

PROGRAM REPORT

Improving Graduate Education In Plant Physiology Through An Interdisciplinary Approach

Laurence D. Moore

Abstract

This article describes a program dedicated to the improvement of graduate plant physiology education at Virginia Polytechnic Institute and State University (Virginia Tech) through the development of a University-wide graduate curriculum. Strategies used in the development of the interdisciplinary curriculum have included: (1) determination of the need for the curriculum, (2) establishment of an administrative committee composed of faculty, (3) initiation of core courses in plant metabolism oriented toward plant physiology and other plant science majors, (4) development of an interdisciplinary graduate seminar and (5) publication of a brochure concerning the faculty, research programs, and course offerings. Development of the curriculum is being stimulated by conducting a workshop on interdisciplinary graduate plant physiology April 7 and 8, 1983 in Blacksburg, VA.

Beliefs and Strategies

As Howard R. Bowen (1978) so aptly stated, "Education, or the teaching-learning function, is defined to embrace not only the formal academic curricula, classes and laboratories but also all those influences upon students flowing from association with peers and faculty members and from the many and varied experiences of campus life." Yet the results of a recent survey (Noggle, 1982) concerning graduate education in plant physiology suggest that many institutions of higher learning can not adequately address the formal education of students let alone the other facets of education. Fifty to sixty percent of the institutions responding to the survey reported that it was difficult or impossible to hire new faculty, that teaching and research laboratories were below standard, and that facilities and equipment were inadequate.

Two major objectives have been established for the Interdisciplinary Graduate Curriculum in Plant Physiology (IGCPP): (1) to provide a diverse and comprehensive graduate education so that students can achieve a high degree of competency in research and are able to apply these research skills to the many-faceted problems which confront agriculture and (2) to

serve as a focal point to illustrate the strong interdisciplinary dependence which characterizes modern plant physiology. Moreover, the establishment of the curriculum has been designed to increase significantly communication among the plant physiology faculty and to insure that the University will provide students a complete educational program including molecular biology, plant biochemistry, and whole plant physiology.

The Interdisciplinary Curriculum

Plant physiology faculty involved in the curriculum are members of the Departments of Agronomy, Biochemistry and Nutrition, Biology, Forestry, Horticulture, and Plant Pathology and Physiology. All faculty with teaching and/or research interests in plant physiology are automatically members of the IGCPP, if they so desire.

The IGCPP is administered through the Dean of the Graduate School by three faculty members representing Colleges of Agriculture and Life Sciences and Arts and Sciences. Each member of the committee serves a three-year term, becoming vice-chairperson in the second year and chairperson in the third year. Other than the publication of a brochure to describe the curriculum, there are few expenses unique to the curriculum since faculty are members of various academic departments and no additional professional administrators or facilities are required.

Graduate students specialize in such areas of research as cell wall physiology, crop production physiology, enzymology, growth regulation, herbicidal action and metabolism, photosynthesis and photorespiration, physiology of disease and stress physiology.

Blanche Haning (1981) observed that there are three ingredients for the success of any interdisciplinary curriculum: (1) need for an interdisciplinary approach, (2) faculty interested, committed, and supportive of the program and (3) administrative support. Virginia Tech's program has these ingredients. Moreover, our program has helped encourage and support the development of individual faculty members by bringing them together to study and discuss common concerns about instructional improvement.

Core Courses

To best meet the educational needs of plant physiology and plant science graduate students, four courses have been developed. Three of the courses,

Moore is an associate professor of Plant Pathology and chairman of the Interdisciplinary Graduate Curriculum in Plant Physiology, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061.

Plant Metabolism I, II, and III, are taught as a series designed so that students can enroll in any one or all of the courses in no specific sequence. The first course presents concepts of energetics in photosynthesis and respiratory processes, metabolism in chloroplasts and mitochondria, carbohydrate synthesis, nitrogen fixation, and biochemical aspects of ion transport. Relationship of intermediary metabolism to lipid, isoprenoid, alkaloid, and hormone synthesis as well as plant cell wall biosynthesis and organelle membrane organization and function are taught in the second course. Intermediary metabolism of amino acids and nucleotides, feedback and allosteric control followed by concepts of metabolic regulation in cells and chloroplasts at the level of gene expression, translocation and protein turnover and modification constitute the third course. Faculty from three departments teach the series. Although a team teaching approach is used, care is taken to avoid pitfalls common to such approaches by having careful team planning, proper coordination, and effective course review as suggested by Matthews (1978).

An interdisciplinary seminar has been employed to integrate the varied teaching and research interests and expertise of the faculty and students. It is a forum for productive exchanges and discussions of research and teaching interests. The enhanced communication which the seminar provides has improved the educational experience of the students through the involvement of faculty from six academic departments.

In establishing the curriculum, 48 courses, in addition to the plant metabolism series and seminar, have been identified in the University Graduate Catalog. Thus, the depth and breadth of plant physiology is revealed in the listing of courses and faculty.

Curriculum Participants

The development of the IGCPP will serve to attract prospective students with interest in plant physiology. A brochure is being prepared which illustrates the comprehensiveness of the curriculum, the faculty involved, their research interests and the courses offered.

To qualify for admission to graduate studies, all prospective students must have a suitable level of knowledge of physiology, biochemistry, botany, biology, chemistry, mathematics and other related sciences and meet requirements for admission in their respective departments. Students are recruited and selected by the respective departments participating in the curriculum: therefore, additional administrative level evaluation has not been required.

Through the participation of plant physiology faculty from more than one department on a student's committee, it will be possible to develop a more uniform set of performance standards. Since the develop-

ment of the curriculum has stimulated greater inter-departmental faculty cooperation, the preliminary examination and the dissertation defense for plant physiology students from the various departments can be administered with greater uniformity, although each department is still responsible for administering the exams for its students.

Research and service areas within the plant sciences continue to seek graduates with advanced training in plant physiology (Coulter and Stanton, 1980). Coulter (1980) has concluded that, "A shortage of highly capable experts in the food and agricultural sciences is a potential bomb, one that could threaten the total food and agricultural system on which much of the world stability is based." A goal of the administrative committee of the IGCPP is to properly prepare students for the job market. Moreover, the plant physiology faculty can be a key ingredient in motivating students into career exploration to enhance successful placement (Darrow, 1980).

The Future

Following the approval of the IGCPP by the University, support for the further development of the curriculum has been provided by a grant from the University's Learning Resource Center and the College of Agriculture and Life Sciences and Arts and Sciences to conduct a workshop, April 7 and 8, 1983, to address such concerns as: the needs of industry, government and academia for graduates of plant physiology, the educational components of basic and applied plant physiology research in the next twenty years and the strengths and deficiencies in current graduate plant physiology curricula. Participants at the workshop will also consider such options as the establishment of equipment centers for team teaching, laboratory courses, and the possibility of sharing teaching facilities. Colleagues from peer institutions, government, and industry have been invited to participate in the workshop. At the conclusion of the workshop, goals will be set and action taken to continue to strengthen the IGCPP at Virginia Tech.

The occurrence of interdisciplinary curricula in plant physiology is relatively rare. The curriculum at the University of California-Davis is an example of a program which is very successful. With the continued support of the faculty and administration at Virginia Tech the interdisciplinary graduate curriculum in plant physiology can help meet future demands for plant physiologists.

Acknowledgments

The interdisciplinary curriculum was developed by Dr. J. L. Hess, A. E. Linkins, L. D. Moore, and J. C. Servaites. Drs. Hess, Moore and Servaites are members of the Administrative committee.

Literature Cited

- Bowen, H. R. 1978. *Investment in Learning*. Jossey-Bass Publ. Washington. 507 pp.
- Coulter, K. J. 1980. Supply-demand for graduates of higher education in food and agricultural sciences. *NACTA Journal* 24 (3):12-15.
- Coulter, K. J. and M. Staunton. 1980. Graduates of higher education in the food and agricultural sciences: An analysis of supply/demand relationships. Volume 1 - *Agriculture, Natural Resources and Veterinary Medicine*. USDA, SEA, Misc. Docum. 1385.
- Darrow, E. E. 1980. The role of faculty in successful placement. *NACTA Journal* 24(1):12-15.
- Haning, B. C. 1981. Interdisciplinary curricula: Ingredients for success. *NACTA Journal* 25(3):10-14.
- Matthews, S. F. 1978. Avoid common pitfalls in team teaching. *NACTA Journal* 23(1):26-27.
- Nogge, G. R. 1982. ASPP survey on graduate training. *ASPP Newsletter* 9(2):32-34.

Student Motivation

David L. Kittrell and
Gary E. Moore

Imagine you have the opportunity to observe two professors as they start teaching a unit on engine operating principles. Professor X comes into the classroom and says, "Today I'm going to teach you about the internal combustion engine. The internal combustion engine generates power by utilizing the force created by burning a fuel and air mixture. This force is confined to a cylinder. The expanding gasses force the piston downward in the cylinder and turn a crank that powers the drive train." Professor X continues to give an explanation in this manner for the rest of the class period.

In a neighboring college, Professor Y drives a small gasoline powered garden tractor into the classroom as the period begins. The tractor engine is obviously not hitting on every cycle and is emitting a dark blue smoke from the exhaust pipe. The professor turns off the engine and gets off the tractor as class begins. Professor Y begins class in this manner. "This is my neighbor's tractor and the engine obviously needs some attention. Our job will be to identify the problems in each of the four systems of this type of internal combustion engine and repair the engine. After we complete this process, we will develop a routine maintenance list for my neighbor to use to help avoid future down-time. Let's begin today by studying this type of

Kittrell is with the Dept. of Agr. and Ext. Educ., Mississippi State University, Mississippi State, MS 39762 while Moore is with the Dept. of Voag. Educ., Louisiana State University, Baton Rouge, LA 70803.

engine and try to understand the four systems that work together to make it run." Professor Y then asks what are the systems within the engine that work together to produce needed power. He records student discussion about the systems of the internal combustion engine on the chalk board and discusses each for the remainder of the period.

If you were one of the students, which class would you prefer to be in? Undoubtedly you want to be taught by Professor Y instead of Professor X. You would probably learn more about engines and remember it longer. Students in Professor X's class will soon be looking out the window, writing notes to others, sleeping, or causing discipline problems. The primary difference in the two classes was Professor Y's attempt to motivate the students to learn. The ability to motivate students is a skill that can be learned but requires thought, effort, and planning. However, the improved interest in class and increased learning on the part of the students is well worth the effort.

Concise But True

Land grant colleges and universities are knowledge centers that integrate the three functions of teaching, research, and service. They should gleam with a different light from the earlier tradition centered institutions because of their common man philosophy developed by the Morrill Act. This act was based on a philosophy of practicability and democracy. This philosophy was intended to save these institutions from self-serving and elitist pursuits and focus on needs of the people (Vines and Anderson, 1976). Most of the non-land grant universities with agriculture programs abide by the same philosophy.

Instruction at these institutions should also reflect the practicability and democracy philosophy. However, often the information giving approach is taken without adding the practicability that was intended in the earlier legislation. Our responsibility is not only to provide information but to cause learning (Brown, 1981). This statement is concise, but true. Both Professor X and Y in the introductory example would accomplish the responsibility of providing information. Yet, Professor Y's procedure would best reflect the Morrill Act philosophy.

Incorporating The Philosophy

A common assumption of many college instructors is that students are internally motivated to learn. These students, especially those in agriculture, usually have a handy set of experiences in their background that allow the generalization of information presented in class. Yet, seldom do students have the same set of classroom experiences and need to be helped in generalizing the information. We, as instructors, need to take some responsibility in getting our students motivated or prepared to learn. The old saying "You can lead a horse