Chapter 9
A Course Continuum

Cooperative learning generates a need for new integrated curriculum and course models. While we need not jump to the conclusion that lectures or lecture courses are obsolete, it is reasonable to conclude that lectures can take up too much time because passive listening reduces opportunities for active learning among students.

How can the traditional college approach be modified to make learning more effective and lecture periods more interactive while accessing information electronically? I developed a "course continuum" approach with main concepts and applications in a cooperative learning environment (Moen et al 2000); it is described after the brief review of the traditional curriculum approach below.

THE TRADITIONAL CURRICULUM APPROACH

Departments have traditionally been subject-matter oriented and students are given a list of courses to take to satisfy the requirements for a "major." Prerequisites are often listed so students must take courses in a particular order.

Professors have traditionally had the privilege of designing their courses in whatever way they felt was most appropriate. Students have been expected to have a certain amount of knowledge before enrolling (assumed or stated prerequisites), and professors have added to their knowledge by lecturing to them. By devoting a portion of their time each semester to each of several courses they were enrolled in, students accumulated knowledge in different subjects,

and when the required number of credit hours were reached, students had completed the "major."

Let's look at a different approach; a seamless course continuum in which there are no arbitrary lines between courses, no barriers to accessing information in different subject areas, and no territorial boundaries between the professors that teach the courses (Moen et al. 2000).

THE COURSE CONTINUUM APPROACH

Students often need to have knowledge from several subjects simultaneously as they complete their assignments in any course. Consider, for example, the teaching of statistics as a collection of separate courses. Students take the first course to learn the basics, the second to build on the first, and so on. Not a bad learning model, except that general biology students may be learning how to do field or laboratory research without having the first course in statistics. They should learn that statistical analyses of data are part of research protocol. So how should students be introduced to the connectedness of biology and statistics? (See page 106.)

Think of learning as a <u>continuum</u> that reflects the connectedncess of knowledge rather than a list of subjects to take as in a curriculum. Recognizing the connectedness of knowledge, courses can be thought of as part of a <u>seamless</u> continuum rather than a collection of separate subjects. The descriptions that follow are based on the course continuum I designed for students in the Department of Natural Resources Cooperative Learning Center in the 1990's.

A <u>course continuum</u> is a group of related courses that provide multidimensional learning opportunities simultaneously. The basic concepts in each of the related courses are presented in a <u>concept course</u> (the lecture course

equivalent) and the active learning opportunities are made available in applications courses (the laboratory course equivalent). The course continuum that was designed for the Cooperative Learning Center in Cornell's Department of Natural Resources is shown below.

A Course Continuum in Wildlife Ecology

NR 104: Natural History Information Management Concepts (1 credit)
NR 105: Natural History Information Management Applications (1-9 credits)
- Section 105.1: Natural History of Plants
- Section 105.2: Natural History of Animals
- Section 105.3: Decision Aids for Field and Laboratory Identification

NR 204: Natural Resource Modeling Concepts (1 credit)
NR 205: Natural Resource Modeling Applications (1-9 credits)
- Section 205.1: Biophysical Modeling in Natural Resources
- Section 205.2: Simulation Modeling in Natural Resources
- Section 205.3: Population Modeling in Natural Resources

NR 304: Wildlife Ecology Concepts (1 credit)
NR 305: Wildlife Ecology Applications (1-9 credits)
- Section 305.1: Wildlife Behavior
- Section 305.2: Wildlife Physiology
- Section 305.3: Wildlife Nutrition
- Section 305.4: Wildlife Energetics

NR 404: Wildlife Population Concepts (1 credit)
NR 405: Wildlife Population Applications (1-9 credits)
- Section 405.1: Wildlife Population Estimating Techniques
- Section 405.2: Wildlife Population Simulation Models
- Section 405.3: Wildlife Population Reconstruction Models

The basic concepts in both printed and electronic formats were made available to all of the students who had enrolled in any of the courses while in-depth discussions of the concepts were held with the students enrolled in each of the concept courses. Thus all of the students gained insights into the basic concepts and how they were related among subject areas while gaining in-depth experiences in the applications sections of the courses in which they had enrolled.

A cooperative learning environment is an essential characteristic of a course continuum because more experienced students worked with less experienced students in a learning group. This was one of the most unique characteristics of the continuum; *each student in a learning group was enrolled in a different concept course*. The learning group would select a common theme, a species for example. Each student would elect one or more applications courses and their research plans would be integrated with the work of other students in their learning group. Thus students in several courses in the continuum met at the same time and worked together on different aspects of a common topic, reinforcing the connectedness of knowledge as they participated in a seamless course environment.

An example is given below of the way in which a learning group might approach a species-based theme. Suppose that the gray wolf (*Canis lupus*) was selected as the theme. Four students—a freshmen, sophomore, junior, and senior—would form a learning group. The 1st through the 4th year students would enroll in concept courses for one credit each as follows:

1st year: NR 104: Natural History Information Management Concepts
2nd year: NR 204: Natural Resource Modeling Concepts
3rd year: NR 304: Wildlife Ecology Concepts
4th year: NR 404: Wildlife Population Concepts

The work of the learning group could be integrated as given in the following examples; many other combinations could be identified, of course.

The 1st year student provided general information on the natural history of gray wolves by writing a natural history file while enrolled in natural history of animals section (NR 105.2) for one credit.

The 2nd year student learned about computer programming by writing programs to meet the needs of the 3rd and 4th year students while enrolled in the modeling applications section (NR 205.2) for one or more credits.

The 3rd year student learned about the nutritional requirements of gray wolves by enrolling in the wildlife nutrition applications section (NR 305.3), working on a nutritional requirement model with the 2nd year student, and providing the 4th year student with information on how nutritional characteristics of the gray wolf affect reproductive success.

The 4th year student learned about population dynamics by writing a simulation model (with the 2nd year student) of wolf population dynamics that also included calculations of reproductive rates as a function of the nutritional status of the wolves prepared by the 3rd year student. The 4th year student would be enrolled in the simulation models applications section (NR 405.2).

This example shows how four students could work together on a larger problem in a seamless course environment, even though each of them had registered for

four different concept and applications courses. The students would gain practice in planning their work, working together on related problems, helping each other, providing meaningful outcomes for the others to use, and meeting individual responsibilities as part of a team. The upper division students provide leadership in a learning group and are good models for the lower division students. The freshmen and sophomore students made meaningful contributions to the group too, however, and all of the students would publish the results of their work on the electronic information system.

With this overview of how students could work together in a course continuum, let's look at the main concept-applications course combination in more detail.

MAIN CONCEPT-APPLICATIONS COMBINATIONS

The main concept-applications combination in a course continuum provides students with the basic concepts in related subject areas and opportunities for cooperative learning across course, subject and grade-level lines. The main concept courses provide professors with opportunities to give lectures and stimulate thinking through discussions of the most significant concepts in a subject area (Moen et al. 2000). The applications courses provide the flexibility and open-ended opportunities for almost unlimited active and cooperative learning. Computer-based modeling was an integral part of the applications courses (Boomer and Moen 1996, Runge and Moen 1996). The main concept-applications combination takes advantage of the power of humans to conceptualize while providing opportunities for students to apply the concepts while taking responsibility for

their own work, working with others, and publishing the results of their work as information resources for others.

The Main Concept Component

Every subject has some main concepts that can be identified as most essential for students to understand (Moen et al. 2000). Students benefit from an overview of the context and a synthesis of the main concepts when formulating questions and solving problems in a subject. Shifting from giving detailed lectures to the discussion of the main concepts can reduce the amount of time spent in traditional lecture courses by over 50%. Examples of main concepts in the course continuum are listed below.

Sample Natural History Concepts…

The concept of individuality
The concept of biological time
The concepts of abundance and distribution

Sample programming and modeling concepts…

The concept of information integration
The concept of scale
The concept of modeling
The concept of ecological significance

Sample species ecology concepts…

The concept of environment
The concept of rhythmic change
The concept of energy balance
The concept of productivity
The concept of social order

Sample population ecology concepts…

The concept of populations
The concept of population growth
The concept of population structure
The concept of population reconstruction

The concept of carrying capacity

Descriptions of each of these concepts were available as "written lectures" for all of the students enrolled in one or more of the continuum courses to read. Each student received a printed copy and the descriptions were also published on our local area network for students to access at any time.

The Applications Component

Reducing the time students spend listening to lectures by over 50% leaves more time for them to work on applications of the concepts in a cooperative learning environment. The traditional 4-credit combination of 3 credit-hours of lecture and 1 credit-hour of lab was inverted in the course continuum; students enrolled in 1-credit concept courses and 1-9 credits of applications courses. The applications component was not just an increase in the number of "laboratory" credits, however. Students could enroll and re-enroll in applications courses in successive semesters, thus enabling them to explore additional areas in one of the main concept courses or to do more in-depth research in successive semesters. No boundaries were placed on a students desire to learn more in any subject area. *Professors could guide students, the "curriculum" did not limit them and the course continuum accommodated them.*

Students could design their own research within the framework of each application section, write and publish natural history files, write and share computer models, analyze ecological functions with computer simulations and visualize population dynamics with interactive computer models. Samples were given in the overview above; the number of possibilities is literally unlimited.

The application sections also provided students with continuous opportunities to work together while applying the main concepts, to broaden their knowledge base and explore specific questions in more depth. Students were actively involved in planning their work and assumed more responsibility for their own learning. They were not only expected to cooperate with other students but also to serve as mentors, helping other students in the "community of learners" created by this approach.

Students as their own teachers. Students don't have to stop learning about a subject because college rules prohibit registration for courses a second time when a course continuum is in place. Rather, students can provide a "learning plan" that describes both the in-depth work they intend to do as they learn more about the subject, and the help they can give less advanced students while serving as a mentor. Such plans can be evaluated by student peers before submitting them to a professor for approval, giving students exposure to the ideas of other students and evaluation of the work being proposed.

Students as mentors. When students are given meaningful opportunities to help other students learn, they will invariably conclude that they learned a lot because (1) the experience provided a review of the material for them, (2) learning how other people think broadened their own horizons, and (3) working with others generated new ideas and questions for further study. I observed undergraduate teaching assistants working with hundreds of students in the 1990s and was impressed with the respect students had for each other in student-mentor relationships.

Professors as guides. What are the roles of professors in a concept-applications course combination and cooperative learning environment in a seamless course continuum?

Professors remain the single most important source of the significant concepts in a particular subject. They are also guides to thinking, a source of ideas for research, a discussion person in learning groups, an encourager of progress and productivity, a respected critic, an editor, and more. Professors need to actively participate with their students in such a cooperative learning environment; they cannot turn the teaching over to the students. It takes time to interact with students in a cooperative learning environment, but learning always takes time. The wide variety of areas being investigated by the students not only challenges professors but also stimulates thinking in new and related areas. *Being a professor in this kind of learning environment is much more emotionally demanding than the traditional lecture environment, but it can be much more rewarding.*

Interacting with students. One reason that passive learning from lectures is less effective than cooperative learning is that students spend less time interacting with other students and professors. Professors can give a lecture and retreat to their office rather than continue to interact with their students. But can professors get any work done if they are so involved with their students? *Interacting with the students is a professor's work.* Teaching and learning are both much more fun in a cooperative setting, and the professor's impact is multiplied when students have opportunities to be both learners and teachers.

Electronic information systems. One of the key supporting components of the main concept-applications combination is the availability of electronic information resources not only to be accessed but also as a publishing outlet for students. On-line services provide access to information worldwide, and an electronic information system can serve as a local publishing outlet for students in different courses and subject areas. Teaching and learning have not

met their potential for long-term impacts in the past because the products have been discarded at the end of a course. Discussions have gone unrecorded and conclusions have been lost, term papers have been graded and discarded, and tests have been temporary evaluation tools rather than long-term learning tools. Student knowledge is too valuable a resource to be so temporary, however. Publishing student work on an electronic information system retains the productive work of students so it is available to students in the future. Designing tests that reside on an electronic network gives learners opportunities to test themselves whenever they want to, learning as they do so. *Increasing the long-term usefulness of learning resources is guaranteed to increase the quality of the learning products produced by students.*

ELECTRONIC PUBLISHING OPTIONS

With the feasibility of Web-based publishing, it is possible for students to share their work with other students around the world. Rather than having an underground network of term papers for sale, electronic publishing by students should be promoted as a legitimate educational activity. A two-level system could be used in which all of the students would be expected to publish on a local area network and the best publications would be placed on the Web. This would provide incentives for students to do their best because they would be rewarded not only with recognition but also by having the satisfaction of sharing their knowledge with students in other colleges and universities. Thousands of professional journals will be published on the Web in the future and student authors should begin participating in the process in a controlled educational learning environment

The Role of Hypertext

Hypertext links between publications enable readers to jump from one place to another at the click of a mouse, satisfying an immediate "need to know" as nothing else can. When a learner comes across a word, concept, or technique that needs to be explored further, going to the dictionary will not be able to compete with the instant gratification provided by hypertext links. *Hypertext links are about the only way that students will look up a significant amount of cross-referenced materials.* Let's look at some examples of how it might work in relation to the "need to know" about statistics.

Probability example. Probability is a central concept in statistics, and it can be introduced in, for example, general biology in relation to genetic concepts. Students need to learn something about probability in order to understand some genetic inheritance concepts. While this has been done in the past by teachers who have prepared the necessary supporting material, an integrated information system approach makes it possible for students to use hypertext links to access probability concepts and applications when they are needed. This biology example is just one of many examples where students benefit from being able to access related material when they need it rather than overlooking it until they "take a course in it" or depending on the teacher to call it to their attention. *Professors should collaborate when preparing course materials so links are found wherever appropriate in the information resources students are using.*

Paired and unpaired t-test examples. The t-test is a commonly used statistical procedure for determining the probability of two data sets being from the same population.

The paired t-test can be introduced in ecology by having groups of two students make separate measurements of some meaningful parameter in the field, enter the data and complete the paired t-test on-site with a portable computer. The results are available immediately for interpretation and discussion. If students do not understand the assumptions underlying t-tests, the distribution of probabilities of the t-value, or why their results were statistically different or not, supporting information should be available on the portable computer so students can make the measurements, do the test, and understand the results of the test *while at the site of the measurements in the field.*

Think of the potential for learning when students are actively involved in a cooperative learning environment and hypertext-based information resources are there at the click of a mouse. Students can access what they need to know when they need to know; *no need to wait for a course in any subject when there are, theoretically, no barriers to learning.*

Personalized Information Systems

While there is a vast amount of information available on the Web, it may be desirable for professors and students to work together on a more personalized information system that is designed to provide support for the local learning environment. Just as a list of terms with their definitions might have been distributed as a handout in the past, a more comprehensive information system could be made available on a local area network now. Teachers need not wait for others to author such resources or for commercial products to become available. Since teachers do not have time to prepare all of these information resources for their students, the alternative is to work with their students to develop the

resources. This was the approach I used in my ecology and management courses in the 1990s, and it resulted in the "*Resource Ecology and Management Information System*" in the Cooperative Learning Center (Moen et al. 2000).

Teachers benefit from this cooperative approach by sharing responsibility for preparing information resources with their students. Students benefit from sharing information with their teachers and other students. Both teachers and students, benefit by having the information available when it is needed. *There is so much to learn from using integrated information resources in a society that is becoming more dependent on electronic information transfer as the primary means of communication.*

Seamless Disciplines

The material up to this point in this chapter has focused on a course continuum within the field of natural resources. The approach can be expanded to include relationships between additional subject areas; electronic information processing does not recognize boundaries between traditional subject areas and administrative departments. Natural sciences should not be separated from social sciences because people are the common element in both. How people act and interact socially and globally affects the natural world, and students should learn about these effects by integrating knowledge from other subject areas. Links between large subject areas as natural science and social science make a tremendous amount of information available at the click of a mouse.

Basic and applied research. There has been a long-standing debate over basic and applied research, although the reason for the debate is often not well understood. What is there to debate? Using an either-or approach, we are forced

to choose. Using more complex logic, we recognize that basic and applied research are both part of a continuum that is not simply sequential, but involves feedback as research results are used and new questions raised. *Simple either-or logic divides us, while recognizing complex logic and a learning continuum unites us.*

Science and the history of science. It is traditional to offer science courses that focus on a particular science, and "history of science" courses that focus on, you guessed it, history. But should science and the history of science be in the separate disciplines of science and history? Why make students wait to take a "history of science" course to learn about the historical context of some aspect of science? Why not incorporate history into science courses and science into history courses as part of a learning continuum? *Links provide instant access to both historical and scientific information, wherever appropriate.*

New administration models. It will be hard to institute new learning models without changing some administration models too. Awarding a certain number of credits in relation to the number of lecture and laboratory periods each week has been a useful practice. If courses become more seamless, learning will still occur in proportion to the time invested, but the time invested will not be packaged as neatly as "three lectures and one lab per week" for four credits. Learning in different subject areas will occur in relation to more integrated and student-defined learning. *Perhaps the time has come to award credits based on measurable outcomes rather than by hours enrolled.*

Authentic assessment. Improving evaluations of what students have really learned should be a high priority. Evaluations of students on the basis of their professional-level involvement and productivity in a cooperative learning environment represents an authentic approach, similar to that

of a supervisor's evaluation of an employee in a professional setting (Moen et al. 2000). In a cooperative learning environment authentic assessment is an ongoing activity because "every event is a test." *I felt that my evaluations of student performance in the cooperative learning environment represented their abilities better than scores on a test would.*

CONCLUDING REMARKS

The cooperative learning environment and course continuum described in these two chapters were designed to promote the professional development of undergraduates. Students learned about the most significant concepts in short lectures and discussions, and they applied these concepts in cooperative learning groups that designed and completed field and laboratory research. Undergraduate teaching assistants and senior wildlife management students coordinated the activities of the learning groups and supervised the student research, learning about personnel management by active participation in leadership roles (Moen et al. 2000). Publication of research results on a local area network enabled students to share what they had learned with their peers. Based on the experiences shared with me by graduates who were in professional positions or graduate school, this approach gave them many advantages over those who had participated in more traditional curricula. *The information revolution with all of its technological advances should force some major changes in learning environments, evaluation of learners, and administration of departments in colleges and universities in order to prepare students better for the more dynamic and interactive careers they will likely have as professionals in the 21st century.*