Chapter 5
Learning to Integrate

Schools have traditionally treated learning as a "one step at a time" process. One step at a time suggests just one time dimension—now—and when you have learned it, you can move on to the next step or grade. Learning proceeds more rapidly, however, when what is being learned is related to what is already known. Relating what has been learned with what is being learned adds another dimension—the past. Thinking about future applications of the knowledge being acquired along with an understanding of relationships adds yet another dimension—the future. Thinking of different applications for solving problems in new situations, for creating new ideas from the old suggests several more dimensions. The human mind is capable of integrating a number of dimensions when it has opportunities to do so; dynamic n-dimensional learning can be a reality in the right kind of learning environment.

What skills are fundamental to the integration of knowledge and understanding? Communication is a fundamental skill. First, people used oral communication to pass their history on by storytelling, and much of our communication is still done orally. Then came written communication, using primitive pictures and scrolls first and eventually the printing press, which is still used extensively. Now we have electronic communication, making the distribution of oral and written communications extremely fast and efficient What does the future hold? More electronic communication and information transfer, for sure, and unprecedented opportunities to integrate knowledge across course and curriculum boundaries. *Learning to* *integrate knowledge and understanding effectively is becoming as essential as learning to read and write.*

FROM ONE-STEP TO N-DIMENSIONAL LEARNING

Sequential learning is a useful approach to adding to our knowledge-base, one step at a time, but even young children integrate many dimensions as they learn. As the steps become more numerous and the number of relationships increases, sequential learning is replaced by n-dimensional learning. Additional knowledge then results in concomitant expansion of several knowledge domains. While simple sequential learning increases with time and can be represented by a line curving upward, n-dimensional learning is represented better by a three-dimensional expanding sphere which increases in size in several directions at once.

Logical Sequences

There are some logical learning sequences that include progressions of concept complexities and skills. We learn to crawl before we learn to walk and to walk before we run. We speak with shorter and simpler words before using longer words and complex sentences. We learn to count before we do arithmetic and trigonometry before we do calculus.

What are some examples of learning sequences in your area of expertise? In ecology, it is necessary to know the identity of a plant or animal before learning about its natural history. It is logical to know about the general natural history features of an organism before getting into some of its complex physiological functions. Behavior is often directly related to physiological functions; breeding activities depend on hormone balances, for example. In resource management, one should understand the physiology and behavior of plants and animals before trying to manipulate their populations. Such learning sequences are logical and seamless, and should be promoted when designing learning environments. *The course continuum in Chapter 9 is an example of a seamless learning environment.*

Information can be divided into fragments that are too small to be meaningful. One approach to learning to read in elementary school was based on learning the alphabet first, then short words, followed by longer words. The sequence seemed so logical that parents were "guaranteed" that their children would learn to read. The problem was, however, that the approach fragmented the English language so much, and short words were so meaningless by themselves that the context of even simple stories was lost. *When students acquire information without a meaningful context, they may not have acquired any meaningful knowledge.*

Perceptive elementary teachers recognize that even young children have the ability to integrate knowledge. Knowledge integration depends on <u>connecting</u> information, a natural tendency. Elementary teachers using an integrated "whole language" approach when teaching reading and writing encourage students to write before they can read! This conceptual approach counters the argument that college students need the "minimum essentials" before they can do meaningful work in a subject. College students should learn the essentials as they use them, while integrating knowledge from relevant information resources. Creating a context for learning by integrating knowledge motivates students and has more potential for meaningful learning than the facts-first approach.

Repetitive Sequences

As soon as something meaningful is learned, a learning cycle begins and new knowledge can be created from previous knowledge. Information is used over and over again, whether it consists of words and numbers or concepts and skills as knowledge increases; integrated repetition is more valuable than meaningless out-of-context drills.

Let's think of a natural learning sequence by visualizing a group of students who have just been exposed to a new activity appropriate for their age and experience. First they observe the new activity, and then they want to try it. If it is fun and rewarding, they want to do it over and over , learning to perform the activity better as they practice regularly for a period of time. Everyone goes through such sequences when growing up. We refer to it as "play" by children and as "work" by adults, which should, ideally, be fun and rewarding like play. *How can college professors make learning fun and rewarding to the point where students want to learn because they love to learn, rather than just fulfilling a requirement for graduation?*

College students are not empty vessels to be filled by professors; they are people with knowledge and experience to build on. They are the same kind of learners they were when they were younger...curious, creative, and interactive. Professors can make learning more fun and rewarding by recognizing what their students already know, and integrating their old knowledge with the new. When students create new knowledge from previous knowledge by cooperative and experiential learning, they will enjoy enlarging their knowledge domains and sharing with other students.

N-dimensional Learning

Learning how to solve complex problems, such as nutritional ecology problems or designing a population model, is an n-dimensional task that involves conceptualizing, designing, calculating, and programming. Since computer programs often involve iteration procedures and feedback loops, learning how to write programs is more than learning a technical skill. *Programming logic requires thinking that is beneficial in many kinds of problem-solving situations.*

Learning how to solve complex problems with many dimensions may involve negotiation, where progressively focused thinking occurs until a solution is reached. Many business issues, many resource issues, and many cultural issues involve many dimensions and negotiated solutions to problems that cannot be arrived at by straight-line thinking. *Negotiation is a skill that improves with practice and cooperative learning environments provide many opportunities for that.*

Feedback is an important component of n-dimensional learning. Helping college students learn how to solve complex problems with many dimensions may involve feedback analyses where new information is used to update current information. The outcome is not the product of straight-line sequential thinking, but of n-dimensional thinking that feeds results back for further analyses. *Feedback loops and iterations, whether mathematical or verbal, are procedures that should be used by students when solving complex problems.*

Negotiation, iterations, and feedback loops were introduced above to illustrate how problems are multi-dimensional and therefore can have alternate solutions, depending on the factors considered, the design characteristics of the analyses, and the data available. Professors should not deliver solutions to such problems as simple facts because students will not understand the factors underlying the solutions unless they become actively involved in solving such problems. *Since we cannot predict what problems students will need to solve in their lifetimes, it is far better to focus on the complexity of problem solving rather than the simplicity of factual conclusions.*

KNOWLEDGE CONNECTIONS

Knowledge implies connections, while information stands alone as facts. For example, a weight model that calculates and graphs weight patterns from conception to death at old age can be a beginning point for students to identify and understand connections that can be made to other biological processes. The output—weight—is by itself just a fact. When students learn how metabolism is dependent on weight, food intake is dependent on metabolism, food production is dependent on primary and secondary productivity, food availability is dependent on range conditions, reproductive rates of free-ranging animals are dependent on the food supply, population dynamics are dependent on reproduction and mortality, mortality is dependent on many factors that are part of community ecology...then students begin to realize how extensive knowledge is connected. *The information students learn about in any subject area is so interconnected that collaboration among learners and new learning models are not options but inevitable outcomes of logical thinking, enhanced by the information revolution.*

Creative Learning

Creative learning may result in the discovery of new concepts, but more often it focuses on the synthesis of available information in new ways. Students who have opportunities to think creatively and synthesize what they know about relationships, problem solving, and decision-making become better at it. Practice in the thinking skills listed below, based in part on a list in Hamm and Adams (1992: 114-115), help students create new information from old, or create more knowledge from previously existing knowledge.

- ***Focusing****...on concepts, problems, and goals.*
- ***Finding…****information related to the problem.*
- ***Remembering****...what we know and by data storage.*
- ***Organizing****...arranging information logically.*
- ***Analyzing****...examining and evaluating information.*
- ***Integrating****...relating information and solving problems.*
- ***Producing****...composing new information from the old.*
- ***Evaluating****...both the process and product.*

Creative Learning is enhanced by Collaboration

If there are many dimensions to learning, if learning is experiencing rather than listening, and if experiencing is an integrated complex activity, then collaboration among faculty is necessary. It is impossible for one person to know enough about all the dimensions in complex problems, the different viewpoints students should be exposed to, and the many experiences students should have when participating in the complex process of learning. *Professors should never be the limiting factor in a learning environment.*

With so much to learn, <u>time</u> becomes the limiting factor because professors and students cannot find the time to explore all of the dimensions. The danger of making problems too complex also exists, but it might be better to design learning opportunities that are too complex rather than too simple.

Collaboration among learners, both professors and students, increases efficiency by making it possible to identify at least some of the many dimensions that should be considered when solving problems at the college level. Cooperation among learners increases efficiency by sharing knowledge with each other, which in turn increases understanding of the many dimensions potentially present in every learning situation. Separate courses in the traditional curriculum may be replaced by seamless courses in a continuum (see Chapter 9) in the future.

Transferring Connected Knowledge

Since academic knowledge is so connected, transferring some of it requires that the rest of it come along. Yet we can't say or write all words or all knowledge at one time. What are we to do? We have to divide the knowledge up and then put it together again. This can be done when we think of a college education as a continuum. In the past, graduates were expected to integrate what they had learned when they were on the job. Now, students should be integrating as they are learning because the task of connecting knowledge is too big to leave for their careers. Rather than expecting miracles upon graduation, let's think about how interconnected knowledge can be transferred as students learn.

Professors who deliver the information their students are to learn are demonstrating vertical transfer. The professors are likely authorities in their subject area and have in-depth knowledge of their subject. The students will likely be lined up in rows in a lecture room while the information is delivered to them. Such vertical transfer is often accompanied by specific problems the students are to work on. Learning is directed and the subject matter is well defined and often well organized. *The material to be learned comes from the professor down to the students, with predetermined boundaries on the knowledge domain being covered.*

When students and teachers learn from each other in a cooperative setting, lateral transfer occurs. Cooperative learning depends on lateral transfer by recognizing the potential of student's prior knowledge as a basis for building new knowledge (Hamm and Adams 1992). Integration of subjects occurs naturally as more factors are brought into consideration as each person makes unique contributions. The material to be learned comes from both the professor and the students in the class, and even from professors and students who are not in the class. *Boundaries on the knowledge domain are not predetermined; learning expands as meaningful opportunities arise.*

Hamm and Adams (1992) are referring to public schools when they state "*Curriculum goals are best if they are aimed at the growth of understanding rather than the coverage of state-mandated information."* Rewriting this statement in reference to higher education..."*the best goals promote curiosity, questions, and interactions among student learners rather than coverage of course-mandated information.*"

Let's think on a scale larger than courses. Think of knowledge domains with meaningful rather than arbitrary boundaries. Think of electronic information systems and the potential for connections by hypertext and multimedia technology. Why limit students to specific reading assignments when they can search globally for information resources by clicking a mouse? Why restrict students to assigned readings when electronic searches and hypertext links are readily available? *Wouldn't it be better for them to learn how to search for meaningful background information than to simply look up page numbers?*

The potential for integrated learning in not only great, but also very new. Can we expect students to know how to sort through the vast information resources now at their disposal? Hardly. Can we expect professors to suddenly begin integrating their course material with other professor's course material? Hardly. *Truly integrated learning may be difficult to implement, but that very truth should compel professors to incorporate n-dimensional thinking into higher education learning environments.*

CONCLUDING REMARKS

Knowledge is n-dimensional and interconnected, and n-dimensional learning is interactive. Children need to learn in context in order to apply what they have learned in different circumstances. College students should have more than a list of courses to choose from each semester. Integrating knowledge should not be left up to them after graduation, for that takes a miracle that may never happen for many of them. College professors should do their best to introduce students to knowledge connections and work with students in active problem solving, integrating, and cooperative learning environments. Then, *the miracle may not be necessary because the graduates will have had meaningful experiences as problem-solvers throughout their college career*.