Most recent papers published in the *Journal of Forestry* on the subject of forestry education have emphasized undergraduate programs (e.g., Dewhurst and Kessler 1999; Ginger et al. 1999; Sample et al. 1999). Likewise, recent natural resource educational conferences (Heister 1998) also have focused on undergraduate education. Literature on graduate student education in forestry is less common, but an increasing number of presentations at these conferences on graduate education suggests a growing interest in the topic.

This article describes three courses—research development and methods, proseminar, and teaching practicum—that are required for all graduate students in the School of Forestry at Northern Arizona University (NAU). The overall purpose of these courses is to develop skills that our faculty feel are critical to a meaningful graduate education and a successful professional career. Our purpose is to describe the concept, content, and implementation of this core curriculum and to share information on how these courses have been received by graduate students.

**Research Development and Methods**

The objective of the research development and methods course is to prepare graduate students to conduct high-quality research in any forestry discipline. The desired outcomes are the ability to prepare a detailed research study plan, provide critical peer review of research plans, and understand important current topics in scientific research. The course was first taught in 1980 and became required for all master’s students in 1985. The requirement was added to the PhD program when it started in 1995. Students are assessed on a pass–fail basis in this three-semester-hour course.

Designing a research methods course in a multidisciplinary field like forestry is challenging. A typical class includes students who are studying various aspects of forest ecology, ecological restoration, silviculture, forest economics, recreation, wildlife management, human dimensions, and other disciplines. This range of thesis topics precludes a teaching approach that covers in detail methods that are specific to certain research disciplines. We address this issue by limiting course topics to those that apply to all research topics. Also, the course is team-taught by three faculty with research expertise in different disciplines.

The course uses active, experiential...
learning. All students are required to prepare a detailed research study plan. Students are also required to participate in an iterative peer-review process designed to improve the study plans. At the beginning of the process, we ask the students to define scientific research and to construct a framework for a study plan by identifying key elements of scientific research. Student-generated ideas are steered toward a consistent study plan format using a framework based on Smith (1990), Leedy (1997), and our experiences. The study plan is developed in sections: research question and hypothesis, outline of the entire study plan, introduction and justification, literature review, methods and budget, and final study plan.

The faculty team and invited lecturers introduce students to skills required for developing each section of the study plan. For example, the class discusses literature searches using both computerized and traditional approaches and managing the literature with emphasis on computerized bibliographic systems. Critical review, synthesis, and evaluation skills are developed through the iterative peer-review process in small groups facilitated by the faculty. In small groups, each student provides written and oral constructive reviews of three other students’ work. The faculty facilitators also provide reviews for all students in their group. The student’s major professor must sign the final research study plan. A passing study plan serves several additional objectives. At the end of this spring semester course, successful students are well prepared to begin their summer research and have a good start on the first parts of their thesis or dissertation text. Requiring the signature of the student’s major professor on the study plan encourages students to interact frequently with their major professor in designing their research project, and encourages faculty to actively mentor their students. The peer reviews are helpful in polishing the research question and methodology, and they help students develop critical review skills.

We believe the research development and methods course is effective in improving student research plans. For example, several students in the course have obtained substantial outside funding from state and federal programs for their research using their study plan as the proposal. Moreover, the Forestry Graduate Student Association (FGSA) at NAU conducted a survey to obtain views on the graduate curriculum, including opinions on required courses. The survey results were consistent with comments on class and faculty evaluation forms. Of the 18 respondents who had taken the course, 15 stated that the course should remain required for both master’s and PhD students. The peer-review process was highlighted as a strength of the course. All students agreed that the class improved the planning and implementation of their research. The portions of the course on research skills and important research topics received mixed reviews: Some students really enjoyed these portions, whereas others, especially more experienced PhD students, found these portions to be redundant and too introductory. However, our observations suggest that master’s students with little prior research experience learn much about research from more experienced PhD students in the course.

Proseminar

The primary objective of the proseminar course is to improve graduate student skills in the preparation and presentation of talks and posters. Such communication skills are essential for success as a natural resource scientist or professional, as well as for success in many other fields. We started the proseminar course in 1995 at the same time our PhD program started, and the course is required for all master’s and PhD students. Like the research methods and development course, proseminar uses an active-learning, experiential model, and it is team-taught with pass–fail grading.

The course is intended for graduate students near the end of their programs who have original research data suitable for a scientific presentation. Students who do not have such data are encouraged to take the course at a later time. Students do not need to have their entire thesis or dissertation data collected and analyzed to benefit from the course; preliminary or partial data is often sufficient. The key point is that we want students to use data from their own research in the course. Reasons for this requirement include greater student motivation to excel and providing opportunities to polish presentations.
Honing High-Tech Skills at Allegany College: A Case Study

Because Allegany College of Maryland has one of 24 SAF-recognized forest technology programs in North America, our faculty was certain that forestry educational standards were being met. However, because new technologies are changing the way technicians practice forestry, we wanted to enhance our program by incorporating geographic information systems (GIS), global positioning systems (GPS), and computer-aided surveying into the curriculum.

In 1997 we began a comprehensive strategy to ensure that field applications with these new technologies were part of our program. Rather than simply adding a separate GIS and GPS course to the curriculum, we want to infuse these new technologies throughout the course load. The Forestry Department was awarded a curriculum enhancement planning grant from Phi Theta Kappa, the national honor society for community colleges. This grant provided “mentors” to help facilitate the planning process. The mentors were part of the Northwest Center for Sustainable Resources (NCSR), a partnership of community college educators and agencies dealing with natural resources–based education programs, and included NCSR forestry and GIS faculty from Central Oregon Community College in Bend and Chemeketa Community College in Salem. The grant helped us identify required changes to the curriculum, computer hardware and software needs, and budget requirements. Of equal importance, NCSR staff helped us develop a software–hardware procurement strategy.

Thanks to Phi Theta Kappa and NCSR, Allegany College forestry faculty was able to transform a traditional forestry program to a state-of-the-art curriculum, a transition that took place in several stages.

Improving Graduate Success

Before we started altering the curriculum, we needed some assurance that our changes would increase graduate marketability and wages. Among the methods we used to assess successful graduates included a graduate and employer needs assessment and Developing a Curriculum (DACUM), an occupational analysis performed by expert workers in a given profession. A DACUM produces an occupational skill profile that can be used for instructional program planning, curriculum enhancement, graduate proficiency, and other employment-related activities. The education department at Oregon State University led the DACUM, and 10 graduate technicians served on Allegany College’s DACUM panel. Both the needs assessment and the DACUM verified the importance of incorporating new technologies into the curriculum.

Forestry has taken on many new concepts in the past two decades: new forestry; adaptive resources management; ecosystem management; and sustainable forestry. Many of these concepts are difficult to define and apply, and can also be difficult to teach in a field laboratory setting. In addition, all of these concepts tend to rely on the use of GIS and GPS for resource management decisionmaking. We received a curriculum test site grant from NCSR to help us evaluate the appropriateness of these concepts to technical forestry education. As a result, we chose to embrace sustainable forestry as a lead concept in our curriculum.

Acquiring the Systems

A GPS grant from the Appalachian Regional Commission provided us with Trimble GPS base stations for three western Maryland community colleges, survey-grade GPS units, mapping-grade units, and all the necessary software. The college houses and maintains the equipment and in return provides training to the surveying community. The forestry program also earns income to maintain and upgrade the equipment by renting it to surveyors and natural resource managers. To complement the Trimble software, a Perkins grant allowed us to purchase Microsurvey, a computerized surveying package.

Acquiring an appropriate GIS was more challenging. In addition to software, local data needed to be purchased. A GIS grant was approved from Autocad for Autodesk GIS, and we formed an educational partnership with Environmental Systems Research Institute (ESRI) to obtain ArcView software. Local data was purchased from Maryland state for thesis or dissertation seminars and professional meetings.

The main activities are described in “Required Activities in the Proseminar Course,” p. 14. To pass the course, students must complete each activity with satisfactory performance. We handle unsatisfactory performance by insisting that the student redo the activity until the performance is satisfactory.

Judging from course evaluations from the past four years, most students felt that they benefited from the proseminar course. In a recent survey of required courses by the FGSA, 16 of the 17 responding students who had taken the course agreed that proseminar should be required for master’s and PhD degrees in our program. The survey also indicated that students appreciated the opportunity to share their research with each other and noted that the course was effective at “broadening their horizons.” On the other hand, most students also felt that exceptions to taking the course should be allowed for students who can demonstrate previous experience or competency in presenting talks and posters. Many of our faculty have noticed improvement in the quality of oral presentations and posters by graduate students since the course started.

Teaching Practicum

Awareness is growing of the need to prepare today’s graduate students and tomorrow’s future faculty for teaching challenges in forestry. Consequently,
agencies and several private vendors. In addition, Perkins funds allowed us to purchase two Huskey handheld data recorders (bringing the total number of handheld recorders to five) and a high-resolution digital graphics camera.

Another goal of the planning grant was to conduct training in sustainable forestry and technology for high school math and science teachers. It is hoped that this will result in “seamless education,” an initiative seeking to reduce the percentage of new college students requiring remedial courses.

The Lab Takes Shape

The systems were purchased, the curriculum changes were planned, and support from the natural resources business community and educators was ensured. Now all we needed was a state-of-the-art forest resources technology lab so that our envisioned curriculum enhancements could come to fruition. We sought and obtained a National Science Foundation Grant for Course, Curriculum, and Laboratory Improvements to implement these changes and to install a Sustainable Forest Resources Computer Laboratory.

The newly established laboratory is an 11-workstation networked lab running 750 MHz computers with two 20-GB hard drives, 384 MB of RAM, a 250-GB Zip drive, and 19-inch flat-screen monitors. The lab includes an HP 755 CM color inkjet plotter, Epson 836 XL scanner, laser color printer, ink jet printer, Altiris educational viewing software, and a Proxima projection system. The lab runs all the GIS, GPS, CADD, and mapping software and is tied to the Allegany College GPS base station.

The Sustainable Forest Resources Laboratory is the most powerful computer lab in Maryland devoted entirely to students. The lab serves as the main forestry classroom. While the computers are used for routine course work (spreadsheets, word processing, statistical packages, and Internet access), the new technologies are used in the following courses: software applications in forestry, surveying, forest measurements, silviculture, forest management, summer surveying, forest fire control, and field measurements.

Our hope is that all Allegany College forest technology graduates are fluent in computer-based field applications of GIS, GPS, and CADD and able to gain employment in a diverse workforce with state-of-the-art technology tools. Our goal is that the graduates of the class of 2001 and beyond are as comfortable using GIS and GPS as they are using a prism and a Biltmore stick.

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Required Activities in the Proseminar Course

In the proseminar course, all students are expected to

• Be prepared to read aloud to the class for two minutes to develop comfort in addressing an audience and to promote camaraderie in the class. Students may read anything they choose.
• Attend workshops arranged by the faculty on topics concerning presenters such as: how to write a research abstract; differences between oral and poster presentations; use of scanners, presentation software, and slide printers; tips on making posters and slides with computer software; do’s and don’ts of talks; and using a computer to present information in a talk.
• Read and critique research posters that are currently being displayed in our building by faculty and other students.
• Prepare an abstract of their research.
• Attend four scientific talks outside class to expose students to different oral presentation styles. We typically use conferences or talks held on campus during the course for this assignment.
• Present to the class a 15-minute talk about their research using a computer projection system. All students and faculty in the audience provide written suggestions for improving the talk, and the talk is videotaped for later review.
• Prepare a written self-evaluation of their presentation that includes changes to improve the next presentation based on the videotape review and constructive comments from faculty and other students.
• Present to the class a revised version of the 15-minute talk using a traditional slide projector. The presentation is graded by all students and faculty using a standard evaluation form that also allows comments for further improvement.
• Prepare a poster about their research using guidelines from a professional conference. These posters are often presented later at professional meetings.

are addressed in short papers and class discussions. The specific activities selected to stimulate thought on effective teaching and learning include the following:

• Preparing a syllabus.
• Evaluating the relationship between an instructor’s presentation style and student learning.
• Evaluating instructor effectiveness.
• Comparing traditional and non-traditional models of teaching.

This last activity involves attending several lectures taught by a highly effective instructor who uses both constructivist and traditional teaching approaches.

The theory that people learn by receiving knowledge and that knowledge can be passed largely intact from teacher to student underlies much traditional educational thinking. This thinking has been used to justify the traditional lecture format to which most college faculty and PhD students are exposed. Consequently, many new faculty often use this approach. However, research supporting knowledge reception as an effective learning approach is equivocal, and there is growing dissatisfaction with the level of undergraduate knowledge and understanding of science (George et al. 1996). Universities are being asked to produce students capable of higher learning rather than merely instructing students in current knowledge. Alternatives to the passive, faculty-delivered lecture format, such as the constructivist model (Atkin and Karplus 1962; Brooks and Brooks 1996), may help in this effort. George et al. (1996) recommended this model for science education to the National Science Foundation and, therefore, it is the primary alternative classroom model examined in the teaching practicum course.

Following the activities and discussions during the first half of the semester, the rest of the course focuses on actual teaching experiences. Students teach at least three class periods in a 100- or 200-level forestry course using alternative classroom methods. Students work with the course instructor and the teaching practicum instructor to develop appropriate constructivist exercises. The teaching experience is peer-reviewed by other students in the course and videotaped. The student teachers review their videotaped performance and meet with the course instructor after each classroom session so that adjustments can be made before the next teaching session. Finally, students write a paper summarizing their teaching experience.

In a recent survey of required courses by the FGSA, 13 of the 14 students who had taken the course supported it as a requirement for the PhD degree. The one negative response was based on the idea that some PhDs would go into research without teaching. Students were excited to have an opportunity to learn about and practice teaching in a more formal environment, and they appreciated being exposed to new and innovative classroom models. Several students who are now teachers reported that that they have been able to effectively use constructivist techniques and cooperative learning in their classes.

Conclusion

The graduate degrees offered by the NAU School of Forestry have more required courses than similar degree programs at many other universities. Some of our required courses are similar to and modeled after requirements of other programs (e.g., statistics, breadth in coursework for PhD students). However, the research development and methods, proseeinar, and teaching practicum courses arose largely from efforts by our faculty to improve student skills in subjects that typically are not taught in forestry graduate courses. The argument could be made that outstanding graduate students will learn research, presentation, and teach-
ing skills on their own or from their faculty advisors. However, our observations suggest that development of these skills can fall by the wayside for many graduate students. Consequently, our faculty have chosen to emphasize these skills by requiring courses on these subjects as part of the core education of graduate students.

Limited survey data from graduate students and comments from faculty indicate broad support for continuing to require these courses for graduate students. However, we acknowledge that there are tradeoffs between requiring these courses and other important activities of graduate students, such as taking courses in their research discipline and devoting time to research. We have not yet rigorously assessed these tradeoffs. Such an assessment would be appropriate in the future after more graduate students have completed the program and reflected on their educational experience.

Recently, Stewart et al. (1998) suggested ways to enrich the experience of graduate students in natural resource fields. They emphasized that faculty should facilitate greater contacts with students in other disciplines and provide an environment conducive to the professional development of graduate students. We believe that the research development and methods, prosemiminar, and teaching practicum courses are a step in the right direction.

**Literature Cited**


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