SECTION FOUR

NATURAL SCIENCES
AND MATHEMATICS
Good teaching is hard to characterize, but Parker Palmer describes it as weaving a fabric of connectedness between the student, the teacher, and the subject matter (Palmer, 1998). Similarly, signature pedagogy (Shulman, 2005) is hard to characterize; but it reveals the patterns of an educational quilt that stitches together the various habits of mind of a discipline. In this chapter, I will describe pieces of the agricultural sciences teaching and learning quilt, beginning with an analysis of the enduring patterns within the discipline throughout the 20th century. This historical perspective allows us to identify the distinctive features, values, and manner of thinking of an agriculturalist. For the last 100 years, our graduating students have been not only specialists within a scientific discipline, but also individuals who have learned professional skills considered the core of successful farming: self-reliance, problem-solving, decision-making, and leadership. A short analysis of two distinct learning opportunities fairly unique to the discipline—the judging contest and the capstone course—will help illustrate our signature pedagogy. Although the former epitomizes the predominant pedagogy of the 20th century, the latter embodies a vision more appropriate for the 21st century. In that vision, our classrooms provide genuine learning experiences in which instructors and students are fully engaged in decision making and real-world problem solving guided by sound scientific, business, and ethical principles.
A Historical Perspective

The unique historical identity of colleges, professional schools, and departments provides a context for the learning that happens within a classroom. Higher education in agriculture has its roots in the land-grant colleges and experimental research stations created and supported by Acts of Congress passed in the late 19th and early 20th century. The welfare of the rapidly expanding nation depended in part on agriculture for economic growth and rural development. Scientific research, technological development, and the training and education of approximately six millions farmers were important to the nation’s food supply at the dawn of the 20th century (ERS, 2000). The mission of the agricultural sciences has been to discover how to grow crops and manage farm animals in order to produce enough high quality food and fiber to satisfy the needs of an ever-growing population. For more than a century, agronomists and animal scientists have been unlocking the laws of nature that govern crop yield and animal (dairy, beef, and poultry) growth and development. Over the years we have seen astonishing successes of research, education, and community outreach in animal sciences (egg and meat production), dairy science (milk production), and closely related disciplines (agronomy, soil science, agricultural engineering, etc.). The collective impact of agricultural sciences on national prosperity has been undeniable. In the 1930s, one U.S. farmer produced food for 10 individuals, but in the 1990s, one farmer produced food for more than 100 (USDA, 2005).

The proper interplay among research, teaching, and extension activities has been essential to the success of land grant colleges; nevertheless some have argued that undergraduate teaching has been neglected since their inception. Fifty years ago, Washburn looked back at the first 50 years of recorded history in animal sciences and argued that “Teaching in general, however, has been treated as an orphan—being always considered secondary to research and other departmental activities” (Washburn, 1958, p. 1117). Nonetheless, early agricultural teachers had a broad view of their teaching mission. They saw higher education in agriculture as “a liberal education insofar as it liberalizes the mind, disciplines the conduct, refines manners, broadens aesthetic interests, and strengthens the capacity for happiness, efficiency, and social service” (Ruth, 1935, p. 158). Although practical hands-on courses such as evaluation of crops and livestock, for example, had been an integral part of the curriculum, instructors hoped to teach more science-based courses. Students’
aptitudes, attitudes, and interpersonal skills were also recognized early as important components of an agricultural education (Rice, 1945). In essence, our teaching forefathers were training young men in a set of core values deemed necessary to the success of family farming, such as independent thinking, self-reliance, and decision making, or as Wentworth (1933) put it, “graduates who can create their own niches in the world” (p. 248).

The changing student population and the expanding career opportunities available to the graduates of four-year programs have substantially impacted the pedagogical landscape of agricultural sciences throughout the 20th century. The typical student of the first half of the 20th century was a male Caucasian who grew up on a farm and looked forward to returning to the farm or finding work as a public servant in an educational or governmental position after graduation (Washburn, 1958). In contrast, by the end of the century, women composed the majority of agricultural students, and one-third of dairy science majors (Kensinger & Muller 2006) and two-thirds of the animal science majors (Taylor & Kauffman 1983) had either no or limited farm background. Since the early 1960s, it’s been necessary to add flexibility to the curriculum in order to address the needs of this increasingly diverse student population and their changing career paths. Interestingly, the lack of first-hand agricultural experience in our current student population has provoked a resurgence in the demand for practical and hands-on courses (Kensinger & Muller, 2006). Today, students have innumerable options to choose from in preparing for futures that may include graduate school or veterinary school, careers in production agriculture (i.e., farming), sales and services, communication, marketing, finances, or business consulting with the allied industries (seed, feed, equipment, processing, etc.). Given the extent to which agricultural sciences prepares students for a farming-related profession, the discipline is not unlike the other professions, such as medicine and law, that have clear, well-established signature pedagogies on which Shulman based his article (Shulman, 2005).

Scholarship of Teaching and Learning in Agricultural Sciences

Not only were early agricultural educators aware of the value of inquiry in teaching and learning, but their analysis of the generally accepted attitude toward teaching is as true today as it was then. For example, as early as 1935, Ruth criticized the disparity in the way scientists engaged in research, compared to their
mindset toward teaching: “Teachers of science accept in education what is
done traditionally, although they experiment continually in their own fields
in the hope of contributing to change” (pp. 154–155). The author, however,
acknowledged that “participation in educational study by an agricultural col-
lege staff will probably never be as thorough and profitable as it might well
be, because of the time that is required in reading and reflection outside the
field of primary interest” (Ruth, 1935, p. 154). The lower status of teaching
relative to research in many institutions has continued to frustrate commit-
ted educators since the early days. In 1931, King articulated the tension
between teaching and research in stark language when he wrote, “A servant
can not well serve two Masters” (p. 262). For his part, Helser (1933) was
highly critical of instructors who “feel that the student is someone to be tol-
erated while investigation work is being done, papers prepared, speeches
made and outside meetings attended” (p. 258). Unfortunately, many in the
1950s construed good teaching as merely sifting through research findings
and incorporating the most important ones into courses (Davis, 1956). By
then, the hands-on and practical courses (such as the judging courses) that
characterized the pedagogy of the first part of the 20th century had been
gradually superseded by lecture courses aimed at teaching scientific facts. As
the original teaching mission was being lost, if not abandoned, some
attempted to find conciliatory approaches. For example, Kauffman, Shrode,
Sutherland, and Taylor (1984) saw scientific discoveries as exciting and liber-
ating truths that enthusiastic instructors strongly desire to communicate
clearly to students. Although laudable and still embraced by many today, this
approach falls short of the original goals set forth by our forefathers in which
students specialize in a discipline and gain a set of values and dispositions
core to agricultural professions.

In the early 1980s, Taylor and Kauffman (1983) published a 75-year
review of the teaching literature in animal sciences and put forth both
groundbreaking and astounding conclusions. First, these authors concluded
that educators of the 1980s were “reinventing the wheel” (p. 172), as what
was considered new in teaching and learning had been registered in the liter-
ature more than five decades earlier. They also identified the “fine screens of
reviewers” (p. 173) as the main reason for the paucity of teaching-related
papers published between 1930 and 1980, and asked whether it would not
have been unforgivable had the same review process prevented teaching-
related publications of the earlier years.
In spite of the continued difficulty in publishing results of inquiries in one's own teaching in discipline-based journals, some dedicated educators have shared their cumulative years of experiences in the form of memoirs (Kauffman, Shrode, et al., 1984; Lasley, 1979; Simmons, 2004). As years of practices are reflected upon, those memoirs may constitute a form of important disciplinary history, if not a form of scholarship of its own right (Weimer, 2006). Remarkably, some have searched for “truth” in their teaching. Reflecting on his career, Simmons (2004) wrote, “Perhaps the one imperishable attitude, above all others, that has informed my practice as a teacher and learner has been my desire to recognize and hold fast to that which is genuine—to that which is ‘real’” (p. 153). The sharing of such insights as well as more formal inquiries should be encouraged.

In addition to reflections and memoirs, existing scholarship in agricultural sciences focuses on curriculum assessment, including new course descriptions and other teaching improvement initiatives. Unfortunately, there are few formalized assessments of student learning or methodological tests of the effectiveness of teaching innovations. Most of this literature is published in two peer-reviewed journals: The NACTA Journal, published by the North American Colleges and Teachers of Agriculture (http://www.nactateachers.org/), and The Journal of Natural Resources and Life Science Education, published by a coalition of nine cooperating professional societies (http://www.jnrlse.org/about.html).

**Disciplinary Values and Habits of Mind**

Despite apparent changes in educational goals throughout its history and limited documentation of recorded scholarship, higher education in agricultural science has a unique pedagogy. Agricultural science programs are designed foremost to provide students with a learning environment in which they gain the knowledge, understanding, and leadership skills required to manage complex biological, economic, and social systems (i.e., a farm or any part of it), and thus make decisions and solve real-world problems. This superordinate goal was true throughout the 20th century and will remain true in the decades to come, in spite of the ever-growing career paths within the discipline. Indeed, regardless of one’s college degree, the credibility of a professional in the agricultural world and closely allied industries is often
dependent upon a deep-rooted and personal experience with the animals, the land, or the reality of daily life on a farm.

Farming was, is, and will remain a high-risk business. Farmers make decisions in the face of many uncertainties on a daily basis. They tend to be conservative individuals who take calculated risks. Not only are their livestock, crops, and markets unpredictable, but even the weather may have profound influences on their business. Thus, although the curriculum has emphasized efficiency and economical means of production since the early days (Kildee, 1925), our forefathers believed in a curriculum which would help students become decision makers and problem solvers. In 1935, Ruth wrote “Problem solving is the concrete expression of the purpose of education” (p. 162), but the author also stated that “Solving new situations by the judicious application of facts is not a natural habit” (p. 163). The emphasis on higher-level thinking skills (analysis, synthesis, and evaluation) as described by Bloom (1956) and the application of these skills in the professional training of students have been consistent educational goals throughout the past century in animal science (Grant, Field, Green, & Rollin, 2000), dairy science (Kensinger & Muller, 2006), and agronomy (Graveel & Vorst, 2007). Oral and written communication, leadership, and life-long learning skills have also been incorporated in most agricultural science curriculum throughout the country. These skills and dispositions characterize successful farmers, who often are not only role models but also leaders in their communities. Thus, the general goals of an undergraduate education in agricultural sciences have been fairly well defined since the early parts of the 20th century. How to reach these goals, however, has been matter of continual debate, tension, and frustration.

Teaching in Agricultural Science in the 20th Century

For any classroom instructor, the design of an environment conducive to deep understanding is an extremely complex process. Such environments must draw on the instructor’s expertise in both content knowledge and pedagogical knowledge (i.e., the knowledge of how to teach). The union of content knowledge and pedagogical knowledge leads to pedagogical content knowledge (PCK), which has been recognized recently as a central element of scholarship of teaching (Paulsen, 2001) and as a point of differentiation between an excellent teacher and a scholar (Kreber, 2002). The need for PCK
in agricultural sciences was expressed as early as in 1925, when McCampbell wrote, “Animal husbandry instructors as a whole are poor teachers. . . . They have had little or no training in the fundamentals underlying the science of teaching, and therefore do not know how to teach even though they may know well the subject matter they are called upon to present in the classroom” (McCampbell, 1925, p. 67).

Also, early animal science educators believed in the importance of students’ attitudes in the teaching and learning process. Gay (1933) argued that masters of subject matter have failed as teachers in many instances in part because of their neglect of the learner: “Attitude of mind of the student is paramount to successful teaching and the first step essential to success on the part of the teacher is to create the proper attitude of mind in the student” (p. 254). Similarly, reflecting on his teaching career, Simmons (2004) acknowledged that “One of the largest errors of educators in agriculture is to presume that our students are ‘blank slates’ and have no prior conception or understanding of the subject matter” (p. 151). Even students with no direct agricultural background hold assumptions regarding the subject matter we teach. An ideal teaching and learning process will measure and address those preconceptions or misconceptions first.

Failure to account for students’ beliefs and aspirations and overemphasis on content knowledge at the expense of PCK often translates into preoccupation for “what” to teach and ignoring “how” to teach. Agricultural science students should learn how to challenge their own knowledge, yet as pointed by Schillo (1997), teaching scientific facts in a teacher-centered classroom often amounts to indoctrination rather than education. Furthermore, teachers should differentiate between the organization of the knowledge as they communicate with disciplinary colleagues, and the organization of the knowledge in a class for the purpose of student learning. Educational scientists have provided evidence for the “expert blind spot” as an impediment to effective teaching. Teachers with advance subject-matter knowledge are blinded by their own use of powerful organizing principles and methods of analysis as guiding principles for their students’ conceptual development. Instead, successful teachers rely on knowledge-scaffolding, which is central to the learning process of student novices (Nathan & Petrosino, 2003). This research demonstrates that teachers who are interested in helping students gain a deep understanding of a subject matter should de-emphasize linear coverage and instead lead students toward
making connections and thus gaining an increasingly sophisticated view of
the issues of the discipline.

In 1971, Kauffman and colleagues highlighted the work of Bloom
(1956) to argue that educational experience of animal science students
should include the cognitive domain, the affective domain (interest, atti-
tudes, and values), and the psychomotor domain (manipulations requiring
neuromuscular coordination). Others have highlighted the linkage between
emotions and cognition (Palmer, cited in Wattiaux, 2000). Teaching facts out
of context rarely stimulates students’ interest; therefore, individual research
projects, individual and group laboratory projects, student travel and field
trips, and intra- and inter-collegiate competitions have been proposed as
means to engage students more fully in the learning process (Kauffman,
Thompson, Anderson, & Smith, 1971). Today, this list can be expanded eas-
ily to include computer laboratories or discussions of case-studies, pre-
assigned web postings, or other forms of content-rich multimedia material.
Lasley (1979) suggested that students should be trained to ask questions
rather than focus on answers. One could go a step further by challenging stu-
dents to formulate hypotheses and evaluate evidences to support or reject
answers to their own questions. Schillo (1997) advocates a teaching approach
that engages animal science students in independent thinking and analytical
skills about the scientific process itself. He argues that critical thinking skills
can be achieved only if the uncertainty of scientific activity is acknowledged.
These inquiry-based approaches can be time-consuming and difficult to
manage in the classroom. Nevertheless, the habit of questioning and know-
ing how to evaluate scientific or other claims should be considered a critical
aspect of any undergraduate degree in agricultural sciences.

In a recent study, Wattiaux and Crump (2006) described students’ per-
ception of the learning environment as the classroom instruction method
transitioned from lecture to discussion of pre-assigned reading material. The
Student Assessment of Learning Gains (SALG; Seymour, 1997) was modified
and administered in three consecutive years, three weeks after the beginning
of the semester and again at the end of the semester. These authors found that
students who had a high interest in the subject matter perceived higher levels
of learning gains with discussion and were strongly opposed to returning to a
lecture mode of instruction. However, the opposite was true for students who
had a lower interest in the subject matter. Although attempts to understand
student motivation in our classes should be encouraged, there are limits to
what could be and should be expected in terms of making a subject matter “interesting” to the students. Motivation is rooted in prior education, life events, socio-economic background, and a host of other factors determining the image of the self and potential for intellectual achievement (Dweck & Light, 1980). Nonetheless, instructors should be encouraged to incorporate multiple feedback mechanisms to monitor classroom dynamics. As each cohort of students is unique, the same class activity conducted for two consecutive semesters can lead to drastically different responses (Wattiaux & Crump, 2006). Used properly, formative assessments are powerful class management tools. They ought to be designed and used to improve the learning experience, to validate what appears to be working successfully, or to highlight what needs to be reconsidered. Classroom assessment techniques (Angelo & Cross, 1993), which can be used as formative assessment tools, are now available on numerous web sites (e.g., http://www.flaguide.org/cat/cat.php).

Unfortunately, our teaching methods have remained more structured around the limitations and constraints of the instructors rather than aligned with the discipline’s genuine educational goals. In a recent Internet survey conducted among registrants of the annual joint meeting of the American Society of Animal Sciences (ASAS) and the American Dairy Science Association (ADSA), respondents were asked to choose one of the courses they had recently taught and to describe activities they used in their teaching. Results included 58 respondents from 38 institutions. The activities and their frequency were as follows: (a) lecturing, 100%; (b) discussion, 47%; (c) student presentations of class project, 41%; (d) individual or group activities (e.g., solving problem set), 64%; (e) computer lab, 21%; and (f) other, 12% (Wattiaux & Moore, unpublished). Although instructors appear to be using a variety of class activities to engage students more effectively, the heavy reliance on lecture may reflect a continued focus on delivering scientific facts.

Designing agricultural science classes to encourage critical thinking is challenging, and a review of the judging courses may be warranted. Judging has been omnipresent in the curricula of dairy science (Guthrie & Majeskie, 1997), animal sciences (Davis, Miller, Allen, & Dunn, 1991), agronomy (Elling, 1981), and soil science (Ponte & Carter, 2000) for most of the 20th century. These courses dominated the curricula in the early parts of the 20th century and thus had been a mainstay of agricultural education well before the science lecture course existed. Although they are now offered primarily as electives or extracurricular activities, they carry an important legacy. Judging
provides students with the opportunity to compete individually or as a team to evaluate a series of specimens by identifying traits or characteristics deemed important, ideal, or most desirable by experts. For example, dairy cattle judging consists of ranking classes (i.e., groups) of four cows or heifers based on visual observation of body conformation relative to a breed-specific ideal (as agreed upon by a Breeders Association). Such an exercise demands not only the knowledge of the desirable traits, but also calls upon a higher level of knowledge to compare, evaluate, and judge the phenotypic value of an animal relative to another. After ranking the animals, students orally present the reasoning behind their classification to an expert judge. Winners are those who rank the animals correctly and demonstrate polished oral communication skills. Students who excel in these contests typically move on, under the tutelage of a coach, to regional and national intercollegiate contests. The ambivalence among educators in regard to the role and value of judging contests as an extracurricular activity was highlighted recently when Kensinger and Muller (2006) found that, despite the fact that dairy judging was the lowest-ranked of 16 skills or experiences deemed important by faculty, 80% of the institutions that responded to a survey had a dairy judging team. Judging contests have long been a recruitment tool (Washburn, 1958), and they remain a powerful way to generate interest in the profession prior to college (Schwanke, 1997).

Early authors deplored what they saw as an overemphasis of judging contests (Gay, 1938), but others have later recognized their value as a way to help students bridge their interest in practical, real-world experiences with a more fundamental understanding of their scientific discipline (Kauffman, Thompson, Anderson, & Smith, 1971). Although few studies have been conducted to evaluate the impact of competitive judging on learning critical life skills, some authors have attempted to investigate this question. For example, Guthrie and Majeskie (1997) have argued that judging contests contribute to critical thinking, self-discipline, situation analysis, decision making, verbal expression, and defense of decisions. Others have suggested that the sharpening of a variety of skills in contestants may contribute to recognition in their respective circles and successful careers (Elling, 1981). The long-term social networking is a definite benefit, but the competitive nature of the event and the restricted number of beneficiaries are two major limitations. Although they are still dear to many students and the farming community, judging contests have remained of limited benefit to a science-based education. Nevertheless,
teaching and learning how to judge have served to nurture critical values and professional attitudes considered most desirable in the agricultural world throughout the 20th century, and the contests should be recognized as an important part of the history of agricultural sciences, even embodying some elements of a signature pedagogy for the discipline at the time.

**A Vision for the Future: Toward a Signature Pedagogy of Agriculture**

As the 21st century unfolds, higher education in agricultural sciences must be transformed profoundly to respond to the ever-increasing complexity of food production systems (Meyer, 1993) and an increasingly diverse student population (Gomes, 1998). Our classrooms ought to become microcosms of societal changes, and our students must be challenged to face problems in the same way as they will encounter them in the workforce. Today, curricula in colleges of agriculture and life sciences are being expanded far beyond agricultural production, to include biotechnology, animal welfare, environmental pollution, international trade, hunger and poverty, social justice, and other issues. It is no longer sufficient to teach only scientific facts and figures. We must help our students learn how the scientific method, as a human endeavor, can contribute to solving complex and global issues. To do so, our students must have first-hand opportunities to apply their nascent scientific expertise to real-world situations. Providing them with capstone experiences will be essential to our future pedagogy. As proposed here, a capstone experience is defined as an experiential learning opportunity whereby a student is called upon to apply critical scientific thinking to a real-world problem (Crunkilton, Cepica, & Fluker, 1997). However, properly structured independent studies, internships, service learning, summer research projects, study abroad, and other international programs can also provide students with a capstone experience.

This emerging signature pedagogy in 21st-century agricultural science faces a few challenges. For instance, neither the students nor the instructors may be aware of these opportunities (Wattiaux, 2006) and their full potential benefits. Additionally, many independent learning opportunities as currently configured are ill-conceived and do not result in a capstone experience for the student. For example, internships have been traditionally approached as opportunities for juniors and seniors to explore possible careers while
gaining work experience. Instead, they should be viewed as an integral component of a student’s educational experience (Kensinger & Muller, 2006). As another example, study abroad programs are often perceived as contributing to a student’s personal growth and world vision, rather than a unique opportunity to gain expertise in academically important domains (Lukefahr, 1999; McKenna, 1991).

Despite the challenges, many traditional classroom courses have been designed to provide capstone experiences, and capstone courses are now prevalent among all disciplines of agriculture across the nation (Andreasen, 2004). They present students with opportunities to apply their knowledge of the subject matter learned in seemingly unconnected or disjointedly organized classes, and to integrate new information into their knowledge base to solve real-world problems. Typically, farms or businesses are partners in a capstone course. For example, in the current Farm Management Practicum course offered by the University of Wisconsin, Madison, dairy science program, students are placed in teams and called upon to act as consultants to a dairy farm. Students may travel to their assigned farm multiple times during a semester to discuss management issues with the owner or operator and to collect data and possibly samples for laboratory analysis. Back on campus, students complete a thorough analysis of multiple sources of information, including material learned in nutrition, breeding, reproduction, and other specialized courses, to identify current limitations in the management of the farm. By the end of the semester, students propose economically sound solutions to problems they have identified or changes to management that may be helpful to the business.

Carefully designed capstone courses that include experiential and contextualized learning are effective for calling upon students’ higher levels of thinking. Andreasen and Trede (2000) have investigated the perceived benefits of a capstone course relative to other courses in the curriculum and cautioned that to be a truly summative educational experience for the student, the capstone course must be rooted in experiential learning, especially hands-on participation (Andreasen, 2004). Thus capstone courses provide students with the opportunity to create a coherent understanding of how to use science-based facts to improve the management of a complex system. Pedagogically, capstone courses have other undeniable educational benefits. First, they help diffuse the longstanding tension in the curriculum between the “how” (applied courses most desired by many students) and the “why” (science-based courses...
most desired by many faculty). Second, they help students confront their pre-conceptions or misconceptions of how science can be used to solve real-world problems. Third, they engage students in a discovery process that borrows heavily from the scientific method. Fourth, they create a learning environment in which neither the student nor the teacher has full control of the process, but both are committed to constructive and positive outcomes. Fifth, they convey credibility and validate the students’ training as managers of complex systems. And sixth, they extend the boundaries of academia to the real world for every participating student. Interestingly, a consortia of agribusinesses has taken an interest in sponsoring a yearly dairy science capstone spin-off event organized as a three-day intercollegiate competition in which teams of students from around the country assess dairy farm management (Weber Nielsen, Domecq, Davis, Beede, Budine, & Martsolf, 2003).

The capstone course and other properly constructed capstone experiences provide unique opportunities for both the student and the teacher to appreciate the complexity of the real-world problems, to solve them with science-based knowledge, and to create a dynamic of common purpose. However, this learning environment should not be restricted to a one-semester course in the senior year: instructors should rethink the nature of the teaching and learning process, and in-class activities should be redesigned to provide students with capstone-like experiences. Similarly, entire curricula should be redesigned with the same goal in mind. The weaving of capstone-like experiences in class, out of class, and throughout the curriculum may provide a foundation for a long-term vision. However, for the time being, capstone courses exemplify a model of signature pedagogy for agricultural sciences education in the 21st century in part because the ways students learn in those courses model how they are expected to carry their college education into their future agricultural-related profession.

In Conclusion

The history of higher education in agricultural sciences is rooted in the spirit of independent, hard-working, innovative, and self-reliant settlers whose success depended on their ability to manage complex production systems. As scientific discoveries, technological advances, and the industrialization of agriculture proceeded at a mind-boggling pace throughout the 20th century, undergraduate programs have been reconsidered and redesigned to accommodate new career
paths, new student demographics, and the changing role of agricultural education. However, the training of independent thinkers and leaders who can make decisions in the presence of numerous uncertainties does not always occur in higher education in agriculture, perhaps because these lofty goals were never enshrined in national standards or endorsed by any professional organization. Left to the discretion of faculty and individual instructors whose priorities are often elsewhere, decisions of what to teach and how to teach have been heavily teacher-centered and influenced by the desire for efficient “transfer” of scientific facts (“truth”). Unfortunately, trials and errors continue to trump systematic inquiry to improve student learning in our classes. The small minority of agricultural scientists who have engaged in the scholarship of teaching and learning are not only role models but also pioneers. In a sense, they emulate the fundamental values of their own teaching. These pioneers are independent, hard-working, innovative, and self-reliant individuals whose success as instructors depends on the ability to use a science-based approach to manage a complex system: the class they teach.

References


