Meeting Standards Through Integrated Curriculum

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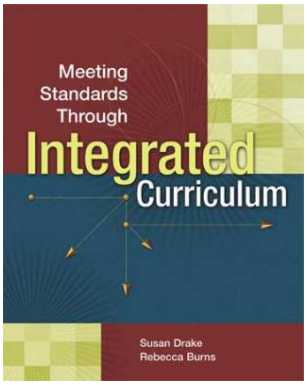
Table of Contents



Sale Book (*2004*)

Chapter 4. Using Standards to Integrate the Curriculum

Alignment is a fundamental principle of the backward design process and is central to a successful curriculum. However, what does alignment mean? Alignment means that the curriculum is coherent: a common framework aligns curriculum, instruction, and assessment.

Alignment

We believe two types of alignment are necessary: external alignment and internal alignment.

External Alignment

External alignment occurs when the curriculum aligns with mandated standards and testing objectives. First, the written and taught curricula reflect the concepts and skills required in the standards. For example, the concepts of ratio and proportion may appear in the 8th grade math standards in the written curriculum guide. Therefore, the taught curriculum (teachers' curriculum maps and lesson plans) should provide evidence that 8th graders are experiencing lessons on ratio and proportion. At the same time, teachers may note that the concepts of ratio and proportion overlap in science and mathematics. This opens the door to interdisciplinary approaches.

Second, external alignment means that teachers are mindful of testing objectives. Standards and assessment practices can be aligned in different ways. Some states and provinces formally align their standards with standardized tests. For example, Virginia's Standards of Learning tests are criterion-referenced to the Standards of Learning. In some states, however, the state standards do not align with the norm-based test used for statewide assessment. When testing and standards do not align, teachers can refer to specific test objectives and test items to achieve external curriculum alignment. In any case, an informal item analysis of test scores is an important aspect of external alignment. Assuming that the test is accurate, it is problematic if all students from one class give incorrect answers on a certain portion of the test, or on a particular test question. This often happens because the teacher did not introduce those concepts and skills, or the students did not master them. It is important for teachers to decide if the missed questions address significant

concepts or skills. In some instances, they may decide that the questions are ambiguous or poorly written. Otherwise, they need to revise the curriculum to include more emphasis on those particular concepts and skills. Teachers also may need to reconsider the strategies they use to teach those concepts and skills.

In our experience, teachers often react negatively to this form of external alignment. They do not want to "teach to the test" but often feel compelled to because of the high-stakes nature of the tests. Given our concept of the KNOW and our commitment to accountability, we are of two minds on this question. We agree that not all standards are of equal value and not all tests of equal worth. Yet we recognize that it is important that students do well on the tests. We can only suggest that teachers be reflective when they make decisions around these matters.

Consider the experience of teachers at Stonewall Jackson Middle School in Charleston, West Virginia. The teachers wanted to improve their students' performance on the Stanford 9 Achievement test. First, they used test-item analysis data to identify the most significant deficiencies. Each day, in an extended learning lab period, the teachers focused instruction on the concepts and skills that the students needed for mastery of the deficiencies. They developed assessments for students to take at three different times before the 2003 administration of the Stanford 9 test. The teachers used Bloom's taxonomy to review their assessments (Bloom, 1956). They found that more than 80 percent of their questions required the lowest level of thinking—recall. However, 90 percent of the standardized test items required students to use higher levels of thinking (Daquilante, 2002). The teachers realized that they needed to align their teaching and assessment strategies with external mandates. This was a thoughtful way to address external accountability.

State- or provincewide testing seems to be a certainty in a context of accountability. Whether or not such testing is a preferred or reliable mode of measurement is unfortunately not up for debate for most teachers. In these situations, external alignment is helpful. Fortunately, we have found that it does not preclude integrating the curriculum. Some of the examples in this book illustrate how this is possible.

Internal Alignment

Internal alignment occurs when the instructional strategies and classroom assessments reflect the language and intent of the standards. To achieve internal alignment, teachers must first know how to "unpack the standards," or decode the performance requirements embedded in them. For example, a science standard may state, "Students will design and conduct experiments." The classroom learning activities and assessments must engage students in the actual designing and conducting of experiments, not just in reading about them in the textbook and answering questions.

To match the requirements of the standard to what students actually "do" in the classroom sounds like common sense. Nevertheless, it is often difficult in practice. It takes an educated eye to read and interpret the standards in a way that leads to relevant curriculum. Internal alignment is an iterative process. Teachers need to constantly check and recheck to ensure that all the pieces of the standards connect to the actual learning experiences. The section in this chapter on interpreting and analyzing existing standards should be helpful for this task

Clearly, both types of alignment are important for the curriculum in each classroom. Surprisingly, alignment is an even stronger predictor of student achievement on standardized tests than are socioeconomic status, gender, race, and teacher effect (Elmore & Rothman, 1999; Mitchell, 1998; Wishnick, 1989). Alignment levels the playing field for all students and, therefore, is an essential ingredient in curriculum design.

Accountability or Relevance?

An externally and internally aligned curriculum does not necessarily mean students learn as well as they might. Curriculum planners cannot ignore the fact that students learn best when the material is relevant to them. Often the only relevancy a teacher can offer is that the material will be on a test, or that students need

to know it in a higher grade. We know that both alignment (and thus accountability) and relevance are possible in an integrated curriculum. Indeed, aligning instruction and assessment with student interests engages students in and promotes retention of learning (Brophy, 2000).

Yet when we worked together on this premise, we found that we were constantly wrestling with tensions that took us back and forth between two seemingly irreconcilable positions. We broadly characterized these positions as accountability versus relevance. At first, we tried to brush these differences aside or to resolve them quickly. The tensions, however, kept reappearing. We recognized that we had to come to terms with them. Figure 4.1 identifies several of the tensions we found between accountability and relevance.

Figure 4.1. Accountability or Relevance?

Accountability	Relevance
We need to cover the standards to be accountable.	We need lessons to be meaningful to students, and the standards aren't necessarily relevant.
We need to follow mandated curriculum.	Students are often really interested in local issues, but these issues aren't in the standards.
We need to think like an assessors when planning activities.	We know some great activities that kids will enjoy.
One-half of the class missed Question 6 on the standardized exam.	We want to focus on big ideas and interdisciplinary skills that students can use for life.
We need to use a zoom lens (microscope) to make sure we are aligning curriculum with discipline standards.	We need to use a wide-angle lens to find the connections and overlaps across the curriculum. Through connections, we can make learning more relevant.

When we considered the tensions to be either/or positions, we found ourselves at loggerheads with each other. When we were able to see them as both/and, our work continued smoothly. Using the metaphors of a zoom lens and a wide-angle lens was helpful. We needed the zoom lens, or a microscope, to see the little picture and deal with issues of accountability. The wide-angle lens helped to explore the big picture necessary for interdisciplinary work. Sometimes we needed to shift back and forth between the two, and at other times, we needed to use both at once.

Interpreting and Analyzing Existing Standards

Standards as they appear in curriculum guidelines around the world share some similarities. For one, they are competency-based and concerned with student outcomes. Unfortunately, at this time, the standards vary considerably in quality. Some states, for example, have more rigorous and well-defined standards than others do. This creates an uneven playing field for comparing the degree to which students from different

jurisdictions meet required standards. Some states and provinces include standards that are interdisciplinary in nature, as well as discipline-based. In these jurisdictions, it is easier to integrate curriculum.

Educators must deal with standards as they find them articulated in their appropriate curriculum documents. Virtually all curriculum documents are concerned with what a student "should know and be able to do." Most documents do not explicitly name these categories. It is left up to the teacher to unpack the standards to decide exactly what the student is expected to know and to do.

We use the KNOW/DO/BE framework as a way to analyze existing standards. In reality, few documents use the KNOW/DO/BE framework as we conceptualize it. The framework allows a richer understanding of what a standard requires, as written, and opens the opportunity to enhance it in a way that might better fit student needs.

To deconstruct existing standards, it is simplest to remember the following:

KNOW = nouns

DO = verbs

BE = attitudes, beliefs, actions

The chart in Figure 4.2 shows how selected standards from the Ontario Curriculum can be deconstructed using this framework. Analyzing standards using the KNOW/DO/BE framework clarifies exactly what a student has to know to demonstrate the standard. For standards that are written with a lower-level skill, such as "recall" or "identify," only the KNOW is important (see Figure 3.10 for examples of lower-level skills). Standards 1 and 2 in Figure 4.2 fit this category.

Figure 4.2. Analyzing Standards from the Ontario Curriculum Using the KNOW/DO/BE Framework

Standard	KNOW	DO	BE
1. Identify some of the significant events that occurred during medieval times. (Social Studies—Grade 4)	Some significant events of medieval time	Not included	Not included
2. Describe aspects of the history of modern Western art and of selected forms of African, oceanic, and Central and South American art. (Visual Arts—Grade 12)	Aspects of modern Western art and selected forms of African, oceanic, and Central and South American art	Not included	Not included
3. Collect and organize data on tally charts and stem-and-leaf plots and display data collected by the students (primary data) and	Tally charts, stem-and-leaf plots, primary data, and secondary data	Collect, organize, and display data using tally	Not included (But objectivity is an implicit value.)

more complex data collected by someone else (secondary data). (Math—Grade 7)		charts and stem-and-leaf plots.	
4. Formulate scientific questions about observed ecological relationships, ideas, problems, and issues (e. g., What impact will supplying excess food for a particular organism have on an ecosystem?). (Science—Grade 10)	Criteria for scientific questions, observed ecological relationships, ideas, problems and issues, sustainability	Create scientific questions.	Not included (But environmental responsibility is an implicit value.)
5. Communicate ideas and information for a variety of purposes (to inform, to persuade, to explain) and to specific audiences (e.g., write the instructions for building an electrical circuit for an audience unfamiliar with the technical terminology). (Writing—Grade 6)	Writing conventions (grammar, punctuation, spelling, visual presentation, word use) and writing styles (persuasive, explanatory, informative)	Communicate effectively by applying writing conventions.	Not included (But values are embedded in most communications and certainly in persuasive writing.)
6. Apply decision-making and assertiveness skills to make and maintain healthy choices related to tobacco use and recognize factors that can influence decisions to smoke or to abstain from smoking. (Health)	Decision-making skills, healthy choices for tobacco use, factors influencing decisions to smoke or not	Develop decision-making matrix and apply decision-making skills.	Though not explicit, values are embedded into “healthy choices”; assumption is to be a nonsmoker.
7. Demonstrate collaborative problem solving, conflict management, and planning skills (e. g., responsibility of each member to carry his or her weight, task analysis, and division of labor, time management). (Social Sciences—Grade 9 or 10)	Procedures for problem solving, conflict management, and planning	Demonstrate problem-solving, conflict management, and planning skills.	Be collaborative.

8. Conduct investigations of the outdoor environment in a responsible way and with respect for the environment. (Science)	Investigation skills	Investigate.	Be responsible, and respect the environment.

When standards move into the realm of higher-level skills, it is important to teach the skills. Standards 3 through 8 in Figure 4.2 require instruction on the skill or the subset of skills required to do the task. Standard 4, for example, requires students to formulate scientific questions about observed ecological relationships, ideas, problems, and issues. Students need to know how to ask scientific questions—one of the subsets of skills for scientific inquiry. It is also interesting to note that these standards are not attached to any specific content—they transcend the disciplines. Most curriculum documents have many standards with similar characteristics.

As previously mentioned, most written standards lack the BE component. This does not mean that values are not implicit in the standards. Standards 3 through 6 illustrate how values, though not explicit, are involved in the demonstration of the standard. Consider Standard 5. It addresses effective communication for a variety of purposes to specific audiences. Joanne Reid from the Trillium District Board of Education points out that the standard assumes the existence of such a thing as neutral language. In persuasive writing, however, the writer must assume a value-laden position. Even informative writing is not neutral. Joanne notes that the writer must consider the audience. What is included or left out to appeal to targeted audiences? What words are laden with innuendo and connotation?

In Figure 4.2, Standards 7 and 8 acknowledge the BE. This is rare. We discovered these examples only after a thorough scan of the standards documents. In most standards, as in 5 and 6, the implicit BE needs to be made explicit.

Although accountability mandates require that we cover the standards, teachers have the freedom to expand on or connect to other standards to make them more meaningful. This is particularly true for interdisciplinary work. Making connections across the disciplines through interdisciplinary concepts and skills may not be in the guidelines, but it can enrich a taught curriculum tremendously. Science teacher Roberta Ann McManus uses a number of literacy strategies in her classroom to ensure that her middle school students develop a repertoire of skills needed to read and understand science texts (Topping & McManus, 2002). She teaches science, but she delivers her program through literacy processes. It works for her students. They write journals, read science-related books for pleasure, and practice “think aloud” strategies for reading and writing. McManus believes that people learn through story, and she has enhanced the written standards to practice her belief through an interdisciplinary approach.

Despite the fact that educators feel overwhelmed by the sheer volume of standards, they still need to enhance them when needed. The KNOW/DO/BE framework offers a meaningful way to do this. In fact, enhancing the standards makes them more personalized and thus more doable. In particular, teachers need to be thoughtful about the BE. What values are we promoting in the classroom? Are we designing learning experiences that encourage students to be, for example, self-confident, responsible citizens, tolerant and respectful of others? Teachers may never formally evaluate BEING. However, naming it during curriculum planning ensures that BEING influences the expectations for learning.

Curriculum Mapping

Curriculum mapping is a process for recording the content and skills actually taught in the classroom over the course of a year. Many districts use curriculum mapping as a tool for achieving external and internal alignment. An extremely valuable benefit of curriculum mapping is that it is usually a collaborative venture. In

our experience, this leads teachers to rich discussions about curriculum and a deeper understanding of the standards.

Educators use several different ways to map the taught curriculum. Fenwick English (1980), for example, defines curriculum mapping as recording the content taught and the amount of time spent teaching it—what teachers might include in a scope and sequence chart. For Heidi Jacobs (1997), curriculum mapping involves recording content, skills, and assessment in monthly chunks to create a year's curriculum map. Rebecca Burns (2001) believes that the "how" of teaching is equally important and recommends recording the students' learning tasks as well. Using her curriculum mapping process, teachers identify the standards addressed by each task. Rebecca encourages them to use a variety of teaching strategies for diverse learning needs. Using Curriculum Creator, a Web-based tool developed at Appalachia Educational Laboratory, teachers apply her curriculum mapping process to design instructional units. They create learning activities and assessments and link them to specific state standards. Teachers create curriculum maps for each month or grading period that include the completed units. The sequenced list of units becomes the year's curriculum map and contains all standards addressed throughout the year.

Curriculum mapping includes recording the actual taught curriculum, comparing it with written and tested curricula (district curriculum standards documents and standardized tests), and revising it where needed to ensure coherence. Some states and provinces provide educators with a scope and sequence of concepts (or essential/enduring understandings) and skills with a recommended period for teaching them. Using a curricular scope and sequence makes it much easier for teachers to achieve external curriculum alignment and to create a curriculum map.

Curriculum mapping helps teachers prepare for curriculum integration. Teachers can compare their curriculum maps with the maps of other people teaching the same course or other courses at the same grade. When teachers review scope and sequence documents and curriculum maps across disciplines, natural areas of overlap in concepts and skills emerge.

As the teachers from Lunenburg County, Virginia, illustrate, curriculum mapping is a methodical way to develop a big picture of school and district curricula. It also helps teachers identify natural possibilities for integrating curriculum. Using the state's suggested scope and sequence in each of four content areas, teachers developed their own vertical scope and sequence of instructional units. Individually and in grade-level teams from kindergarten to 12th grade, they mapped what they were teaching into monthly chunks. To identify broad-based concepts and skills, they reviewed the charts horizontally at the end of the year. This process helped them decide which concepts and skills to integrate and what they would continue to teach from a disciplinary perspective.

Figure 4.3 offers an example of a monthly curriculum map. Fifth grade teacher Mary Ann Whitlow from Lunenburg County completed this map primarily for mathematics. It illustrates how Mary Ann integrated language arts and social studies into the lessons by making connections through the interdisciplinary concept of "patterns."

Figure 4.3. Example of Monthly Curriculum Map

Grade: 5 **Month: September** **Content: Mathematics** **Teacher: M. Whitlow**				
Content	**Unit/Content**	**Cross-**	**Activities/Resources**	**Assessments**

Standard/Learning Expectations		Disciplinary Connections		
SOL 4.11, 4.12, 4.13 Estimate, measure weight and mass, length, and liquid volume.	Customary and metric length measurement.		1. The teacher demonstrates parts of the body as approximate measurements for real measurements. Teacher demonstrates how to read inches and centimeters. Students pair up to measure heights. 2. Teacher reads the book *Math Curse*. Class discusses Mrs. Fibonacci's name and students try to figure out the Fibonacci pattern. 3. Teacher reads *Sea Squares* and helps students build square numbers using orange square pattern blocks, grid paper, and a chart to record findings. 4. Teacher and students build triangular	1. Students complete "Measuring Me" profile sheet and decide based on their height and arm span whether they are square or rectangular. 2. Students hunt for Fibonacci's sequence in nature—sunflowers, pine cones, pineapples, etc. Bring in examples. 3. Students' grids and charts. 4. Students' grids and charts. 5. Page 271 of math text. 6. Diagonal drawings and chart. 7. Patterns quiz. 8. Students investigate the numerical and geometric
5.19 Investigate, describe, extend numerical and geometric patterns, including triangular numbers, perfect squares, patterns formed by powers, and arithmetic sequences.	Fibonacci's sequence. Square numbers. Triangular numbers. Diagonals of polygons. Building apartments (patterns to find 10 apartments).	Language Arts SOL 5.5 Describe the characteristics of free verse, rhymed, and patterned poetry.		
5.20 Investigate, describe concept of variable, use variable to represent a given verbal quantitative expression involving one operation, and write an open sentence using a variable to represent a given mathematical relationship.	Geometric patterns (tiling kitchen homework). Calculator pattern problems. Hands-on algebra lessons.	Social Studies SOL 4.1, 4.2 Time line (patterns in the years on the scale).		

			numbers using hexagons (discuss beehives), grids, and recording chart. 5. Teacher reads *A Cloak for the Dreamer* and discusses geometric patterns. Students complete text on p. 271. 6. Teacher and students solve diagonals in polygons pattern. 7. Students find the pattern to solve problem of number of blocks needed to build 10 apartment buildings. 8. Students discuss and solve word problems and calculator problem-solving patterns. 9. Teacher models the set up of additional algebra problems.	pattern and then extend it. 9. Transparency. 10. Hands-on class worksheet (kits, calculator, and pictures will be used).

			10. Students use their hands-on lkits to build and solve algebra problems.	

Scanning and Clustering Standards for Integration

The scan-and-cluster process is crucial for effectively integrating a standards-based curriculum. At first glance, it will seem to be a daunting task. Simply reading about it is intimidating. However, it is work well worth doing. *One intensive scan and cluster for each grade is enough*. Then, the scan-and-cluster process becomes second nature. This is not curriculum mapping. Mapping is a disciplined-based activity that works with the curriculum in a literal way to identify what standards are already covered. During the process, teachers identify curriculum gaps and overlaps. Curriculum mapping, therefore, definitely provides a head start for scanning and clustering.

The first step in the scan-and-cluster process is to scan with a wide-angle lens for KNOW and DO—interdisciplinary concepts and skills—that cut across the subject areas selected for integration. A scan is really just that. It is not a detailed journey. It provides the curriculum designer with a big picture. Scanning vertically through the same subject areas shows what students studied in past years and what they will study in the future. The second step is to cluster standards into meaningful chunks. This step needs more detail—the zoom lens helps to zero in on the standards.

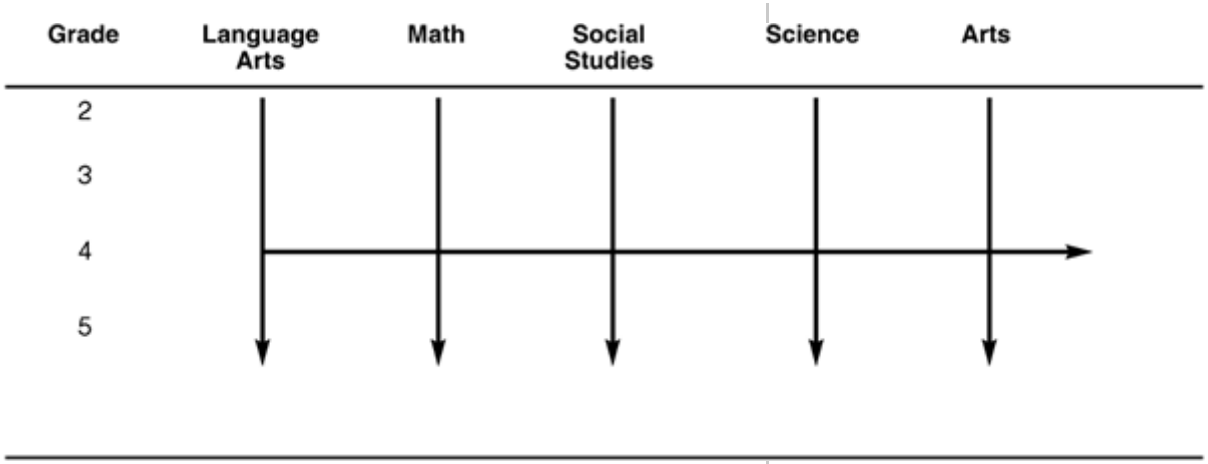
To scan and cluster is to review the curriculum using the KNOW/DO/BE bridge as an interpretive filter. Generally the KNOW and the DO exist in curriculum documents, but they are not necessarily obvious. The interdisciplinary skills of the DO are similar in every subject at all grade levels, but they increase in complexity in the upper grades. The interdisciplinary concepts also cut across subjects and reappear at different points throughout the grades.

Some curriculum documents cluster together subskills of an interdisciplinary skill. Alternatively, subskills may appear seemingly at random. The scan-and-cluster process is much like putting together a jigsaw puzzle. The teacher identifies the pieces and puts them together into a meaningful whole. The curriculum documents often hold clues for this process. In Ontario, for example, chunks of standards are identified as “inquiry” and “communication.”

Most concepts in the documents are disciplinary ones, such as pulleys and gears, or magnetism. Some interdisciplinary concepts also appear in the standards. At other times, it is up to the curriculum designer to enhance the unit by adding a conceptual lens (theme) that can be used as a filter. Some documents identify interdisciplinary concepts in the introduction. Take a close look at the organization of the documents that you are working with to see if they offer shortcuts for this scan-and-cluster process.

Figure 4.4 is a simple depiction of the scan-and-cluster process. The next sections provide a detailed description of the process.

Figure 4.4. The Horizontal and Vertical Scan



Horizontal Scan and Cluster for Skills

Here are the steps involved in a horizontal scan and cluster for skills:

1. Select standards documents at the appropriate grade level for the subjects you wish to integrate.
2. Identify one interdisciplinary skill—one that involves a complex performance such as research or communication. See the DO triangle (Figure 3.10) for further examples.
3. Identify the subset of skills that are involved in the performance of the complex interdisciplinary skill. For example, research includes skills such as formulating questions, locating information, organizing resources, and so on.
4. Scan the standards document in one subject area to identify specific standards that are a part of the interdisciplinary skill. Look at the verbs for help in finding the related standards. In the case of research, for example, these might be verbs such as *formulate, analyze, investigate, plan*, and *compile*.
5. Choose one color of highlighter. Highlight all standards that relate to the interdisciplinary skill in that subject area.
6. Cluster together standards into meaningful chunks if standards are not organized in this way.
7. Repeat this process with the same highlighter color for other subject areas.
8. Note similarities across subjects. For example, the chunk of standards that describe the scientific method (research skills) in science will be similar in character to standards chunked together under research skills in social studies.
9. Use different colors of highlighters to repeat the process for other interdisciplinary skills across subject areas.

Vertical Scan and Cluster for Skills

Here are the steps involved in a vertical scan and cluster for skills:

1. Select standards documents for one subject area from two grades below and one grade above the one you teach.
2. Scan and cluster vertically through the documents for one interdisciplinary skill (e.g., research) and highlight the standards that address the skill.

3. Note similarities and increased complexity in required performances over the years.
4. Repeat the process for other interdisciplinary skills.

Horizontal Scan for Concepts

Here are the steps involved in a horizontal scan for concepts:

1. Select standards documents in one subject area.
2. Identify concepts that students are expected to know.
3. Differentiate between disciplinary concepts and interdisciplinary concepts (see the KNOW triangle in Figure 3.4 and the examples in Figures 3.5 and 3.6).
4. Repeat for other desired subject areas.

Vertical Scan for Concepts

Here are the steps involved in a vertical scan for concepts:

1. Select standards documents for one subject area from two grades below and one grade above the grade you teach.
2. Scan vertically for disciplinary concepts and interdisciplinary concepts.
3. Consider which of the concepts are transferable to other disciplines. For example, the concept of life systems (science) connects to the concept of systems in government (social studies).
4. Repeat the process for subject areas.

The "Advanced" Quick and Easy Scan and Cluster for Broad-Based Standards

A thorough scan and cluster of the curriculum leads to a deep understanding of the standards and helps teachers chunk them together in meaningful ways. With this understanding, teachers can quickly complete what we call the "advanced" quick and easy scan and cluster for broad-based standards. This is simply a cursory scan to identify the broad-based standards that include interdisciplinary skills and concepts. A broad-based standard may identify an interdisciplinary skill that is wide enough to include the subsets of skills. Alternatively, a broad-based standard may identify a higher-level concept that includes other lower-level concepts. Several standards fall under the umbrella of a broad-based standard.

Consider this standard: "Formulate questions about and identify needs and problems related to structures and mechanisms in their environment and explore possible solutions and answers." This standard is broad enough to include the entire subset of skills for the scientific method when studying pulleys and gears in 4th grade science.

Once teachers have a deep understanding of the different levels of concepts, they can scan the documents quickly to identify the required concepts and to decide how to enhance the curriculum by adding a conceptual theme. The stage is set for integrating the curriculum. The teacher begins the design by selecting one or two broad-based standards for each subject included in the integration.

One Team's Experience

Susan and teachers Sonja Upton, Ellie Phillips, and Melissa Rubocki of the District School Board of Niagara, Ontario, used this process as they prepared to design integrated units for grade 4. The teachers intended to

integrate the entire curriculum for a full year. This meant that we needed to use all the grade 4 Ontario Curriculum documents for the horizontal scan and the grades 2, 3, and 5 documents for the vertical scan. The most intensive scan was for grade 4.

To scan properly, we needed to know what we were looking for. We used the KNOW/DO/BE bridge. The scan process gave us a good sense of the big picture. We did not try to examine the standards in detail, but rather used a wide-angle lens. Because we were all familiar with the standards, this step took us a little more than half an hour. We noted that skills such as research were in every grade and subject area. They just became more complex with each grade. Communication skills appeared not just in language arts, but indeed were in every subject area. Once we had made our general observations, we were ready for the clustering process.

Similarly, we had a lot of discussion around levels of concepts. We found that the categories were not black and white. When one of us defined a concept as lower level, another could defend why it was really an interdisciplinary concept. We discovered during our vertical scan that the higher-level concepts tended to reappear throughout the curriculum. We began to understand why the curriculum documents are not cut-and-dried on these matters (although we believe that curriculum documents need to identify and to provide ground rules on interdisciplinary skills and concepts). Nevertheless, the dialogues were valuable, and we arrived at consensus on what defined a higher-order or interdisciplinary concept.

To cluster, we equipped ourselves with different colors of highlighters for different categories. We looked first for the DO—the interdisciplinary skills within a subject area. We highlighted, for example, all the research standards blue. Design and construction standards were green. Sometimes we had to use more than one color. We looked first for a skill within a subject area (often found in clusters) and across different subject areas. The interdisciplinary skills we highlighted in most subject documents were these:

- Research
- Scientific method—inquiry
- Problem solving
- Communication
- Design and construction
- Presentation
- Comparison
- Prediction
- Making charts and graphs

Once we got started, this step was quite easy. Figure 4.5 shows some of the standards we clustered together for research skills. We used a set of numbered standards. In most jurisdictions, numbered standards are available. (If the standards are not numbered, it is helpful to number them before the scan-and-cluster process.) In social studies and science, we identified a chunk of standards that presented research skills sequentially (see, for example, 4s29–4s34 and 4z39–4z44). In the other subjects, we found the research skills scattered somewhat randomly in the document.

Figure 4.5. Clusters of Research Skills Emerging from a Horizontal Scan of 4th Grade Ontario Curriculum

Language

4e41—Begin to develop research skills (e.g., formulate questions, locate information, clarify their understanding of information through discussion).

Math

4m96—Pose and solve problems by applying a patterning strategy.

4m101—Collect and organize data and identify their use.

4m115—Read and interpret data presented on tables, charts, and graphs.

Science

Matter

4s29—Design and make instruments for a specific purpose or function.

4s30—Formulate questions about and identify problems related to the ways in which materials transmit, reflect, or absorb sound or light and explore possible answers or solutions.

4s31—Plan an investigation for some of these answers and solutions, identifying variables that need to be held constant to ensure a fair test and identifying criteria for assessing solutions.

4s32—Use appropriate vocabulary including correct science and technology terminology in describing their investigations, explorations, and observations.

4s33—Compile data gathered through investigation in order to record and present results using tally charts, tables, and labeled graphs produced by hand or with a computer.

4s34—Communicate the procedure and results of investigations for specific purposes and to specific audiences . . .

Social Studies

The Provinces and Territories of Canada

4z39—Use appropriate vocabulary to describe their inquiries and observations.

4z40—Formulate questions to facilitate the gathering and clarifying of information on study topics . . .

4z41—Locate key information about natural resources and their use.

4z42—Sort and classify information to identify issues, solve problems, and make decisions.

4z43—Construct and read a wide variety of graphs, charts, diagrams, maps, and models for specific purposes.

4z44—Communicate information about regions, using media works, oral presentations, written notes and descriptions, drawings tables, charts, maps, and graphs.

Health and Physical Education

4p6—Analyze over a period their food selections, including food purchases, and determine whether or not they are healthy choices.

Arts

Visual Arts

4a43—Plan a work of art, identifying the artistic problem and a proposed solution.

Drama and Dance

4a52—Identify and apply solutions to problems presented through drama and dance and make appropriate decisions in large and small groups.

Now we needed to do a similar scanning process for the KNOW—the interdisciplinary concepts. Unlike the interdisciplinary skills, we knew that concepts might differ from grade to grade. As well, they might not be as easy to spot. Few curriculum planners had concept-based education in mind when they created the documents.

The Ontario Curriculum was helpful in some areas. The introduction of the science document, for example, included a chart to identify topics and strands. With our interpretive lens, we wondered how interdisciplinary concepts might enhance the curriculum by acting as a larger umbrella for both topics and strands. Reading the introduction, the intentions of the curriculum designers came quickly into focus. Now we could see the intended continuity for the concepts in the document. Figure 4.6 shows how we used a KNOW/DO filter to interpret two strands and topics for science and technology for grades 2 through 5 in the *Ontario Curriculum Grades 1–8* (http://www.edu.gov.on.ca).

Figure 4.6. Vertical Scan for Concepts

Concepts/Topics	Grade Level	Example	Example
Umbrella interdisciplinary concept	All	Systems	Models
Umbrella higher-level disciplinary concept	All	Life systems	Structures and mechanisms
Topic	2	Growth and change in animals	Movement
Topic	3	Growth and change in plants	Stability
Topic	4	Habitats and community	Pulleys and gears
Topic	5	Human organ systems	Forces acting on structures and mechanisms

An interpretation of a vertical scan for concepts is similar to a scope-and-sequence chart. Alternatively, it offers a big picture of the KNOW—interdisciplinary concepts and the lower-level concepts that fit within them. In Figure 4.6, the higher-level concept of life systems acts as an umbrella for the topics of growth and change in animals, growth and change in plants, habitats and communities, and human organ systems. An even higher-level concept is that of systems because it is transferable across disciplines.

Similarly the concept of structures and mechanisms acts as a higher-level concept that includes movement, stability, pulleys and gears, and forces acting on structures and mechanisms. The concept of models is interdisciplinary and acts as an umbrella to them all.

Armed with new understandings, we were ready for the advanced scan-and-cluster exercise—to select one or two broad-based standards for each subject we planned to integrate into a unit.