They can, of course, make up any labels they wish, but it would be helpful to have a convenient title offered by the developer or database maker. The titles do not have to be uniquely distinctive, so there is no need for a national registry, such as there is for the many millions of site names on the Internet. If publishers X and Y both put out a textbook called *Modern Earth Science*, designers would have no trouble referring to "X's earth science" and "Y's earth science." Similarly, one could easily refer to a hypothetical "Philadelphia Schools' environment seminar" or "Livermore Labs' environment seminar." Although it is always helpful for each title used in the database to reveal something about the block's contents (for example, BSCS's "Science and Health Sequence"), the titles of some highly respected blocks have not even hinted at what was to be learned (for example, Bank Street's "Voyage of the Mimi" collection).

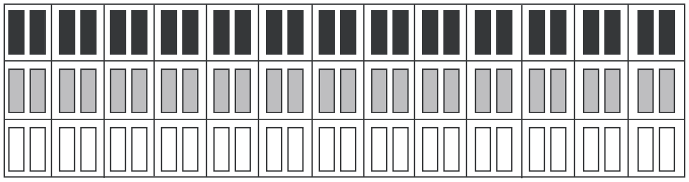
Overview

The purpose of a block overview is to provide enough information to enable curriculum-design teams and others to find out quickly what is meant by a block title and to decide whether to examine the candidate block. In a brief paragraph, perhaps slightly larger than the college-catalog course descriptions shown in Chapter 3, the overview of a block (as the template indicates), should provide these six pieces of information: who the block is intended to serve; what the subject-matter focus is; how instruction is organized; what the time requirements are; prerequisites, if any; and the block's rationale.

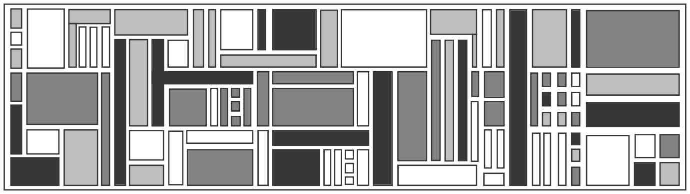
Intended Students. A curriculum block may be designed for all students as part of a core curriculum or only for certain categories of students. Examples of special categories include blocks for various specializations (trigonometry, computer programming, French, music composition, etc.), advanced placement, and remediation. Typically, blocks are identified as being intended for use at a particular grade range such as K-2, 3-5, 6-8, or 9-12. Such usage does not preclude a block being used at a level other than the one specified, but it does suggest exercising caution when not following the developer's recommendation. In principle, a block could even be designated as K-12, if it were designed to be used in any or all grades.

Subject Area. The intent here is to have the overview signal the block's general subject turf, such as science, mathematics, technology, arts, humanities, or vocational or combinations of those such as science/mathematics/technology, arts/technology, or science/history. (A more complete description of specific content appears below under the heading Content.) Further turf designation here could include traditional discipline—for example, chemistry, trigonometry, architectural drawing, music composition, or U.S. history—or broad thematic areas such as environmental studies or ethics in science and medicine.

Separate subjects, traditional scheduling of two semesters per year.



Mixture of separate and combined subjects, highly flexible scheduling.



A K-12 curriculum can include uniform or varied time blocks and integrated or single discipline blocks.

Format. Instruction can be organized in several ways. The most traditional way is to organize instruction as a "course." Courses have evolved to include lectures, demonstrations, class discussion, homework, tests, and (depending on the subject matter) practical work such as laboratory, studio, or shop. Some of the possible formats are lecture/discussion course (which would typically include demonstrations), laboratory course (which adds 25 percent or more time in individual or small-group investigations in addition to lecture/discussion/demonstration) and shop course (design and construction). Other formats include course-independent design projects, seminars, independent study (individual and group), and peer teaching, which are believed to often be more effective than the traditional course format for certain kinds of content and purposes.

Time Frame. First, the overview needs to identify the total time requirement of a block—whether it is a quarter of a school year, a semester, a year, or several years, and also whether the duration is continuous or divided (for example, one semester a year for three years in a row). Then the overview should specify how the time will be divided, to include meeting frequency and duration. For some blocks, only the total time in hours may be needed, permitting great flexibility in clock and calendar scheduling. For example, a one-quarter course that is typically scheduled for an hour a day for 10 weeks would total 50 hours, which conceivably could be scheduled as densely as five hours a day for two weeks or strung out as a half-hour a week for two years.

Although the overview may specify an optimal duration for the block, it is also important to estimate the permissible range of configurations in time—that is, a range outside of which the block would have to be substantially modified or given up. Because there are human limits to dealing with complexity and change, curriculum designers must consider what balance to strike between possible benefits of curriculum flexibility and the tolerance of local teachers and students for varying clock and calendar schedules.

Prerequisites. Curriculum designers need to know what conditions, if any, students should have met before being admitted to the block in question. Prerequisites may be stated as previous experiences (other blocks to have been completed satisfactorily or, better yet, as knowledge or skills to have been acquired). In the case of blocks in the service of science literacy, *Benchmarks for Science Literacy* can serve as a convenient guide and reference.

Rationale. A curriculum block should be more than a collection of miscellaneous topics and units. It is a program of study that makes conceptual sense, to students as well as to teachers. The learning goals at which a block aims provide one kind of rationale, but students often need a more immediate sense of purpose to motivate and focus their study. For example, block rationales for students could be to explain or predict certain kinds of phenomena, design products, characterize different perspectives on societal issues. Multiple rationales could be relevant to different parts of a single block (such as understanding a given phenomenon so as to be able to consider possible results of a proposed social policy), but it is desirable to have an overall orienting rationale for the block as well. (More suggestions for block rationales appear toward the end of this chapter under the heading Ideas for Curriculum Blocks.)

"Provide a sense of purpose" is one of the criteria for block evaluation, described in CHAPTER 6: BUILDING PROFESSIONAL CAPABILITY.

Content

The content of a curriculum block can be described by the learning goals targeted, main topics treated, typical student activities, teacher and student options, and links to other subject matter. Each of these categories represents an important feature of the block that curriculum designers need to take into account. From the Project 2061 point of view, the first of those listed here, learning goals, is by far the most important, even if the next two on the list—topics and activities—seem to currently get more attention from both developers and teachers.

Stated Goals. The purpose of a curriculum block is to foster learning, and the block description should reflect what specific learning the block developer had in mind. That learning expectation must be explicitly stated in the overview to provide a basis for adopting or rejecting a block. If the block claims to address many of what the designers have identified as key learning goals, then its other properties can be examined. If not, it should be quickly eliminated from further consideration.

How specific should these goals statements be? The broader and fewer the learning-goal statements are, the easier it is for developers to claim a block in some way serves them. If a block's goal is as general as "learn about cells," for example, then anything at all about cells would do, for it is not clear what it is about cells that students should understand. Very specific goal statements, on the other hand, offer more guidance—but are likely to be more numerous and require closer attention (and be more constraining for developers). A compromise on specificity is to have the stated goals section indicate block goals by benchmark "family"—say, the section headings in *Benchmarks* or the standards headings in *National Science Education Standards* (*NSES)*. That way the block's goals can be examined at two levels: first to choose candidates for a goal area and then to make final decisions using the more specific benchmarks themselves. For example, the description of a block suitable for grades 5–8 could indicate, at one level, that it deals with aspects of heredity, cells, human development, uncertainty, and models (all *Benchmarks* sections), and then at a more detailed level, list which of the benchmarks in each of those *Benchmarks* sections it actually targets. (The *NSES* parallel for this procedure would be to list the particular content standards the block includes and the "fundamental concepts" each of the standards targets.) Determining whether blocks actually do serve benchmarks well is taken up below under the heading Credibility.

All this is still at the level of claims. It should be kept in mind that science-literacy goals are not the only kinds of learning goals that a block may target. Effective and safe work habits or good citizenship, for example, can be important goals. But if they are going to be included in the block description, they should be specified as clearly as other learning goals (for example, which particular work habits or aspects of citizenship the developer has in mind).

Main Topics. Blocks can also be described in terms of what topics students will study. Students studying a particular topic may not be aware (at least initially) of what the underlying learning goals are. A topic is whatever a block seems superficially to be about—chemical equations, whales, gardens, pollution, telescopes, lotteries, epidemics, space travel. There is an important distinction to be made between Main Topics and Rationale. A block's *main topics* may be thought of as the answer that students would be most likely to give when asked *what* they are studying in a school subject; a block's *rationale* would be their likely answer when asked *why* they are studying that topic in particular. And both topic and rationale need to be distinguished from specific learning goals (either the developer's stated goals or benchmarks identified through a careful analysis), which may or may not be shared with students. A good example of a main topic is acid rain. Although acid rain is nowhere mentioned in *Benchmarks* (or in *Science for All Americans*), it would be possible for a block ostensibly about acid rain to target a variety of specific benchmarks in measurement, technological and social trade-offs, water cycle, statistics, mathematical models, and so on. Moreover, several blocks called "Acid Rain" could have different primary rationales—for example, understanding chemistry in the atmosphere or following public debate on pollution or tracing the history of industrialization.

The distinction between different meanings of "topics" is discussed further in Chapter 7: UNBURDENING THE CURRICULUM.

Activities. In addition to describing the topics to be taught and learning goals targeted, the block description should include information on how a block is characterized by what students typically *do*. Hands-on work, experiments, field trips, group work, individual study, simple projects, long-term projects, or looking up information are all possible activities. The block description should not recite all the detailed learning activities themselves, but limit itself to describing kinds of experiences and sketching typical examples of them.

Options. It is possible, even desirable, for blocks to range from those in which everything is spelled out in great detail, leaving few instructional options for the teacher, to those in which the instructions are quite general, presenting teachers with freedom to choose or invent. The same range pertains to student options; some blocks can have all students doing the same thing, others can give them choices. Most blocks are likely to be somewhere between these two extremes. Sometimes options may merely point to other resources, and sometimes all the resources for an option may be provided within the block itself. Option information in the block description enables taking local circumstances and preferences into account.

A vivid display of links appears in the dozens of growth-of-understanding maps in Project 2061's *Atlas of Science Literacy.*

Connections. It is helpful in curriculum design to know whether a block under consideration has useful conceptual or operational relationships to other blocks. The block description should list complementary blocks that target different but related benchmarks, blocks that contain reinforcing benchmarks, blocks that include precursor benchmarks, and follow-on blocks whose benchmarks extend those in the block being described. Teachers wanting to cross subject-matter boundaries would like to know that a block has been designed to connect gracefully to blocks in other subjects—for instance, a physics block that features Galileo connects to a history block that focuses on the Renaissance. Blocks can also be related by common contextual components, quite aside from specific content—the same measuring apparatus, the same analysis technique, the same community site, or the same historical period.

Operation

To operate effectively as their developers intended, all blocks require human and material resources, time and money, means for assessing student progress, and professional preparation. Block descriptions should provide the following information:

Human Resources. Above and beyond the personnel it takes to run a school, each block in a curriculum has its own personnel requirements, which are the key to its success. The staff of a course or subject is often one teacher, but not always. A block may call for a team of teachers or for a teacher plus one or more teacher assistants. A block may also have been designed to be taught by a teacher plus a student (or team of students) or by an adjunct teacher. To increase efficiency or improve instruction, some blocks are intended to be lead by project directors, seminar leaders, or independent-study coaches. In all of these cases, of course, relevant experience and skills may be more important to consider than job titles.

Material Resources. A block description should specify the print, electronic, audiovisual, physical, and living materials that are essential, as well as those that are recommend-

EXCERPTS FROM AN ACTUAL BLOCK DESCRIPTION

Title *Chemistry That Applies*

Overview

Intended Students: grades 8, 9, or 10
Subject Area: physical science
Format: course
Time Frame: 6-8 weeks, 5 meetings/week, 1 period/meeting
Prerequisites: Not specified (but student misconceptions are noted and addressed)
Rationale: To learn to develop empirical tests of hypotheses; to design and conduct scientific investigations….

Content

Stated Goals: Unit's "Philosophy and Rationale" section lists these goals—matter is conserved in all chemical reactions; all matter is composed of atoms that join together to form molecules; new substances form when the atoms of the reactants come apart and reassemble in new arrangements….
Main Topics: Describing Chemical Reactions/Weight Changes in Chemical Reactions/Molecules and Atoms/Energy and "Boosters"
Activities: Predict weight changes and design experiments to test them; write equations to represent chemical reactions; use marshmallows and toothpicks to build models of molecules….

Operation

Assessment: "Think and Write" sections check student understanding early in each lesson, with answers. End of unit exam is provided, with answers.

Credibility

Benchmark Analysis: Rated satisfactory in a 1999 evaluation by an independent review team as part of Project 2061's middle grades science textbook evaluation. Includes content relevant to the following benchmarks: 4D 6-8#1 atomic/molecular structure of matter; 4D 6-8 #7 conservation of matter in shuffling atoms; 4E 6-8 #7 chemical energy…. Provides oustanding instructional support for benchmark 4D6-8#7….
Development: Michigan Science Education Resources Project, Michigan Department of Education

Parts of a description of an actual (though rather short) block.

ed but optional. If special facilities or events are essential—not just desirable—the block description should alert school districts to that need. A course built around field studies, for instance, ought not to be installed in the curriculum at all if suitable nearby sites—or safe transportation to more distant sites—are not available. The description should make clear that books alone would not be adequate. The same can be said for technology blocks that require a shop with power tools, science blocks calling for laboratory investigation, blocks that rely on student access to computers. An actual block package should contain either all of the needed materials or all of the information needed to enable schools that wish to adopt it to acquire the required materials.

See extended discussion of assessment roles in *Resources for Science Literacy: Curriculum Materials Evaluation* and also in *Blueprints for Reform.*

Assessment. How student progress will be monitored is an issue that is almost as important as quality of instruction in the view of most teachers, students, parents, and school administrators. Does the block include assessment materials linked to the targeted learning goals? What assessment techniques are integral to guiding day-to-day instruction and what are appropriate to longer-term summary judgments about student or program success? Are they objective tests? Essays and reports? Interviews? Portfolios? Is guidance provided on scoring and grading? Do the assessment materials provide suggestions on how to use the assessment results to revise the block?

Teacher Preparation. A block description should make clear what special knowledge or skills a teacher (or whoever is to teach the block) should have beyond what is ordinarily expected. A science course, for instance, may call for the teacher to be familiar with certain episodes in the history of science, knowledge that even well-prepared science majors may lack. A block may demand skill in supervising student research projects. To this end, a block may include professional development materials (print, audiovisual, computer, on-line) or it may cite readily accessible books, articles, films, computer programs, or other resources.

Cost. Costs vary from course to course, although it is not clear how often costs are taken into account in making curriculum choices. If block descriptions give fair estimates of financial and time costs, then design teams can at least make rough comparisons of the cost-effectiveness of contending blocks. Although benefit-cost analysis is not highly developed in education, even rough approximations are useful, and the process of conducting such analyses can be counted on to at least lead to a more penetrating consideration of curriculum decisions than if costs are ignored.

Credibility

The learning goals intended (or at least claimed) by block developers will already have been cited under "Content" above. But materials do not always correspond well with the goals claimed for them. How confident can one be that the claims will actually be achieved? Scientific evidence of student learning is rarely obtainable, but confidence in the credibility of the learning claims made for a curriculum block can be strengthened considerably by rigorous benchmark analysis. In the absence of such analysis, some suggestions of effectiveness may be provided by uncontrolled empirical studies of student learning, published reviews in professional journals, and the testimony of users. If the developer of the block has demonstrated high credibility in other blocks, that too may provide a clue.

PROJECT 2061 CURRICULUM-MATERIALS EVALUATION PROCEDURE

Step 1: Identify benchmarks that appear to be covered by the curriculum material.

Step 2: Clarify the benchmarks' meaning.

Step 3: Reconsider how specifically the material targets the benchmarks.

Step 4: Estimate how effective the instruction would be.

Step 5: Recommend improvements.

Empirical Evaluation. Ideally, the evaluation of curriculum blocks ought to be based on concrete evidence of what students who experience the instruction really do or do not learn. Empirical research studies are difficult to conduct and very costly in the bargain, but sometimes they are carried out and the results are made available in professional journals and institution reports. But even then there are many cautions, including bias in the selection of comparison groups. Oftentimes, for example, research on instruction is conducted on particularly able and interested teachers and students, which leaves open the possibility that the materials and methods may be significantly less effective in less special circumstances. Therefore, reports on research should describe who the trial teachers were (from development participants and volunteers at one extreme of specialness to randomly selected samples at the other) and how special the students were in previous academic achievement and motivation. Also important is the nature of the actual assessment tasks and how long after instruction they were administered. This reflection on evidence can be seen as a step toward putting judgments about curriculum on a more scientific footing.

Benchmark Analysis. Short of scientific studies of what students actually have learned, but more credible than general opinions or published reviews, are systematic analyses of curriculum-block materials and activities to estimate what students would be *expected* to learn from them. A careful analysis based on principles of how students learn is not an easy or rapid undertaking. Even experts have a tendency to make general, impressionistic judgments about whether the content seems to feature benchmarks and use sound instructional approaches—judgments that they often reverse when they are required to cite specific evidence in a block's materials and activities (or notes to teachers) that those *particular* benchmarks would likely be achieved through *particular* activities.

Sophisticated methods have been developed by Project 2061 for this kind of analysis of curriculum blocks and materials. More information on the analysis of curriculum materials vis-à-vis specific learning goals can be found in *Resources for Science Literacy: Curriculum Materials Evaluation* and below in CHAPTER 6: BUILDING PROFESSIONAL CAPABILITY.

Project 2061 has organized expert analysis by educators experienced in the procedure to make possible a sort of “consumer report” on popular curriculum materials in mathematics and natural science. Familiarity with the analysis will nonetheless be necessary for educators, parents, and community leaders to make the most of the reports. For more information, see the Project 2061 web site at project2061.org.

A valid and reliable analysis requires just that: identifying evidence in instructional materials and teacher guides that the block would be effective in helping students to achieve specific benchmarks. In the future, we can expect that teams composed of teachers, curriculum specialists, and university researchers—all of whom have undergone extensive training in such benchmark-by-benchmark analysis of materials—will be able to examine blocks in detail and report their findings in a concise form that practitioners can use in making block-selection decisions. As such reports become available, they should become essential parts of block descriptions.

Reviews. In the absence of empirical studies or systematic analysis, or as a supplement to them, personal-opinion reviews can be of some value. Some teachers and scientists are exceptionally good at critically reviewing learning materials. For decades, the journal *Science Books & Films* (published by AAAS) has successfully called on such aficionados to write reviews of trade books and other science materials that have been prepared for children and the general public. The *Science Books & Films* reviewers comment on materials' scientific accuracy, readability, interest, and suitable audiences. Similar reviews could be published for textbooks and curriculum blocks, with additional commentary on ease of use and appeal to teachers. As reviewers become more familiar with the criteria for effectiveness used in benchmark analysis, they can tune their work more closely to estimating what students would actually learn. Then, as the education profession matures, its journals will certainly devote substantial space to expert reviews of curriculum blocks. As such reviews become available, block descriptions will be able to cite them.

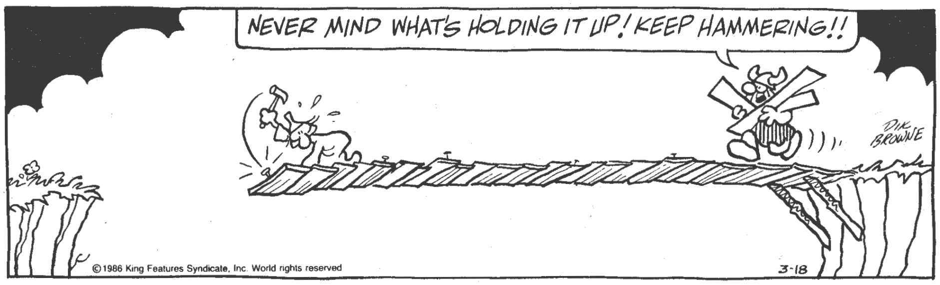
Users. Curriculum designers considering a particular block will be interested in who has already judged the block favorably enough to adopt it—and what they have to say about how it has worked out for them. A block description ought to indicate whether the block developer maintains and makes available an up-to-date list of users in different regions of the country. Such a listing would make it convenient for a curriculum-design team to communicate directly with users in school districts similar to its own. Interviewing teachers who have actually taught the block can bring to light useful information, both positive and negative, not found in any other way.

Development. It matters how and by whom a block was created. The block description should indicate how teachers and scientists were involved and with what kinds of students the block material was tested in classroom settings. The description should also refer to published research on teaching and learning that support the block's instructional strategy. The more that scientists and classroom teachers are involved in the block's development, the more extensive and representative the field testing, and the more rounds of revision in response to that testing, the greater the confidence that can be placed in the block being able to deliver the learning outcomes that are claimed. Serious attention to cognitive research, when explicitly and specifically claimed (or done) by developers, is also an important source of credibility.

Such explicit research on student learning is summarized in CHAPTER 15: THE RESEARCH BASE of *Benchmarks for Science Literacy* and in *Resources for Science Literacy: Professional Development.*

In the short run, the task of describing blocks in these template terms will likely fall on specialists who set up the database. In the long run, developers of blocks, perceiving consumer interest in using the database, may do much of the description work themselves— especially once they have begun to build in the desirable properties that the template implies.

Inevitably, a large curriculum-block database—perhaps a single, national one—would include blocks of differing quality. The objective is to include blocks in the database on the basis of the completeness of a block's description, not on a definitive conclusion about its quality. Local school districts, not distant agencies or organizations, will decide which blocks merit adoption.



Hagar the Horrible by Dik Browne

WHERE WILL CURRICULUM BLOCKS COME FROM?

The design-by-assembly approach calls for a large national pool of curriculum blocks, that are well described in an accessible database. But where will the blocks come from? Who will actually create them?

Developing curriculum blocks is a job for teams of specialists: scientists, mathematicians, historians, engineers, statisticians, psychologists, educational researchers, artists, literary critics, and other scholars and practitioners. It also takes graphic artists, writers, activities inventors, filmmakers, computer-program writers, test makers, and others. Among the most important specialists to have on the team are classroom teachers.

This book, as already explained, merely supposes that such an inventory of blocks and database of descriptions will become available in the early years of the 21st century and does not offer any direct advice on how to develop them. But here are some thoughts on how the actual development of curriculum blocks could come about.

Sources of Curriculum Blocks

Curriculum blocks can be designed by modifying some of the creditable courses and units currently in the curriculum. American elementary and secondary education is blessed with a large number of highly creative individuals—classroom teachers, professors, grantees of public agencies and private foundations, and editors and writers for publishing houses. Some of them have succeeded in developing courses or smaller modules that, with some work and with complete and accurate descriptions, could become curriculum blocks of the highest quality. Perhaps the most crucial aspect of this task would be tying these existing courses—operationally, not rhetorically—to specific learning goals such as those in *Benchmarks*.

Another potential source of curriculum-block material consists of some of the courses developed during the era of curriculum reform a generation ago. For one reason or another, many of them have gone out of use or have left only a few traces in other materials. With a modest investment of time and money, some could be recast to take advantage of the greater flexibility now possible in format and time, the advances in research knowledge about how students understand and learn, and the availability of more powerful technologies. Indeed, some of the nonprofit organizations under whose auspices the courses were originally produced continue to be world leaders in the development of innovative instructional materials. Given suitable financial support and incentive, those organizations could expeditiously and creatively undertake this refurbishment.

As a way to stimulate thinking about curriculum blocks, *Designs on Disk* contains a database for creating block descriptions.

But in the long run, a large number of altogether new blocks will have to be created to provide more choices for curriculum design tailored to a spectrum of populations, resources, and viewpoints. They can be developed starting with interesting ideas on instruction, with a selection of specific learning goals, or with readily available materials, particularly trade books.

The Role of Teachers in Developing Curriculum Blocks

It is sometimes thought that classroom teachers create the courses they teach and that the teachers in a school create the school's curriculum. In truth, very few teachers design courses *de novo*. Instead, they shape a given course—5th-grade arithmetic, say, or 9th-grade earth science—to fit their prevailing circumstances (students, resources, policies) and to reflect their professional judgment. This invaluable contribution to learning acknowledges the fact that such shaping is almost always needed, which is one reason that good teachers will always be essential. Teachers also are a key source of ideas on what is needed and what students are likely to respond to well. Some teachers, of course, become expert contributors to development teams. And many teachers are needed to carry out the field testing of prototypes and provide systematic feedback on the blocks once they are in use. But to expect all teachers to develop their own curriculum blocks is unreasonable. Few have time or resources or experience for such an undertaking and are better occupied in fine-tuning commercially available blocks for their own students.

However, it is neither possible nor desirable to have all new curriculum blocks developed by teams or organizations. There is the obvious limitation of resources, for those groups can do development work only if they are able to secure adequate financial backing. The availability of such support varies greatly over time and often does not last long enough to sustain steady curriculum development. The commercial sector, on the other hand, has the resources to provide the needed research and development capital and is able to assemble the creative talent needed to do the job. Many publishers, television stations, filmmakers, and software developers produce innovative materials and have a strong market incentive to meet new curriculum demands. But they too must include teachers on their development teams.

Realistically though, how can we expect teachers to take part in such research and development (R&D) when their day is already taken up by teaching, preparation, and dozens of other duties associated with schooling? Although most teachers do some R&D in their own classrooms, there is no tradition in the schools—comparable, say, to that found in research universities—to justify such work, and no provisions for supporting it. And even if there were, few teachers have the training or experience to conduct R&D at a high professional level.

To some degree, the participation of teachers in creating curriculum blocks could be arranged by allowing them to become members of funded development projects based in universities or professional societies. That happened in the 1960s with great success. Not only were the products of those curriculum projects much better than they would have been without teacher input, but the nation ended up with a cadre of trained curriculum specialists. The process should be reinstituted, this time with the understanding that the teachers who participate will return to teaching in specialized institutions in which they can continue to engage in R & D. And they should be sought out by those publishers seriously intent upon investing in state-of-the-art product development.

For financial and historical reasons, few of the 15,000 school districts in the United States are able to undertake R&D activities on a sustained basis. Hence, teachers with applicable experience-based preparation have nowhere to go to utilize their new knowledge and skills. The notion of the "R&D school district" holds that out of all of the school districts in the nation, we need to transform only a relatively small number—perhaps a few dozen—into formal R&D school districts—that is, school districts that, as a matter of policy, would participate in R&D activities of one kind or another on a continuing basis. (All school districts, however, will continue to do local R&D in adopting national products for their own contexts and students.)

Some of the varied arrangements known as "professional-development schools" already include components of R&D. Also, there is collaboration on R&D between regional education laboratories and schools. Some R&D school districts could be just such hybrids, analogous to "research universities" or "teaching hospitals," both of which typically have parallel and mutually supporting roles of education, research, and development.

Some university faculty members do conduct research studies in schools, and specially funded development projects do test their own materials and courses in schools. But in-school faculty research is not the equivalent of clinical research conducted in research hospitals (most hospitals are not research institutions), and in-school testing is rarely very systematic in design. And just as the clinical investigators in a research hospital can call on the help of the basic researchers in the university with which it is associated, and are able to scour the research literature for knowledge that can be applied to medical practice (which most practicing physicians are not prepared to do), so too would "clinical researchers" in R&D school districts. The main point here is simply that it will take institutional change to enable teachers to participate effectively in developing the curriculum components of the future.

The experience of Project 2061 strongly suggests that some such arrangements will pay off. Six Project 2061 school-district centers were established in 1989 to provide the project with colleagues who would contribute to its work in creative ways. Each center's team members had the freedom to participate in R&D activities that were not necessarily aimed at improving instruction in their districts. In other words, they were not set up as traditional demonstration sites but as district-based R&D centers with university ties and a national focus.

The Project 2061 school-district team members have had a major hand in developing *Benchmarks for Science Literacy*, *Benchmarks on Disk*, *Designs for Science Literacy*, *Designs on Disk*, *Resources for Science Literacy: Professional Development*, *Resources for Science Literacy: Curriculum Materials Evaluation*, and *Blueprints for Reform* as well as Project 2061's growth-of-understanding maps. The team members have been in on the conception of these reform tools, have provided many of the key ideas in them and helped to clarify them, and have undertaken a critical appraisal of all of the draft documents. They have not been merely helpful, they have been essential players in what is at heart an R&D effort. Given the opportunity and the resources, teachers in other districts could be equally productive, in time ameliorating the shortage of teachers prepared to participate in such efforts.

Ideas for Curriculum Blocks

As the curriculum-block idea gradually took shape, along with clarification of the curriculum-design concept and emergence of the notion of curriculum design described in the previous chapter, Project 2061 began to accumulate suggestions for blocks *to be created.* Ideas came from Project 2061 staff, the school-district team members, and consultants. In some cases, contributions were complete enough to be considered specifications for block development, though most were less complete than that.

Below are some categories of ideas to illustrate the variety of curriculum blocks that could well be part of the national inventory. They are not offered as a set of definitive or mutually exclusive categories, but as emphases that would allow many mixes to be worked out in detail.

Applications blocks emphasizing the uses of science, mathematics, or technology. Examples: Chemistry and Society, Public Opinion Polling, and Science and Crime Detection.

Case-study blocks in which the content is organized around one or more case studies that focus on historical episodes, social issues, or technological problems. Examples: Darwin's Finches, The Chemical Revolution, and Brecht's Galileo.

Design blocks organized around design challenges for students to respond to individually or in groups. Examples: Energy Conservation, Measuring Time, Remote Controls.

Cross-cutting blocks that link science, mathematics, or technology to other domains. Examples: Architecture, Dinosaurs and Dragons, the Panama Canal, Evidence in Law and Science.

Discipline blocks that present some important aspects of the content, methods, and conceptual structure of a discipline. Examples: Anthropology, Statistics and Probability, Biochemistry.

Explanation blocks that are designed to help students understand phenomena, objects, and systems. Examples: Fire, Growth and Decay, Science and Technology Underground, and Plagues.

Any of these "types" of curriculum blocks might be provided in different forms—a mailable package, an Internet site, or access to the resources of a particular institution.

Exploration blocks that examine a place or time from the perspective of science and technology. Examples: Science and Technology in Ancient Egypt, the Lewis and Clark Expedition, Science Underwater, and Science in Space.

Inquiry blocks that engage students in designing and carrying out scientific investigations to foster an understanding of how science goes about its work. Examples: Objects in Motion, Neighborhood Insect Species, and Traffic Patterns.

Issue blocks, usually seminars, that engage students in an examination of issues involving science and technology. Examples: Ethics of Experimentation, Genetic Engineering, and Populations.

Theme blocks based on broad concepts—such as those in Chapter 11: Common Themes in *Science for All Americans* and *Benchmarks for Science Literacy*—that cut across science, mathematics, and technology. Examples: Feedback in Biological and Social Systems, the Size of Things, and Evidence.

When curriculum blocks are thoroughly and accurately described as to specific goals targeted, operational requirements, and evidence of success, school-district curriculum-design teams will have the information they need—now almost completely lacking—to select a set of blocks that will meet local and state requirements. A district will construct its curriculum from a relatively few of the blocks, but different districts could end up with different arrays of blocks and still meet national, state, and local standards.

Looking Ahead

A national computer database of complete curriculum designs will eventually be available as an alternative starting place for curriculum designers. Using computers, designers will be able to draw on libraries of specific learning goals, fully described curriculum blocks, curriculum-design concepts (many of them elaborated well beyond the concise examples we have given), and complete curriculum designs. To top that all off, they can expect to have access to information about school districts that have actually implemented specific curriculum designs and how those designs are turning out. What is learned from the implementation of designs can then be used to improve the designs for use by others and to enhance our knowledge of curriculum more generally.

How will the new school curricula of the future be created and implemented? The next chapter presents the still-imaginary stories of how that will happen in three different school districts of the 21st century.