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Education for sustainable agriculture: a typology of the role of teaching farms in achieving learning goals and objectives

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Teaching farms have recently gained popularity, but they are often expensive venues per student credit hour. It is therefore important they are used effectively. This research explored why faculty members use teaching farms, their goals and objectives with regard to the farm, and how they integrate teaching farms into curriculum. Twenty interviews were completed with faculty representing 15 institutions. A combined inductive and deductive approach was used to analyze data. The result was a typology of the roles of teaching farms in achieving educational goals and objectives. Four types of roles emerged: enhancement, competency, exploration, and foundation. Three of the four types reflect one of three models of higher education prevalent in the US. Our research suggests a better understanding of educational theory and pedagogy, combined with a firm appreciation of the different models of higher education could significantly enhance the quality of the learning experience provided on teaching farms.

Keywords: teaching farm; pedagogy; sustainable agriculture; higher education

Introduction

Terms like hands-on, applied, state of the industry, and real world characterize much of the contemporary discussion about how to improve post-secondary education in the United States. These terms are often juxtaposed to classroom learning, described as theoretical or impractical. Two aspects of this discussion of how to improve post-secondary education are problematic. First, the emphasis on practical knowledge seems to relegate higher education to honing a set of skills rather than developing higher cognitive abilities or a deeper knowledge base. Second, terms like hands-on imply that instruction should use experiential learning, but the way the terms are used fails to reflect the pedagogical foundations of experiential learning in educational theory and research.

In the agricultural and life sciences, the emphasis on practical education using 'learning by doing' or 'experiential learning' has fueled a growing interest in teaching farms. Although the use of teaching farms may seem like a novel approach, they have existed for more than a 100 years, inspired in part by the early demonstration farms used to expose farmers to innovative farming techniques (Bailey 1905; Leis et al. 2011; Mazurkewicz, Harder, and Roberts 2012; Sayre and Clark 2011). There

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are 54 four-year degree programs in sustainable agriculture in the US (Sustainable Agriculture Education Association 2014). Approximately 170 post-secondary institutions offer some sort of program (minor, certificate, etc.) that focuses on sustainable agriculture (Thompson 2012). Tal (2008) argues that a sustainable agriculture curriculum requires students call upon what they learn in many courses – biology, ecology, economics, geology, and sociology. History and ethics are also critical for students to understand where practice has gone wrong in the past, how to improve practice in the future, and how to address issues where values inform practice (Biedenweg, Monroe, and Oxarart 2013; Chrispeels and Mandoli 2003; Dwyer 2009). Faculty support for an interdisciplinary approach to sustainable agriculture education is well documented (Anderson 2013; Clark et al. 2013; Jacobsen et al. 2012; Parr et al. 2007; Tal 2008). Students *must* synthesize knowledge across disciplines and draw upon core knowledge gained prior to entering professional study for them to be able to create the kind of location specific, comprehensive solutions that sustainable agriculture envisions. It is therefore crucial that teachers of sustainable agriculture help students develop the higher-order cognitive skills like analysis, evaluation, and creating. Many sustainable agriculture programs focus on using a teaching farm as a key component of the curriculum and as an opportunity for incorporating experiential learning or other learning theories into the program. The purpose of our research was to explore how faculty members use teaching farms to enhance the educational experience for students. We were particularly interested in the role of teaching farms in achieving learning goals in courses related to sustainable agriculture (Sustainable Agriculture Research & Education Program 2012).

Literature review

Professors commonly say that they use teaching farms to provide experiential learning for students through opportunities to 'learn by doing' (Andreasen 2004; Parr and Trexler 2011). It is true that experiential learning theory suggests that students learn best when they are active and engaged in topics relevant to their personal interests and goals. However, experiential learning involves much more than simple 'hands-on' application of techniques or skills (Ballantyne and Packer 2009; Libarkin, Beilfuss, and Kurdziel 2003; Mans, Shiimshon, and Suransky 2010). A brief overview of the development of learning theory explains our motivations and rationale for this research.

John Dewey, one of the first professional educators to insist that experience was the basis for learning, recommended that teaching should embed new knowledge in the prior experience and knowledge of the learner (Dewey 1938). Benjamin Bloom led a group of educational psychologists who developed a classification of levels of intellectual behavior important in learning. Bloom identified three domains of learning: cognitive (mental skills), affective (growth in feelings, attitude or emotion), and psychomotor (manual or physical skills) and six cognitive levels (Bloom 1956). Anderson et al.'s (2001) revision of the taxonomy retains six levels: knowing, understanding, applying, analyzing, evaluating, and creating. Achieving higher cognitive levels is important to problem solving, assessing alternatives, developing innovative and original solutions, and creating new knowledge and technologies.

Integrating the work of Dewey and Bloom, Kolb (1984) developed experiential learning theory. Kolb's model includes four distinct processes, Concrete Experience (CE), Reflective Observation (RO), Abstract Conceptualization (AC), and Active

Experimentation (AE). Optimal learning occurs only when learners can complete all four processes. Learning occurs in two phases. First, learners must grasp new knowledge. The CE and AC processes are active in this phase. Only after a learner has grasped new knowledge can s/he complete the learning experience by using the new knowledge to construct mental models. The second phase occurs when a learner transforms simply 'knowing something,' into meaning, understanding, and an ability to use the knowledge beyond rote application or specific techniques or skills. RO and AE are critical processes in this final phase of learning. Learners usually *prefer* one or two processes over the others, generating preferred learning styles (Hawtrey 2010), but extensive evidence indicates that all four processes must occur for the learner to move beyond lower level cognitive abilities like understanding a concept to higher level abilities like evaluation or creativity (Kolb and Kolb 2005). A pedagogical approach based largely on 'learning by doing' or hands-on experience can lead to an overemphasis on CE and a failure to provide students with the complete set of learning experiences required to construct meaningful mental models of what they learn in the lab or field setting and encourage higher cognitive thinking.

Little work has been done evaluating the degree to which theoretically based teaching practices are utilized on teaching farms and the contribution of the farm in achieving student learning outcomes. Parr and Trexler (2011) argue that a teaching farm is an opportunity for students to participate in reflection and experimentation, but they do not make it clear if the farm actually serves a purpose beyond students being able to practice concepts learned in the classroom. Hamilton-Ekeke (2007) encourages the use of field activities to enhance the learning experience for students but conclude that these activities often do little more than stimulate interest in course content, provide an opportunity for students to visualize concepts discussed in the classroom, or offer a unique venue for bonding among students and between the students and instructors rather than encouraging higher cognitive thinking. Some research explores student learning outcomes achieved through field-based education and outdoor learning activities for elementary or secondary education programs, but rarely are pedagogical practices addressed or evaluated for effectiveness (Hamilton-Ekeke 2007; Klemmer, Waliczek, and Zajicek 2005; Miller 2007; Mittelstaedt, Sanker, and VanderVeer 1999).

One could argue teaching farms serve a laboratory role in agriculture and research shows that many labs fail to make effective use of experiential learning. Abdulwahed and Nagy (2009, 284) examined the degree to which experiential learning theory is used in laboratory classes and concluded that 'There is a general consensus that laboratory work generates poor learning outcomes compared to the time, effort and costs invested in laboratory education …' They attribute much of this failure to inadequate attention to all four of the learning processes that are keys to cognitive development, a thorough comprehension of subject matter, and the ability to use knowledge creatively. In general, low cognitive levels, such as knowledge, understanding, and application, tend to be reflected in the language used to discuss the goals and outcomes associated with using a laboratory or teaching farm. Despite the lack of research on teaching farms in higher education, the body of literature that does exist generally does not focus on the use of pedagogy or curriculum development (Lawson and Brew 2004; Mittelstaedt, Sanker, and VanderVeer 1999).

To reach higher cognitive skill levels, professors must also influence the holistic educational development of the student. Angelo and Cross (1993) describe six teaching goal areas that are critical to the student's development as a learner and

professional. These include the higher-order thinking skills Bloom and Kolb discuss, but also basic academic success skills, discipline-specific knowledge and skills, liberal arts and academic values, work and career preparation, and personal development. The six goal areas for instruction are highly interrelated and failure to teach to multiple goals reduces instructional success overall and in specific areas. For example, teachers often focus heavily on discipline-specific knowledge and skills, but a student with poorly developed academic success skills usually cannot gain a full comprehension of content subject matter. Groves et al. (2012) found that the experiential learning model was effective in teaching academic success skills to students. Overall, enhanced attention to all goal areas can increase learning in discipline-specific topics. Teaching to the 'whole student' addresses the National Research Council's (2009) recommendation that institutions should broaden the undergraduate student experience to include training in transferable capabilities such as communication, teamwork, and management.

Educational research also demonstrates the importance of setting clear learning and outcome objectives for any curriculum and for each component or module in any curriculum (Alonso et al. 2008; Hauer and Quill 2011; Meyers and Nulty 2009). Learning objectives, in turn, should drive the content and activities covered in the classroom or in a field setting. In most cases, activities on the teaching farm do not comprise the entire curriculum for a program of study, or even an entire course. Field-based learning experiences should therefore support the overall learning goals of a broader curriculum. It is critical to design activities that incorporate all processes in the learning cycle, or complement processes that will occur in other venues like the classroom, and that support defined learning and outcome objectives in order to generate higher level learning outcomes (Quinton and Smallbone 2010).

Teaching farms are potentially very valuable, perhaps even critical, components in an educational program designed to achieve higher cognitive thinking and integrate multiple academic disciplines. For this to occur, the professor will need to integrate farm activities into the curriculum as a whole and take advantage of the opportunities to include learning processes like RO and AE. The research evidence regarding the need to go beyond a single focus on learning by doing is extensive in diverse professional educational programs like engineering and medicine (Bullock et al. 2009; Cobos-Moyano, Martin-Blas, and Onate-Gomen 2009; Dewoolkar et al. 2009; Furian 2009; Lawson, Abraham, and Renner 1989; Meah, Smith, and Thomas 2009; Regev, Gause, and Wegmann 2009; Sherman and MacDonald 2009; Ti et al. 2009). Roberts (2006) discusses the application of the theory of experiential leaning to agricultural education.

Although they are potentially valuable, teaching farms can be relatively costly to operate per student credit hour generated, which is problematic in a period of constrained budgets. The average annual operating budget for teaching farms can vary greatly. Leis et al. (2011) report that the annual cost of running a teaching farm can range from $5000 to more than $125,000. It seemed prudent therefore to make sure that the farms are used effectively. The purpose of our research was to (1) understand why faculty members use teaching farms, (2) their goals and objectives with regard to the farm as a teaching venue, and (3) how they can more fully integrate teaching farms into overall curriculum.

Methodology

Sample selection

Mazurkewicz, Harder, and Roberts (2012) used a snowball sampling technique to identify all four-year institutions where teaching farms were used to teach sustainable agriculture using online search engines, USDA databases, and an inventory compiled by the Sustainable Agriculture Education Association. They contacted 243 institutions and 80 responded. Next, every professor who could be identified that used the teaching farms was asked to submit a copy of his/her syllabi for any course in which the teaching farm was used. Seventy-eight syllabi were gathered (Mazurkewicz, Harder, and Roberts 2012). Mazurkewicz, Harder, and Roberts (2012) evaluated each syllabus on a four-point scale for the degree to which the professor used the teaching farm to integrate experiential learning into the course.

However, course syllabi are rarely complete descriptions of a professor's goals and objectives or of the totality of learning experiences provided to the student. We therefore decided to interview professors to explore more thoroughly how and why they use a teaching farm as part of their curriculum. It was unrealistic to interview all of the professors who had submitted syllabi. We therefore selected a maximum variation sample of courses for the present study (Coyne 1997). Maximum variation samples are useful when the researcher's objective is to understand the variety of ideas about complex subjects in a group of potential participants (Curtis et al. 2000). The ultimate goal is not statistical generalization, but rather to be able to characterize the range of different perspectives that are present rather than the typical or 'average' perspective. The sample included the professors of the ten syllabi scoring the *lowest* and the *highest* on the scale used by Mazurkewicz, Harder, and Roberts (2012) in their study. Twenty professors of the 22 contacted agreed to participate. Those who declined were replaced by the next highest or lowest scoring syllabus. The twenty professors selected represented 15 institutions from around the country. The institutions varied in terms of public and private, small and large, and land grant and liberal arts schools. The final sample included two private institutions, six small institutions (<20,000 students), and seven land grant universities.

Interview development

We developed a semi-structured interview to explore how and why faculty members use teaching farms in their courses and the degree to which the farm is used to incorporate experiential learning theory into the course or accomplish other teaching goals. The topics covered in the interview reflect key components in the body of theory upon which this research rests (see Table 1). This body of knowledge and theory has developed over several decades as researchers built on preceding work and as a result provides a coherent and overlapping set of key ideas or concepts to guide instructional practice. For example, a portion of the interview addresses experiential learning, which directly addresses professors' understanding of Kolb's concept of learning preferences. Another portion of the interview determines the cognitive levels professors are seeking to achieve on the teaching farm, which is directly related to one of the teaching goal areas identified by Angelo and Cross. One reason for using the semi-structured interview is that it allows the participant to tell his or her story; to provide information about a general topic or set of topics in a way that 'makes sense' to him or her (DiCicco-Bloom and Crabtree 2006; Miller

Table 1. Topics covered in semi-structured interviews with faculty members who use teaching farms for courses related to sustainable agriculture.

Topic	Areas covered
How Farm Is Used	Extent to which the instructor uses the physical facility of the farm in his/her course; frequency of use; kinds of activities that are conducted on the farm
Goals and Objectives	Identify the faculty member's learning goals and objectives; understand the degree to which the faculty member relies on the farm to reach those goals and objectives; provide examples of farm-based activities that are specifically tied to reaching learning goals and objectives
Experiential Learning	Understand what the instructor means by experiential learning; identify how the instructor uses the farm in experiential learning with probes about different components in the learning cycle
Learning Preferences	Identify how the instructor defines the terms 'learning styles' or 'learning preferences;' explore whether the instructor specifically uses the farm to address diversity in learning preferences; identify examples of specific activities used
Cognitive Levels	Identify the cognitive levels the instructor wants to achieve; understand whether s/he uses the teaching farm to help reach those levels; identify specific kinds of activities associated with reaching desired cognitive levels
Barriers	Identify the most important barriers that instructors face to using the teaching farm as they would like to use it in their teaching program

and Glassner 2004). While the interviewer has a rather specific set of topics in mind, six in our case, these topics are apt to fold together into a larger framework for the participant (Ogden and Cornwell 2010). Ultimately, the researcher's task is to capture these larger frameworks.

We used cognitive testing to ensure that the questions were clear, made sense to respondents, and would provide the information we needed (Beaty and Willis 2007). The major revisions to the instrument after cognitive testing were to change the order of the topics covered and to include a question about the kinds of activities conducted on the farm, frequency of use of the farm, and other descriptors of the resources used on the farm. Some revisions were also made to question order to reflect the logical order in which respondents thought about each topic. We also found that some faculty members use the teaching farm in more than one course. When this was the case, we asked the participant to select a specific course and respond to our questions with regard to that course only.

Data collection and analysis

Each professor was contacted via email to request his/her participation in the study. We provided an informed consent document and a description of the topics that would be included in the interview by email upon scheduling. Verbal informed consent was obtained prior to conducting the telephone interview. Interviews lasted approximately 45 min. One individual conducted all interviews. She recorded each interview and took extensive notes throughout the interview. The interviewer created a one to two-page case summary of the key points that the participant made and sent it to the participant as soon after the interview as possible (Bernard and Ryan 2010; Northcutt and McCoy 2004; Patton 2002). Participants had the opportunity to

correct any misunderstandings on the part of the interviewer, delete information, or provide additional information. Participant verification is a recommended procedure to enhance the reliability and validity of data collected through techniques like interviews (Hardy and Bryman 2004; Patton 2002).

We used a combined inductive and deductive approach to data analysis (Felding 2009; Maxwell 2012), incorporating the recommended practices of multiple, independent analysts (Saini and Shlonsky 2012) to enhance reliability and an iterative and interactive process. The analysis process consisted of three basic steps. The first was to identify specific ideas or themes that emerged from the data. The team began by identifying specific ideas or themes that emerged in response to each of the six topical areas covered in the interviews, using the case summaries as amended and approved by the interviewee. We chose to use the case summaries rather than interview transcripts for analysis as this method has been reported as being superior to verbatim transcripts for thematic analysis procedures that seek to capture broad concepts (DiCicco-Bloom and Crabtree 2006; Easton, Fry McComish, and Greenberg 2000; Halcomb and Davidson 2006; McLellan, MacQueen, and Neidig 2003). In this step, each of the three analysts independently identified and wrote down the key themes that emerged. A combined inductive and deductive approach uses concepts from grounded theory and avoids the assumption that all relevant topics and concepts are known prior to data collection allowing for both theoretical and emergent themes to surface during data analysis. The analysts used a deductive approach to identify themes based on the theoretical concepts for the research, the topics listed in Table 1, and an inductive approach to identify unanticipated or emergent themes (Bernard and Ryan 2010). Emergent themes show unanticipated relationships between theory based concepts and other ideas that are not yet part of the theory. Theoretically based themes are concepts or ideas relevant to the body of literature from which this research draws upon. After completing a case, the three researchers reviewed their findings as a group to identify commonalities and differences in what they had identified.

In the second step of the analysis, we grouped the themes identified in step one into larger conceptual frames that reflect over-arching relationships among the themes that emerged from the interviews (Bernard and Ryan 2010; Felding 2009). Identifying these larger frames permits one to gain an understanding of how respondents' views about several potentially related topics 'fit together' into a holistic framework. Even if subconsciously, human beings create these larger mental models or scaffolds in many aspects of their lives (Austin and Fischhoff 2012; Capelo and Dias 2009; Stibel 2005). This component in the analysis process allowed us to identify these larger mental constructs that the responses to our questions elicited, and to understand the commonalities among respondent's views of the role of the teaching farm in their programs.

The third step was to create a model, a typology in this case, that reflects the key characteristics, particularly the differences, in how professors use teaching farms to enhance learning about sustainable agriculture (Northcutt and McCoy 2004). The ultimate aim of this research went beyond understanding the role of the farm for individual professors in individual courses. Rather, we wanted to understand the way teaching farms are being used by professors in terms of their overall mission as educators. What are professors trying to accomplish when they incorporate a teaching farm into their classes? How do they think the farm will help them achieve their overall educational aims for their students? What do they think the farm adds to the

student's educational experience that will make the overall educational experience more meaningful and lasting for the student? The final stage in our analysis was to create a model or models of how faculty members at four-year universities perceive the role of teaching farms in achieving their goals and objectives as professors.

A typology is a system of classification based on identifying the key characteristics of different members of an overall set of objects, organisms or, in our case, the role of a teaching farm in achieving broad educational objectives. Any typology is based on identifying 'ideal types.' An ideal type is a model of a specimen that has all of the critical or key characteristics used to define a category in the typology. Actual specimens in any typology usually vary from this abstract model. Ideal does not mean best; rather ideal simply refers to the abstract (or idea) model of something. The nuclear family is one type of family and the 'ideal type' for a nuclear family consists of two married adults of opposite sexes and their offspring. We often find families where grandparents also live in the home. However, this doesn't change how we describe this family – we still consider it a nuclear family rather than an extended family (another type), for example. In short, ideal types are abstract representations that include all of the most common versions of the key defining characteristics of that particular type. In our case, the characteristics of each type of farm are based on differences in the conceptual frames identified in step two.

Results

Both emergent and theoretical themes emerged in the initial step of examining the responses of each participant to the six topics covered in the interview listed in Table 1. We provide one example in Table 2 which shows the five themes associated

Table 2. Themes associated with the topic 'How Farm Is Used' and examples of the kinds of specific responses from participants.

Theme	Type of theme	Examples of responses
Role of farm in course	Theoretical	Students experience hands-on application of ideas presented in the course Students get to experience a real farm environment
Components of the farm used	Emergent	The farm provides experience with organic production systems Students can gain experience with cropping systems, livestock production, or both
Methods of assessing learning in farm activities	Theoretical	Respondents mentioned self, peer, and faculty evaluation of student performance and learning Techniques like diaries and presentations used to assess learning
Teaching methods using the farm	Theoretical	Students get opportunities for problem solving in assignments Use a combination of individual and group work Diaries allow students to reflect on what they have learned
Time and effort required of students	Emergent	Visits to the farm for demonstration purposes Students spend additional hours on the farm outside of class meeting time

with the interview topic 'How Farm Is Used': (1) the professor's perceptions of the role of the farm in his/her course or curriculum; (2) the components of the farm that the professor uses in his/her teaching; (3) to what degree and how the professor uses the farm to assess learning; (4) the kinds of teaching methods or techniques used on the farm; and (5) how much time and effort the professor requires of students for farm-based learning activities.

We provide a few examples of the specific ideas or concepts that participants mentioned for each theme about how the farm is used in Table 2. The theme 'role of farm in course' was a theoretically based theme because of the potential importance that a professor's perception of the role of the farm would reflect his/her understanding and application of experiential learning or other learning theories. Some participants saw the farm mostly as a way to give students a realistic farm experience – similar perhaps to a field trip or practicum on a farm. Others saw the farm as a way of letting students apply concepts that they learned in other settings (like the classroom, for instance) to solve problems. The theme regarding the time and effort required of students was an emergent theme as it does not directly relate to the theoretical foundations of this study. As the examples of specific comments in Table 2 show, the time and effort required of students varies greatly. Some professors take students to the farm essentially on 'visits' to see some aspect of farming while others require that students complete entire semester projects that constitute a significant component of the course grade on the farm. This example demonstrates the breadth of specific concepts or ideas that participants gave regarding the same theme. In other cases, participants' responses were much more similar. For example, the theme 'components of the farm' emerged because many participants mentioned specific enterprises or facilities on the farm that were important to them, such as organic production plots, a livestock unit, or a sales point for farm products.

In some cases, an idea or concept was associated with more than one topic, sometimes by the same respondent. For example, some professors mentioned reflection of some sort as both a teaching method used on the farm and as a component of how they assessed student learning. This does not, in our view, represent confusion but rather reflects the individual's association of related theoretical concepts in their practice as a professor. Reflection is a critical component of experiential learning – and assessing the quality of a student's reflections is certainly a valid way to assess the student's learning, particularly the development of higher cognitive skills if used well.

Table 3 indicates the themes, both theoretical and emergent, associated with each of the six topics covered in the interviews. The more detailed discussion of the range and type of responses provided by individual participants for the first topic listed in Table 2 are representative of the range and mix of types of themes and comments for the other topical areas. We do not provide a detailed list of specific examples of each theme in Table 3. A few examples will illustrate the range of ideas. For example, when asked about how they used the farm to achieve course goals and objectives, professors' responses ranged from 'analyze how systems interact' to 'understand how to behave around livestock.' Similarly, professors used the teaching farm to reach both lower and higher cognitive skill levels (Topic 5). In some cases professors felt achieving higher cognitive levels such as evaluating and creating required intimate use of the teaching farm. In these courses students might be required to develop a farm plan or solve a problem. In other courses professors

Table 3. Themes associated with each of the six topical areas covered in the interviews with instructors using teaching farms in instruction related to sustainable agriculture.

Topic	Themes	Type of theme
How Farm Is Used	Role of farm in course	Theoretical
	Methods of assessing learning in farm activities	
	Teaching methods using the farm	
	Time and effort required of students	Emergent
	Components of the farm used	
Goals and Objectives	Cognitive level of student learning outcomes	Theoretical
	Role of the farm in meeting course goals and objectives	
	Who sets the goals and objectives	
	Desired skill set reflected in course goals and objectives	
		Emergent
Experiential Learning	Instructor understanding of experiential learning Motivation for using experiential learning in the course	Theoretical
	Application of the four learning processes	
		Emergent
Learning Preferences	Faculty perception of learning styles	Theoretical
	Role of farm in meeting the needs of different learners	
		Emergent
Cognitive Levels	Factors affecting cognitive level achievable	Theoretical
	Farm relationship with classroom curriculum	
	Amount of effort required by instructor	Emergent
Barriers		Theoretical
	Financial cost of operating a teaching farm	Emergent
	Availability of personnel resources	
	Course time available to be on the farm	
	Availability of farm equipment	
	Administrative support	
	Environmental conditions	

viewed the farm as an opportunity for students to reach the cognitive level of application where students would practice what they learned in the classroom.

Our objective in the second phase of analysis was to identify overarching or conceptual frames (sometimes called mega-themes in the literature). The majority of the themes identified in Table 3 are connected to one of three conceptual frames, although there are a few themes that appear to be relatively unconnected to larger mental models of the teaching farm and its role in construction. An example of one theme will illustrate how these interconnections were identified and interpreted. One theme that emerged under the topic 'How Farm Is Used' is the role of the teaching farm in the course (Table 3). Some instructors indicated they use the farm to turn abstract ideas and concepts taught into the classroom into real experiences, to get beyond academic understanding. The theme 'Motivation for using experiential learning in the course' emerged under the topic 'Experiential Learning.' For example, instructors said that they use the farm to actively engage students in the learning experience, to get them involved in learning. Although these themes emerged under different topics during the interviews, both relate to a broader conceptual frame of the role of the teaching farm in overall pedagogy and course organization and structure.

We identified three overarching conceptual frames: (1) the role of the teaching farm in overall pedagogy and course organization and structure, (2) the desired

Table 4. Themes identified in step one of data analysis associated with each conceptual frame identified in step two.

	Conceptual frames		
	Role of farm	Student outcomes	Institutional support & faculty commitment
Theoretical and emergent themes	(1) Role of farm in course (2) Teaching methods using the farm (3) Role of the farm in meeting course goals and objectives (4) Instructor understanding of experiential learning (5) Motivation for using experiential learning in the course (6) Application of the four learning processes (7) Role of farm in meeting the needs of different learners (8) Farm relationship with classroom curriculum	(1) Methods of assessing learning in farm activities (2) Cognitive level of student learning outcomes (3) Who sets the goals and objectives (4) Desired skill set reflected in course goals and objectives (5) Faculty perception of learning styles (6) Factors affecting cognitive level achievable	(1) Time and effort required of students (2) Components of the farm used (3) Amount of effort required by instructor (4) Financial cost of operating a teaching farm (5) Availability of personnel resources (6) Course time available to be on the farm (7) Availability of farm equipment (8) Administrative support

student learning outcomes associated with using the farm, and (3) the institutional support and faculty commitment required to use the farm in the desired fashion (Table 4). The first two of these frames are theoretical. For example, we would anticipate that the professors views of the role of the teaching farm in overall pedagogy and course organization and structure reflects the professor's pedagogical orientation, understanding, and application of theoretical models for instruction. The third frame, however, is an emergent concept that we did not anticipate, although we perhaps should have given the cost per student credit hour on most teaching farms.

While we originally anticipated that a single model might emerge from our analysis, the analysis revealed four distinctly different roles for the teaching farm as a component in an overall instructional strategy and approach. Table 5 presents a typology of the role of teaching farms in contemporary agricultural education at four-year institutions of higher education. This is not a typology based on the physical attributes of teaching farms (the kinds of infrastructure, crops, etc.), but rather a typology of four distinct approaches of faculty members who use teaching farms to achieve overall educational goals and objectives. In fact, any specific physical farm – the infrastructure – could play different roles for faculty members who have different overall teaching goals and objectives. The three conceptual frames that emerged in the second step in our analysis provided the structure for identifying the key characteristics of each of the four ideal types. Each type is distinct, however this is not to say that each instructor uses the farm in only one role. These types represent the various ways farms can be used – the same instructor could use the farm in multiple ways throughout a single course or their use of the farm may vary between courses. Table 5 provides a summary of the key characteristics of each of the four ideal types in the typology.

Enhancement role

In this role, the teaching farm provides complementary activities to a primarily classroom-based course. Faculty members typically want to reach application level types of learning objectives on the farm, but the role adapts well to a wide range of learning outcomes. Examples of specific learning outcomes include introducing students to agriculture, giving them an appreciation of what is involved in farming, or allowing students to apply a concept or idea learned in the classroom. Activities emphasize building on or extending the concepts and ideas from the classroom. Examples are demonstrations, short projects or tasks, and observations. The time spent on the farm is largely limited to class time and instructors may describe the use of the farm as 'farm visits.' Assessment techniques are not elaborate and may be based primarily or even exclusively on compliance with required activities. Teachers often see the role of the farm as a way to more fully engage students in the course: get them outside or eliminate distractions that often occur in the classroom. The teaching farm is also used to 'equalize' students, to allow 'non-academics' or 'students with learning disabilities' to succeed. Levels of institutional and faculty support are not critical for this role because the faculty make use of what facilities are available opportunistically. They rely on what is available or make do with what they have. Accessibility can be a major constraint for this role since time on the farm is typically during the school day. An off-campus farm seriously limits its utility in this role. Many faculty members say their course would be different without the teaching farm, but they do

Table 5. A typology of the role of teaching farms in achieving educational goals and objectives of instructors teaching about agriculture in 4-year institutions of higher education in the United States.

	Conceptual frames		
Ideal type	Student outcomes	Institutional support	Role of farm
Enhancement	Expected outcomes are mainly application level outcomes. The farm is an opportunity for students to apply what they learn in the classroom	Institutional support required is minimal. Instructor makes use of existing farm facilities, tools and resources. Success of the course does not depend on specific features of the farm	The teaching farm is an added feature that allows instructors to expand on their classroom-based curriculum. The teaching farm is not essential to reaching course goals and objectives
Competency	Instructors want students to be able to manage a farm in its entirety. Core competencies developed are primarily technical knowledge to operate a farm	Human and financial resources required to operate this type of teaching farm are demanding. The teaching farm functions as a working farm	The teaching farm is an essential component in these courses. Students spend a significant amount of time on the farm and learn every aspect of the farm operation. The course depends on the existence of the teaching farm
Exploration	Learning to operate a farm is secondary. However, the teaching farm allows students to learn specific techniques or skills related to farming. The primary objective is to allow students to explore social, economic, and environmental aspects of agriculture	The cost per student for the learning experience is high. Institutional resources are critical to provide students a complete learning experience	The teaching farm serves an important role in these courses. The teaching farm engages the students' senses and facilitates an intellectually stimulating experience
Foundation	Desired student outcomes also include personal and professional development. Emphasis is put on creativity and problem-solving	Faculty and institutional support are not critical. Instructor time with students and the depth of interaction are more important than the facilities available	The teaching farm provides an opportunity for a more holistic educational approach that allows students to explore their own life goals and address larger social concerns

not use the farm as the core of the learning experience. Achieving course objectives does not depend on the farm.

Competency role

The teaching farm in the competency role serves fundamentally as a replica of an operating farm. Learning outcomes focus on technical competencies needed for employment in production agriculture. Professors use the teaching farm as a critical

component in the curriculum, often requiring lengthy and intensive effort on the part of students. Full two-semester course sequences, requirements for students to complete activities and projects on their own time, and designation of the course(s) as the students' capstone experience are common. Emphasis on the application cognitive level is pronounced. Professors typically stress 'hands-on experience,' learning about all aspects of farming including farm management, and giving students a chance to apply what they learn about in the classroom. Professors also stress professional skills like communication, responsibility, and time management as desired course outcomes. Class projects that incorporate farm, crop, or business plans may be part of the course, and a wide variety of farming practices are incorporated, in some cases involving both livestock and crop production systems. Analytic abilities are a secondary emphasis, with a strong focus on identifying problems and the potential solutions to them. A typical example would be that a group of students must diagnose a problem, find information about how to solve the problem, and then decide which of several potential solutions they would apply. Professors often emphasize keeping a journal of observations and presentations as components of the learning activities. Assessment also stresses the 'practical' or 'applied' emphasis in this role. For example, some professors use peer evaluation by group members and evaluation by faculty and non-faculty members of group projects in addition to the traditional individual professor evaluation of student performance, stressing assessment to determine how 'realistic' or 'practical' the plans are. Faculty and institutional commitment is critical for the competency role. To function as 'replicas' of operating farms, the teaching farm needs to reflect the kinds of enterprises, equipment, and conditions that students can expect to encounter after graduation. Marketing components like an on-campus CSA or farmers' market, for example, may be important for students to learn about marketing. The need for fiscal, human and physical infrastructure is high and one problem for these farms is the high cost per student for the educational experience.

Exploration role

In this role, the teaching farm is a critical component in allowing students to explore complex concepts dealing with the social, economic and environmental aspects of agriculture. Desired student learning outcomes focus on higher cognitive skills like analysis, evaluation, and, in some cases, creating. Faculty members want students to be able to identify problems and pose potential solutions for them as in the case of the competency role, but the importance of discovery learning is much greater. Faculty will stress the importance of learning from the consequences of decisions or learning from mistakes, often encouraging students to test alternative solutions and evaluate the outcomes from each. Assessment also tends to be comprehensive. Peer, group, and self-evaluation are commonly important components of assessment. Assessment also often involves reaction papers in which students use what they learn on the farm to reflect upon and discuss complex topics or issues. Group activities are the core of the learning experience on the farm. Unlike the competency role, group projects tend to be developed and planned by the students, not by the professor. Group projects often include an experimental or inquiry component and the end product includes reflection upon the learning experience. Learning about group processes is itself a learning objective in many cases, going beyond shared responsibility to goals that deal with management of the group or team experience. Activities

are often designed to *integrate* what students learn in the classroom, including concepts, processes and skills. Farms used in this role are much more apt to explore the social components of agriculture. Service learning experiences are not uncommon components in this type. Faculty members frequently mentioned using all of the students' senses (auditory, kinesthetic, visual) in the learning activities. Overall, their objective is to provide an intellectually stimulating learning experience in which the student gains mastery of both skills and competencies and higher level critical thinking skills. Faculty and institutional support for these farms are critical because the cost per student for the learning experience is high. In addition, outside support may also be critical because student projects may involve service learning components. The need to involve faculty members from multiple disciplines and to have the facilities that provide for the range of projects and activities needed to achieve course goals drives costs in this role.

Foundation role

In the foundation role, the teaching farm serves as the organizing or focal point for a holistic educational approach that focuses on giving the student a foundation for his/her life career and personal development. The role of the farm is not particularly necessary to teach students about agriculture or farming, or how to run a farm. Rather, the farm becomes the professor's venue for personal and professional development for students. The learning outcomes deal as much with the student's ability to make life and career choices and develop his/her intellectual abilities as to learn specific techniques or skills relevant to production agriculture. The activities are varied, but tend to focus on learning experiences that will encourage students to explore a wide array of ideas and concepts and how s/he can apply those in his/her own life. Group activities are common, but the outcomes in the foundation role include students bonding with their peers, developing a sense of their own life goals, and exploring how to use what they learn to address larger social concerns. Faculty members use the teaching farm to break down barriers between themselves and their students and between students. Assessment focuses strongly on what the individual gains from the process, both in terms of knowledge and experience. Reflection papers, group discussions, and peer reflection are strong components in assessment. The faculty member serves as a guide and mentor in the learning process. Faculty and institutional support are important, but not critical for this role. Facilities are not as critical as time with the student and the students' ability to interact with each other, with faculty members, and with individuals and organizations outside the university.

Discussion

The four types of roles in which teaching farms are used in post-secondary education provide insight into the diverse learning experiences professors try to create by utilizing a farm. Farms can be critical components of a course or can serve to supplement concepts and ideas presented in a traditional classroom setting. Many of the faculty members interviewed demonstrate their belief that teaching farms can enhance student learning and assist professors in facilitating learning experiences that encourage higher cognitive abilities. However, the degree to which professors take advantage of the farm as a teaching tool that promotes creativity and problem

solving largely depends on professors' understanding of pedagogical methods. All of the faculty members interviewed said that they do try to incorporate experiential learning into their courses by using the teaching farm, but their understanding of the theory of experiential learning varied. Most faculty reduced experiential learning theory to lower cognitive goals, giving students the opportunity to 'apply what they hear in the class room' or gain 'hands-on experience.' This view of experiential learning theory is incomplete and over-emphasizes the CE component in the learning process. It also misidentifies this component, essentially equating CE to simple repetition of a skill or idea. CE in Kolb's view involves higher cognitive skills, such as problem solving. This view of experiential learning is quite pronounced among faculty using the teaching farm in a competency role. Professors using the farm in the exploration or foundation roles were more likely to incorporate all four of the learning processes into their courses whether or not they were able to clearly articulate the theory of experiential learning.

Faculty also use the farm to accomplish other teaching goals. For example, the teaching farm was often seen as a way to meet the needs of diverse learners. Many faculty felt the teaching farm created learning opportunities that were appealing for students who may not enjoy traditional classroom learning, preferred 'learning by doing,' or were more kinesthetic learners. This approach reflects an outdated pedagogy and limits their ability to use contemporary learning theory to design learning objectives and course activities. Experiential learning and most other theoretically based learning models suggest learners need to participate in multiple learning processes and that although students may have a preferred learning style, completion of the learning cycle is critical for higher level comprehension and cognitive skill development (Kolb and Kolb 2005).

The extent to which the six teaching goal areas proposed by Angelo and Cross are accomplished through teaching farms also varies depending on the professor's overall course objectives and approach to using the farm. Strong emphasis was placed on career and work preparation when course learning objectives focused primarily on preparing students to work on a farm. However, other professors made it a priority to incorporate other disciplinary perspectives into the curriculum and provide students an experience on the farm that would contribute to their personal development. Focus on these goal areas was more common in courses using the teaching farm in its foundation role. Courses using the teaching farm in the exploration role often focused on teaching students discipline-specific knowledge and skills and basic academic success skills to help them succeed in their academic and professional careers.

The emergence of four distinct roles for teaching farms has implications for the development of teaching materials for use on teaching farms. No single set of materials can adequately serve the needs of all faculty members using teaching farms. Materials appropriate for a competency role would, for example, typically focus on lower level cognitive skill development than those for a foundation role. While the content would certainly overlap to some degree, the differences in the professor's broad educational objectives could lead to different emphases in content or other teaching goal areas. The professor using the competency role would typically be more interested in presenting material constituting well known and broadly accepted concepts while a professor using an exploration role would be more likely to want a more comprehensive presentation of concepts, including concepts open to debate or yet to be broadly accepted by practitioners. Exercises for the competency role would

focus more on development of basic operational skills while those for an exploration role would emphasize analyzing and solving problems that require intellectual skills like assessing scientific evidence. The distinct approaches to using teaching farms calls for materials that are appropriate to the overall teaching strategy and an attempt to develop a 'one size fits all' set of materials is likely to yield a product that is not very satisfactory for any of the roles.

Specific course or curriculum objectives grow out of an institution's or an individual faculty member's model of what post-secondary education is – what it should accomplish for students and, ultimately, for society as a whole. There is growing concern, expressed by the National Academies of Science and other key institutions that contemporary agricultural education does not prepare students adequately to meet challenges that they are likely to face in the contemporary world (National Research Council 2009). These challenges will require innovation, creativity, problem solving capabilities, an ability to understand and appreciate diverse peoples and ideas, and a deep understanding of basic scientific concepts and principles of scientific discovery.

Our research revealed some interesting relationships between contemporary ideas about the role of post-secondary education and what professors emphasize in their use of teaching farms. Our intent in this research was not originally to develop a typology of the use of teaching farms by faculty members, nor did we intend to examine how the professor's model of the role of post-secondary education is reflected in how s/he uses a teaching farm. That there were four quite distinct roles for teaching farms was unanticipated and led us to try to understand the underlying bases for these quite different approaches to using teaching farms. As we examined the roles, we found that three of the four ideal types in the typology reflect one of the three models of post-secondary education prevalent in the US: (1) vocational education, (2) professional preparation, and (3) the classic liberal arts model.

One model for post-secondary education grows out of a long tradition of vocational or trade schools in the US. The vocational model is common in two-year institutions (U.S. Department of Education 2010). This model focuses on training individuals for a specific job. Once oriented toward positions like secretary or appliance repairman, contemporary institutions and programs have evolved to train for the jobs available today, such as IT or laboratory technician. This model provides the individual with an explicit skill set that will permit him/her to meet the requirements for specified positions. The competency role in our typology focuses largely on the kinds of skills, cognitive development and content that are central to the vocational model of post-secondary education. The objectives and activities described by participants who stressed learning by doing, providing 'a real farm experience,' and gaining 'practical' knowledge intentionally or not reflect the foundations of a trade or vocational education.

A second view of post-secondary education is to provide people with the knowledge and skill sets needed for a lifelong career in a profession. Today's universities include a number of professional colleges that require only two years of general education, often in specific pre-professional programs of study, prior to admission to a professional college. Agriculture, architecture, and business generally follow this truncated model of professional education, whereas law and medicine have retained the original concept of professional development as a post-baccalaureate program of study. The exploratory role in our typology most closely reflects this model of post-secondary education. The emphasis on higher level cognitive skill development,

understanding basic scientific principles, and developing and testing solutions to more complex problems are typical components of this model. Professional development focuses on providing core knowledge and broad skill sets that prepare an individual to continue to develop professionally across the lifetime. In fact, medicine, business and many other professional programs today require on-going professional development.

A third view is that higher education (as opposed to post-secondary education generally) creates an educated, informed, and thoughtful citizenry. This concept of higher education, or the academy, grows directly from the vision of the early national leaders in the US, who argued that a successful democracy requires citizens, and particularly citizen leaders, who can apply a sound knowledge in the arts and sciences to solve changing, complex problems. This vision of the role of higher education is to give people a foundation that will prepare them to reach reasoned decisions in all aspects of their lives across their entire lifespan (Ben-Porath 2012). The foundation role clearly is the most representative of this model of higher education in our study. However, this was also the rarest of the four roles. RO is a key aspect of the foundation role and has been shown to encourage the development of good citizens who contribute to policy and decision-making in their communities (Schusler et al. 2009). The discussion, or perhaps more accurately in some cases, debate, about the role of post-secondary education in the US reflects the key features of each of these three models. Many of those involved in the public discourse are probably unaware of or have not considered that there are at least three quite distinct models of the role of post-secondary education in the US and that each model demands a different content and skill set both from the student and from the professor (France 2000). Nonetheless, perhaps surprising, the discussion often is framed poorly in the post-secondary education community as well. This may be particularly true in the land grant universities. There seems to be a prevalent belief among faculty members that these institutions were designed on the trade or vocational model, as evident by the predominant use of the teaching farm in the competency role by the faculty we interviewed at land grant institutions.

Conclusions

Overall, we found that many professors use terms like ‘hands-on learning’ and ‘experiential learning’ as though they are synonymous. The in-depth exploration of what faculty members mean by experiential learning in reference to how they use teaching farms showed that many are not familiar with the theory of experiential learning and regard *any* activity that occurs in a farm setting as experiential learning. However, this was not the case for faculty members who used teaching farms in the foundation role.

We found that faculty members often state learning objectives related to use of teaching farms that reflect limited or low cognitive levels of achievement. Their descriptions of how and what they teach versus what they actually expect students to accomplish suggest that this may be a problem of expression rather than content. For example, faculty members in our research routinely said that their objective was for students to ‘understand …’ when further discussion shows in many cases that they actually want to achieve higher level goals of application or even analysis. This is particularly true for professors who use teaching farms in the exploration and foundation roles. Professors who use the farms for the competency role tend to focus

on the application cognitive level and often seem to confuse this level with analysis and evaluation or even creating.

Few of the professors responded directly to the six teaching goal areas of Angelo and Cross. However, professors who used teaching farms in the exploration and foundation roles clearly identified several of the teaching goal areas as critical in their approach to teaching. They discussed key objectives in the Angelo and Cross framework like time management, reflection and personal development, and developing professional ethics and standards of performance through their activities, objectives for using the teaching farm, and assessments. Teachers who use farms in the foundation role were more apt to emphasize less 'practical' aspects of teaching to the whole student. Examples include developing value systems, understanding the history of farming and its relationship to the environment and society, appreciation of the esthetics of agriculture, food, and agricultural landscapes.

Our findings also indicate the emphasis on hands-on, practical, and 'real world' learning was more prevalent among professors in colleges of agriculture at land grant institutions than professors at liberal arts schools. In many cases – but certainly not always – land grant professors espoused limited learning objectives and described learning activities and outcomes that can best be described as technical competencies (e.g. lay irrigation tubing or calculate a fertilizer application rate). The increasing budgetary limitations facing land grant institutions, declining undergraduate enrollment in traditional production agriculture majors, and high cost of operating teaching farms may make the revival of teaching farms short-lived. A better understanding of educational theory and mastery of pedagogy could significantly enhance the quality of the learning experience provided on teaching farms, potentially making the cost of operating them more palatable to administrators and legislators. These farms offer extraordinary opportunities to provide students with rich and varied learning experiences, teach basic principles of scientific inquiry, and challenge students to address complex issues. They are particularly appropriate for helping students address the complex relationships between environmental quality, social well-being and economic productivity that lie at the core of education for sustainable agriculture. Our research suggests that this promise is yet to be fulfilled and would be better addressed by relying less on the competency role and more on the exploration and foundation roles for the teaching farm. We recommend future research explore the effectiveness of each role in accomplishing teaching goals and objectives.

These findings also shed light on the ongoing discussion of the purpose of post-secondary education generally. Three of the four roles identified reflect distinctly different models of post-secondary education and offer a tangible example of how student learning outcomes vary depending on the model of education endorsed by the professor. Continued use of teaching farms as a learning tool should include a discussion among institutional administrators and faculty regarding the desired level of student learning outcomes and the role of the farm in preparing students to be good citizens, critical thinkers, and successful professionals.

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