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Designing sustainable agriculture education: Academics' suggestions for an undergraduate curriculum at a land grant university

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Abstract. Historically, land grant universities and their colleges of agriculture have been discipline driven in both their curricula and research agendas. Critics call for interdisciplinary approaches to undergraduate curriculum. Concomitantly, sustainable agriculture (SA) education is beginning to emerge as a way to address many complex social and environmental problems. University of California at Davis faculty, staff, and students are developing an undergraduate SA major. To inform this process, a web-based Delphi survey of academics working in fields related to SA was conducted. Faculty from colleges and universities across the US were surveyed. Participants suggested that students needed knowledge of natural and social science disciplines relating to the agri-food system. In addition, stakeholders suggested students learn through experiences that link the classroom to field work, engaging a broad range of actors within applied settings. Stakeholders also emphasized the need for interdisciplinary and applied scholarship. Additionally, they proposed a range of teaching and learning approaches, including many practical experiences. Given the diverse suggestions of content knowledge and means of producing knowledge, the survey presented unique challenges and called into question the epistemological and pedagogical norms currently found in land grant colleges of agriculture. This study has implications for land grant universities seeking to develop undergraduate curriculum appropriate to the field of SA.

Key words: Curriculum, Experiential learning, Interdisciplinary, Land grant university, Pedagogy, Post-secondary education, Sustainable agriculture

Abbreviations: LGCA – Land grant colleges of agriculture; SA – Sustainable agriculture

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Introduction

The land grant university and colleges of agriculture (LGCA) system stands out as a unique contributor to public education in the United States because of its mandate to bring higher education of a practical nature to citizens of ordinary means (NRC, 1996; LaMay, 2001). When legislated, land grant institutions were "to teach such branches of learning as are related to agriculture and the mechanical arts... in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life" (Morrill Act, 1862). Land grant university colleges of agriculture emerged in an era of competing educational ideologies, which shaped these institutions in a multitude of ways.

In the late 19th and early 20th centuries, the philosophical debate about educational reform in American society focused primarily on the child and adolescent. College curriculum at the time, however, was also subject to critique. Competing philosophical camps that fueled the debate included the developmentalists, humanists, and the social efficiency educators (Kliebard, 1995). Social efficiency[1] educators and other traditionalists argued for schooling as a means of social control and industry employment training, whereas developmentalists[2] and humanists[3] emphasized curriculum for individualization and democratic civic participation. Similarities can be seen between the legislative debates over the purpose of LGCAs and the debate of the epoch's scholars.

Concerns over issues relevant to public education and LGCA raised during this time prompted another camp to emerge, the progressives. Among this camp's leaders was John Dewey, perhaps America's most respected educational scholar. Dewey (1916) argued for student centered, experientially based curriculum that placed learners in real-world contexts and engaged them in purposeful activities that focused on personal interests. Theoretical perspectives on curriculum are often placed on a continuum spanning the traditional and progressive views (Dewey, 1938; Gardner, 1990; Posner, 1995). Those arguing the traditional perspective believed the purpose of education was to prepare the young for future responsibilities and for success in life, by acquiring organized bodies of knowledge and skills that were worked out by past generations. The notion that learners are to acquire knowledge from those more educated is a hallmark of the traditional view. In the traditionalist view, the learner is an empty vessel and the purpose of education is to transmit knowledge (whether it be on the cultural heritage of Western civilization or disciplinary knowledge of physics) and wisdom of the past generations (Posner, 1995).

In contrast, the progressive view holds that learners come to each situation with important experiences of their own. As such, learning is based on active construction and reconstruction of preexisting mental frameworks or concepts, which are most productively altered or built upon when learners are engaged in contextually based experiences that are personally meaningful (Kolb, 1984). From the progressive perspective, then, the learner is the focal point of the process of learning. S/he requires meaningful experiences to personally motivate and interest her/him to actively become involved in the learning process. In the first half of the last century the progressive stance gained ground in terms of acceptance; however, by the turn of this century, the traditional perspective became firmly entrenched within institutions spanning elementary school through college.

Curricula in post-secondary academia has historically been discipline driven (classes and majors), pedagogically didactic (classroom lecture and drills), and focused on transmitting canons of formal knowledge. The invention of the land grant university and colleges of agriculture in many ways challenged the orientation of these age-old academic traditions. Until the emergence of LGCAs, post-secondary education in the US was designed to serve the privileged class, focusing primarily on teaching classics. The work of early LGCAs, however, was aimed at serving the applied agricultural needs of students by addressing both the theory and practice of agricultural and mechanical arts and sciences. In short, LGCAs proposed a national transformation in higher education, making college curricula both accessible and relevant to the industrial class.

As LGCAs struggled to design this "new" curriculum, the fledgling institutions called on the leading thinkers of the early 20th century. One major question concerned the role of a university farm in terms of teaching and research. Cornell Professor Liberty Hyde Bailey, one of the era's most progressive educators argued "the value of the university farm from a university man's point of view consists in its usefulness as a means of teaching" (Bailey, 1905: 4). Bailey's experientially based teaching philosophy proposed distinct uses for the farm. He contrasted learning on the farm with learning from books or the use of farms as mere models, museums or collections where students simply acted as spectators. He claimed, "if we study plowing in the classroom, we must also study it in the field... we must determine and test the relation of plowing to moisture, aeration, microbial life, and many other questions" (ibid.). For Bailey, a farm "justified from the university or pedagogical point of view must be made a true laboratory to collate and articulate with the theoretical instruction " (ibid.). Bailey proposed students should learn by engaging in concrete field experiences, making observations and reflecting on the relationship of these discoveries to the more abstract disciplinary knowledge found in the classroom. This approach stood

in sharp contrast to those who argued for memorization drills or simple vocational training. Bailey, like Dewey, was interested in progressing students' intellect and skills, and considered the development of both as interdependent. Thus, progressive educators sought to infuse experientially based activities into the curriculum to wed theory and practice. Such curricular transformations have been successful in varying degrees because there has been a constant tension between advocates of traditionalist views of learning[4] and those with a more progressive stance, even in LGCAs where progressive reforms were originally mandated.

While academia's discipline delineated structure and didactic teaching have their roots in the western reductionist science tradition, the pronounced trend within LGCA toward a research multi-versity architecture occurred most dramatically during the Cold War era (Kerr, 2001). Along with the G.I. Bill, enormous federal research funds were channeled through the National Science Foundation and the National Institutes of Health reinforcing expanded disciplinary specialization within departments and colleges. This specialization generated unprecedented advances in modern medicine, military, industrial, and agricultural production technologies. The rise of the multi-versity also promoted teaching approaches that focused on and privileged the dissemination of packaged techno-scientific knowledge from specific disciplines. Contemporary progressive critics, like their progenitors in the early 1900s, however, have argued that excessive disciplinary specialization has negative consequences for teaching and research.

In the 1990s a number of studies (Boyer Commission, 1998; Kellogg Commission, 1999) called into question LGCAs' fulfillment of the promise to meet the needs of their mandated constituencies. In ''Reinventing Undergraduate Education: A Blueprint for America's Research Universities,'' the Boyer Commission (1998: 4) called for radical reformation of research universities' mode of operation. The commission noted: (1) a pervasive and gross imbalance between teaching responsibilities and research, (2) a predominance of didactic teaching and passive learning approaches, and (3) over specialization within disciplines through departmental hegemony. The report claimed the ''concept of integrated education requires restructuring both the pedagogical and the integrative aspects of the research university experience.'' The report specifically called for undergraduates to experience interdisciplinary collaborative learning that is inquiry based and socially engaged.

Other critiques (Kunkel, 1992; National Research Council, 1996) echoed concerns similar to the Boyer Commission. The National Research Council's ''Colleges of Agriculture at the Land Grant Universities: Public Service and Public Policy'' report (1996) identified a number of problematic conditions that weakened the performance of LGCAs. The report identified a need to (1) develop and expand research programs and academic curricula to reflect a contemporary view of the agri-food system and, (2) remove historic disciplinary barriers and encourage interdisciplinary research, teaching, and extension collaborations. The historic report went on to suggest requiring internships representing diverse career settings found in food and agricultural sciences. Finally, the report recommended expanding efforts to ''develop innovative multidisciplinary and systems-based course materials and curricula'' (NRC, 1996: 5). Further considerations appear warranted when the NRC, a body of scientists involved in the academy, argues for significant reforms within LGCAs. Progressive reforms and innovative strategies are called for to ameliorate this crisis in undergraduate agricultural education at the nation's leading public institutions of higher learning.

The last decade has witnessed important changes in the agricultural community, consumers, and society as a whole. Sustainability issues, centered on human health and the environment, are broadly acknowledged as increasingly important. One economic metric of this response has been the development of the organic food market sector in both California and the US with sales growing 15%–20% per year both statewide and nationally in the last decade (Dimitri and Greene, 2002; Klonsky et al., 2002). Over the past decade, the international organic sector also grew at 20% per year, while the conventional food sector grew by 5% annually during this same period (Thrupp, 2002). Market trends and sales represent a limited and potentially misleading measure of sustainability and need to be interpreted cautiously, particularly when market trends parallel increasing corporatization and the eroding of policy that ensures social justice, animal welfare, and stringent environmental quality standards. Nevertheless, increasing producer and consumer awareness and attraction to the concepts and products associated with sustainability appears to be encouraging LGCAs to examine and promote sustainable agriculture (SA) in an active and systematic manner.

Sustainable agriculture is an interdisciplinary field of study that offers a potentially effective organizing structure with which to address many of the complex societal and environmental problems in the agri-food system that have heretofore been unapproachable by single disciplines (NRC, 1989, 1991; Allen et al., 1991; Allen, 1993; Altieri, 1998; Gliessman, 1998; Francis et al., 2003). Over the past two decades, SA education has expanded from the academic margins (USDA, 2000). Previously, few SA formal educational activities existed beyond a rare faculty or graduate student conducting a limited research project or seminar on the topic. Formal undergraduate studies in SA have been virtually non-existent,

whereas informal student initiatives such as student farms have been instrumental in supporting the growth of SA education on campuses nationwide.

Much of the development in alternative agriculture grew out of critiques of conventional agriculture. The consequence for higher education of an increasing focus on SA, however, has not been limited to the development of alternative agronomic production technologies. Concomitant to the development of alternative agronomic practices has been the introduction of "new" or alternative educational practices.[5] These alternative educational practices include curricular and teaching approaches some argue are better suited for the study of SA.[6] Authors have examined linkages between the ways scholars are educated, science is conducted, and agriculture is performed (Busch and Lacy, 1983; Kuhn, 1962; Latour, 1992). In a review of existing barriers to and potential solutions for the development of SA, MacRae et al.(1989) have drawn attention to the effects of disciplinary isolation and reductionism on both the agricultural sciences and agricultural scientists. They argue:

> [P]aradoxically, much of the research and research process that has made conventional agriculture so productive has been a barrier to implementing sustainable agriculture. It is our contention that we rely on too few approaches to agricultural science, that these approaches are not sufficiently comprehensive, and that agricultural scientists have traditionally been associated with too few players in the food system to establish a sufficient knowledge base for sustainable agriculture (MacRae et al., 1989: 174).

MacRae et al. (1989: 200) also maintain that the education of future scientists is a key strategy for implementing SA; however, they assert "it is not just the content of the curricula that needs to be changed, but also the way students are taught." They persuasively claim that the focus of agricultural education needs to be broadened and research needs to be conducted in ways beyond the dominant natural science paradigm of logical positivism. Further, they call for the inclusion of diverse frameworks and approaches found within social sciences and farmers' own fields and working communities. These contemporary calls for an integrated and engagement oriented SA curriculum harkens back to the turn of the last century when scholars in LGCAs and elsewhere were envisioning how best to educate students of agriculture in a holistic manner.

Contemporary academics are working to achieve a clear vision of the best educational approaches for SA. Recent works (Bawden, 1990, 1996; Francis et al., 2001; Lieblein et al., 2004) stand out as significant attempts to communicate the unique educational needs of SA within university contexts. Writing on praxis, or a dialectical set of theories and practices, the aforementioned authors articulate a series of distinctions embodied in the education of agroecology and SA. Distinctions are of particular import when ascertaining the limitations and specific transformational needs facing existing education programs. Drawing from their work in curriculum development, Bawden (1990, 1996) and Francis et al. (2001) contrast characteristics of traditional agricultural programs with their recent efforts in SA education (Table 1). The present study is organized theoretically around the framework explicated in Table 1 and uses the mixed methods inherent in the Delphi technique to "test" or validate the qualitatively derived assertions from the above authors.[7] A Delphi technique is a group process used to elicit, collate, and direct informed (expert) judgment toward consensus about an issue under question.

Table 1. Distinctions between traditional programs and sustainable agriculture education based on Bawden (1990, 1996) and Francis et al. (2001).

Traditional agricultural education	Sustainable agricultural education
Disciplinary specialization, de-contextualized and narrowed inquiry	(Hard) Systems inquiry engaging complexity*
Predominantly natural science focus on production problems, biophysical experiments, technological solutions	Interdisciplinary methods and learning objectives addressing biophysical, socio-cultural, and political economic problems and solutions
Didactic teaching method	Facilitation of active and interdependent engagement of students
Passive students dependent on teacher for learning	Teacher as facilitator in a student–teacher collaborative, participatory, and action-oriented inquiry process
Learning in classrooms and labs	Experiential and practical learning both on and off campus.
Faculty and texts as sole sources of expert knowledge	Students and faculty co-construct knowledge and learn through engaging practitioners in their place of work

* Hard systems refer to explanatory concepts and formal knowledge that society has constructed to describe phenomena in the world (e.g., ecosystems), whereas soft systems describe the process of individual and social learning of these world views (e.g., how we come to see and consider the world as an ecosystem) (Checkland, 2000).

Bawden (1990, 1996) and Francis et al. (2001) propose educational praxis be seen as realignment away from disciplinary specialization and passive learning of formal knowledge, towards the use of integrated, critically reflective educative experiences. Such facilitated experiences apply interdisciplinary approaches that engage complexity in learning-communities of practice. The emphasis moves from the transmission of existing knowledge and research methods used in isolation from the variability of real world agriculture, towards a focus on purposeful, self-directed learning as individuals and communities work in authentic problem situations. This shift in curriculum, teaching, and learning clearly resound the original mandate of the LGCA system as well as the early and late 20th century calls for educational reform.

Formal SA programs in higher education, however, have only recently begun to emerge as undergraduate emphases, minors, and majors (USDA, 2000). As institutional interest for SA increases, few models exist for undergraduate curriculum design or program evaluation. Academics and others involved in the development of such programs often ask: What constitutes an education in SA? What should a SA curriculum include and exclude? How should SA be taught? And how do learners come to understand SA concepts?

Some land grant institutions have started taking steps toward answering these questions and making undergraduate education reforms a reality. For example, Dean Van Alfen of the College of Agricultural and Environmental Sciences at the University of California at Davis has observed that "sustainable agriculture has been recognized as field of study... that is gaining prominence among researchers, students, industry, and the public" (King, 2003). This trend in thinking, however, is recent. One significant step toward institutionalizing these educational reforms would be to develop undergraduate SA majors. There are, however, few published studies that document US land grant university progress toward the development of SA majors or curricula. This study was designed to meet the applied needs of a specific university pursuing this end. As such the survey findings are limited in scope, but may provide other universities insight and examples of processes to aid their efforts to establish reforms and SA education programs.

Context

In 2002, a University of California at Davis committee of faculty involved in SA education, research, and extension appointed by the Dean of the College of Agriculture and Environmental Sciences proposed the establishment of an undergraduate major in SA. As a result, a curriculum committee was appointed to design the major. In summer 2003 a public meeting was held to publicize the committee's report and recommendations and to solicit feedback from internal and external stakeholders. At this meeting the recommendation for an undergraduate major enjoyed broad support, with stakeholders specifically advocating for the inclusion of social sciences, field based experiential learning, and a systems orientation within the curriculum. Many in this group were concerned about the inadequate emphasis on the social aspects of agriculture and the lack of applied learning experiences in existing University of California at Davis curriculum. With this support and stakeholder feedback a new curriculum committee of faculty and staff was appointed to develop a SA major that integrates natural and social sciences and identifies an appropriate administrative structure for the major. Students successfully lobbied for representation on the committee.

The new committee, now comprised of faculty, staff, and graduate students, believed it important to receive advice from academics working across the US in various agriculturally related disciplines to inform the development of curriculum. The committee sought the advice of these academics via an extensive web-based Delphi study. This paper focuses on the content knowledge and experience-related suggestions put forward by these agricultural education stakeholders.

Purpose and objectives

The purpose of this Delphi survey study was to garner academics' perspectives on the development of an undergraduate major in SA. The specific objectives were:

(1) to determine what content knowledge should be included in an undergraduate SA major and
(2) to determine what experiences should be included in an undergraduate SA major.

The scope of interpretation around the definition of SA was intentionally left open to allow participants' opinions and perspectives to influence the findings.

Methods

The Delphi survey technique was employed to determine the perspectives of academics from various US agriculturally based colleges and universities, including LGCAs. This method was chosen because it has proven itself useful in collectively defining areas of import and bringing groups to consensus.

Initially, 56 agricultural academics were invited to participate in the study. Nominations came from University of California at Davis SA curriculum committee members. The committee was composed of natural and social scientist faculty and graduate students. The committee purposefully selected participant representation

from multiple fields within natural and social science disciplines. The greatest input, however, came from disciplines closely allied with the agricultural and environmental sciences and economics. It is also important to recognize that disciplines such as anthropology, history, geography, urban planning, and ecological psychology were not represented. The survey sampling was not representative of the total US academic population working in agriculture. The survey findings therefore are not generalizable beyond the University of California at Davis context. However, as a case study the results can corroborate or contest SA education efforts elsewhere.

Thirty-nine (39) or 70% of the 56 participants responded to the initial invitation and open-ended questions. From this initial pool, 29 or 74% participated from round one to round two and 28 or 97% participated from round two to round three. In total, the survey achieved a 72% participant completion rate in rounds one through three.

Twelve social science, 1 humanities, and 15 natural science academics completed the survey. In the final round, survey participants included representatives from the following disciplines (numbers behind the discipline description indicate the number of respondents):

- *Social Sciences:* Agricultural Economics (1), Natural Resource Economics (1), Agricultural Education (2), Human Ecology (1), Political Science (1), Rural Sociology (2), Sociology (3), Rural Development (1)
- *Humanities:* Philosophy (1)
- *Natural Sciences:* Agricultural Engineering (1), Agronomy (2), Biology/Agroecology (1), Biology/Agronomy (1), Botany/Agroecology (2), Crop Physiology (1), Crop Science (1), Ecology and Evolutionary Biology (1), Entomology (1), Horticulture (3), Production Management (1).

Seventeen North American universities and colleges were represented in the final round. Of the 28 final round participants, 21 were male and seven female. As detailed above, a goal of broad representation from distinct academic disciplines was reached, with no one discipline or field overly represented.

This web-based Delphi study followed procedures described in Dillman's *Total Design Method* (2000). Each participant initially received an invitation to the study in an official letter from the Dean of the College, followed by an email invitation. If they chose to participate, participants linked through the email invitation and responded to the survey questions. Postcards were sent periodically to spur response rates and participants were telephoned approximately three days prior to each round's cut-off date. All participants were phoned until personal contact was made.

This study was conducted in three stages. A panel of experts, represented by university faculty and graduate students, developed the following open-ended questions that guided the study: (1) What content knowledge is necessary for students to have when graduating from a SA undergraduate major? (2) What experiences are necessary for students to have while pursuing a SA undergraduate major?

Participant answers were received in the form of suggestions for specific content knowledge and experiences to be included in the major. From these qualitative responses, lists of unique content and experiences were developed. The researchers used the constant comparative method to distill and cluster participants' round one suggestions into logical categories (Strauss, 1987). In the second round, participants were presented with a list of all unique suggestions made by their peer group and were asked to score the importance of each on a Likert-type scale with "1" being not important, "2" being somewhat important, "3" being important, "4" being very important, and "5" being extremely important. The participants were also given an option to choose "DK," meaning don't know.

To determine the most agreed on knowledge content and experiences, researcher-defined criteria were employed. Statements that met the criteria moved on to the third round. Criteria were: (1) a Group Mean score of 3.5 or higher and (2) a Standard Deviation (SD) of 1.0 or less, indicating a strong consensus for inclusion among peers. Exceptions were made for items that met the mean threshold but failed the SD criterion if the distribution of scores for that given item held 51% or greater within the 4 and/or 5, "very important" and/or "extremely important" values.

In the third round, participants were asked if they still agreed with their initial ratings and, if not, to adjust their ratings. They were provided with both group mean ratings of suggestions and their own personal ratings from the second round. Data were collected and analyzed in FileMaker Pro and Microsoft Excel. Results from the final round are represented as mean scores (M) and SDs. Mean scores and SDs were calculated for individual suggestions. Grand mean scores were also calculated for the researcher defined categories of suggestions, serving as thematic headings. The grand mean was the mean of the mean from thematically grouped sets of suggestions.

Findings

Content suggestions

Academics considered content knowledge in both natural and social science disciplines as very important for undergraduates in SA (see Table 2). In addition to disciplinary knowledge, academics considered interdisciplinary and applied content knowledge to be very

Table 2. Content knowledge categories: Disciplines represented, grand mean for each category, and number of suggestions within each category.

Content knowledge	Grand mean	# of Suggestions
Natural sciences		
Ecology	4.48	6
Soil science	4.33	5
Pests	4.20	2
Water	4.02	3
Animal science	4.02	2
Plant science	3.59	1
Social sciences		
Policy	4.02	2
Food systems	3.94	6
Business/Economics	3.88	5
Marketing	3.82	1
Philosophy and ethics	3.79	3
Social studies	3.76	2
History	3.69	2
Interdisciplinary and applied		
Interdisciplinary	4.21	6
Farming practices	4.20	5
Research methods	4.03	2

Very important = 3.50–4.49.

important. Disciplinary, interdisciplinary, and applied content knowledge categories all received grand mean scores between 4.48 and 3.59. Within the natural science category, ecology and soil science received the two highest mean scores and number of suggestions. Within the social science category, policy, food systems, and business/economics received the three highest mean scores, with food systems and business/economics receiving the two highest numbers of suggestions. The interdisciplinary category ranked third highest overall with a mean of 4.21, tying ecology and food systems for the highest number of suggestions (6). The farming practices category ranked fourth with a mean of 4.20, tied with pests. The number of farming practices suggestions ranked second, tying with soil science and business/economics.

As noted in Table 3, academics considered *Interdisciplinarity* in content knowledge and experiences to be very important, with suggestions receiving a mean scores range between 4.46 and 3.70. The relation between agriculture, environment, and community suggestion received the highest mean score (4.46) and lowest SD (.79) within the category. The second highest mean score (4.39) was content knowledge of social and economic impacts of agriculture. interdisciplinary experiences included suggestions for an interdisciplinary lab and projects with interdisciplinary minded and holistic thinkers, with means of 4.12 and 3.70, respectively.

Table 4 shows where greatest agreements on the most important content knowledge suggestions were found. The single most agreed on content area (93%) deemed extremely important by academics concerned ecological processes within agricultural systems, followed by environmental impacts of agriculture (86%), interface of food systems and environment (65%), nutrient cycling (64%), relation between agriculture, environment, and community (61%), and social and economic impacts of agriculture (61%).

Experience suggestions

As noted in Table 5, experience suggestions related to Teaching Approaches ranged in mean score between 4.33 and 3.52. The three Teaching Approaches with the highest mean scores were experiences in the classroom and in the field, experiential learning, and the opportunity to apply learned theory into practice.

Academics greatest area of agreement within suggested experiences are found in Table 6. The single most agreed upon suggestion (59%), deemed extremely important, was *experiences in the classroom and in the field*. Closely following in rank were suggestions for internships: on-farm (58%), on-farm experiences: hands-on (54%), opportunities to apply learned theory into practice (52%), visits to sustainable farming operations (50%), and talking with farmers (50%).

Table 3. Interdisciplinary suggestions within content knowledge and experiences.

Interdisciplinarity	Mean	SD
Content knowledge		
Relation between agriculture, environment, and community	4.46	0.79
Social and economic impacts of agriculture	4.39	0.96
Interdisciplinary approaches	4.33	0.83
Multi-dimensionality of sustainability	4.31	0.88
Impacts of technological processes on economic, environmental, and social lines	3.96	1.20
Experiences		
Interdisciplinary lab	4.12	1.05
Projects with interdisciplinary minded and holistic thinkers	3.70	0.95

Very Important = 3.50–4.49.

Table 4. Content knowledge suggestions scored "Extremely Important" by 60% or more of participants.

Content knowledge	Extremely important (%)
Ecological processes within agricultural systems	93
Environmental impacts of agriculture	86
Interface of food system and environment	65
Nutrient cycling	64
Relation between agriculture, environment, and community	61
Social and economic impacts of agriculture	61

Discussion

This study confirms many of the contemporary ideas and arguments made by seminal scholars in SA education about the design of meaningful curriculum and learning environments. Specifically, we call attention to the work of Bawden (1990, 1996) and Francis et al. (2001). These authors have published widely, providing reflections on their experiences designing and implementing novel SA curriculum that runs counter to the status quo in LGCA education. Their work comes from an epistemology of practice (Schon, 1983). In other words, their knowledge is generated through a reflective process on past experiences that result from everyday practice. Schon (1983) has argued that practitioners (medical doctors, architects, teachers, etc.) develop new knowledge by reflecting on their daily professional experiences. In the present study, we take this qualitative work one step further by using a mix of qualitative and quantitative techniques to build consensus among academic professionals in the field of SA.

Bawden (1990, 1996) and Francis et al. (2001) argue, based largely on their reflection on practice, that sustainable agricultural education curriculum and pedagogy must differ from traditional university agricultural education (see Table 1). Similar cries for change in LGCAs have been heard since the 1990s (Boyer Commission, 1998; NRC, 1996; Kellogg Commission, 1999). The results of this study add to the body of literature on sustainable agricultural education and progressive teaching and learning approaches because they support Bawden and Francis et al.'s theoretical work. Table 7 lists distinctions articulated by these scholars about what makes SA education distinct; it also includes confirming data from this study.

The definition of SA is evolving: it remains a matter of significant practical and philosophical debate. This ambiguity is disconcerting for many who, for personal or pragmatic reasons, desire a set of conclusions or "truths." Debate, critical discourse, and issues clarification are however consistent, if not central, to a progressive education that shifts emphasis from transmitting knowledge or "factual" definitions to constructive civic dialogue and a shared construction of meaning. Progressive education places issues of knowing and learning within a dialectical discourse and embraces, as a first order of intellectual "business," the value of definition making as a social learning endeavor aimed at democratizing knowledge itself. As a result, there would be a paradigmatic shift from a narrowly defined expert knowledge and associated truth claims of what SA "is" to a socially constructed definition that evolves as individuals and groups learn to negotiate meanings, power inequalities, and conflicting worldviews (Röling and Wagemakers, 1998; Pretty, 1995).

In essence, findings from this study support the argument that sustainable agricultural education requires progressive, integrated, experiential, interdisciplinary, systems-based curricula where learning grounds theory to practice in relevant and purposeful social and environmental contexts.

Recommendations and implications

Earlier in this paper, we explained that at the beginning of the last century LGCAs were exploring progressive ways to help people learn about the theory and practice of agriculture. The status quo of university and college

Table 5. Experience suggestions related to teaching approaches.

Teaching approaches	Mean	SD
Experiences in the classroom and in the field	4.33	1.00
Experiential learning	4.27	0.87
Opportunity to apply learned theory into practice	4.22	1.01
Multiple mentors who are passionate and clear headed about sustainability	4.12	0.99
Group projects	3.89	1.15
Case studies	3.74	1.13
Critical and self-reflective experiential learning	3.70	1.30
Deliberative-dialectic-discursive mode	3.52	1.29

Very Important = 3.50–4.49.

Table 6. Experience suggestions scored "Extremely Important" by 50% or more of participants.

Experiences	Extremely important (%)
Experiences in the classroom and in the field	59
Internships: On-farm	58
On-farm experiences: Hands-on	54
Opportunity to apply learned theory into practice	52
Visits: Sustainable farming operations	50
Communication: Talking with farmers	50

education was challenged and new teaching strategies (e.g., experiential agricultural education, university farms, etc.) and curricula were introduced. Today, academics in SA education are similarly challenging the status quo. Interestingly, the present status quo looks very similar to the traditional curriculum of which progressive scholars of the earlier epoch were most critical.

This paper has implications for other universities that are considering how to design and implement programs in SA education. The findings indicate that a purposefully sampled subset of academics from across the country think there is a need to teach sustainable agricultural principles in a manner that provides a curriculum that is both steeped in diverse experiences and crosses disciplinary lines. If such a curriculum is implemented on a large scale, then professional development of faculty will be required because most were taught and in all probability still teach in a manner more closely linked to the traditional paradigm and therefore may have difficultly teaching in a more progressive fashion. Certainly more research is needed to determine how best to help faculty teach SA in the manner explicated in this paper.

A first step toward integrating the disciplines would be to help faculty identify and then construct an understanding of ways to maneuver around barriers to interdisciplinarity. Once faculty understand potential roadblocks, novel curricula and administrative support structures may be devised. Universities contending with challenges to disciplinary integration might consider reviewing efforts being made at institutions elsewhere (Karsten and Risius, 2004; Parr and Van Horn, 2006). The curriculum design and advising structure proposed by the University of California at Davis SA curriculum committee were based on a non-departmentally centered administrative model to assure close and continuing cooperation among faculty from several different disciplines.

Many of the changes now sought (the content and experiences described in this paper) are akin to the progressive stance advocated at the turn of the twentieth century. On a larger scale, questions arise that are linked to the past. For example, why were the progressive reforms advocated at the beginning of the twentieth century not firmly established in the bedrock of the LGCA system? What was it or is it about an experientially based, interdisciplinary curriculum focused to community problems and issues that runs counter to the dominant epistemology of LGCA education? What lessons can be learned from the past that might help LGCAs make meaningful and lasting changes to agricultural curricula in the twenty-first century?

Conclusions

Academics agreed SA content should consist of both natural and social science. Further, they underscored the need for an interdisciplinary approach to link often isolated social and natural science content to the theory and practice of SA. Particular attention was drawn to

Table 7. Sustainable agriculture education: Comparison of distinctions proposed by Bawden (1990, 1996), and Francis et al. (2001) and findings from academics' survey.

Bawden & Francis	Survey Direct Quotes
(Hard) Systems inquiry engaging complexity	"Relation between agriculture, environment and community"; "Case studies"
Interdisciplinary methods and learning objectives addressing biophysical, socio-cultural, and political economic problems and solutions	"Interdisciplinary approaches"; "Projects with interdisciplinary minded and holistic thinkers"; "Multi-dimensionality of sustainability"
Facilitation of active and interdependent engagement of students	"Group projects"
Teacher as facilitator in a student–teacher collaborative, participatory, and action-oriented inquiry process	"Opportunity to apply learned theory into practice"; "Critical and self-reflective experiential learning"; "Deliberative-dialectic-discursive mode"
Experiential and practical learning both on and off campus.	"Experiences in the classroom and in the field"; "Internships: On-farm"
Students and faculty co-construct knowledge and learn through engaging practitioners in their place of work	"Multiple mentors who are passionate and clear headed about sustainability"; "On-farm experiences: Hands-on"; "Talking with farmers"

approaches to curricular content that make more transparent the interface between the agri-food system, the environment, and the social and economic spheres.

In terms of experiences, academics thought it extremely important to link classroom theory to "practice" in a variety of real-world social settings. They also suggested progressive teaching approaches that were outside the dominant mode of instruction in contemporary undergraduate courses at LGCAs. Particular attention was drawn to application of knowledge in field settings, such as on-farm experiences including internships, student farms, short-term visits, and conversations with farmers.

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Notes

1. Social efficiency educators proposed to manage schools with the same social control mechanisms found in factories. They believed students needed to be controlled for their own good and for the good of society, with the goal of educating students into predetermined roles in society.
2. Developmentalists focused on examining the contents of students' minds and having this determine what curriculum was appropriate. They believed that all the answers existed within the child.
3. Humanists believed that curriculum should exercise the mind as a muscle and as such they proposed classical disciplines and didactic teaching.
4. Often characterized by narrow disciplinary boundaries and didactic teaching methods.
5. Attention limited to changes in agronomic practices such as organic farming techniques fails to recognize contributions made by the educational alternatives students and faculty have used in pursuit of understanding the totality of SA (e.g., consumer choices, growing food themselves, political debate, or participatory on-farm research).
6. Primarily experiential based learning, often referred to practical and hands-on combined with reflection on personal experience. Practicality refers to working within real-world contexts such as farms and food systems where the complexity of social, economic, and environmental consequences are realized. Increased interest in these alternatives is occurring simultaneously with shifts towards increased urban and suburban student demographics.
7. Synthesized from the work of (Bawden, 1990, 1996; Francis et al., 2001)

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