Developing a Guide for the Sustainable Agriculture Education Program at the Duke Campus Farm

by

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Abstract

The goal of this study was to create a guide that aids individuals and institutions develop educational programs about sustainability for their farms. Interest in such programs is increasing and relatively few guides are available. The Duke Campus Farm is the intended first audience. To create this guide, I assessed current practices in sustainable agriculture education (SAE) using two methods: a curricular analysis of various courses about farming education, and in-person interviews with observations of existing local programs. I evaluated fifty-eight syllabi from 30 post-secondary institutions using three broad "meta-categories": Content, Tools, and Approach. I performed interviews and observations about local best practices, needs of different ages and useful educational activities. The curricular analysis showed consistency for 14 content areas, 10 tool areas, and 10 approaches. For Content the top five were categories were Sustainable Agriculture Theories and Concepts, Farm Management, Production Methods, Soil and Natural Science. For Tools, these categories were Traditional Academic, Hands-On Experiences, Comparisons, Evaluations, Assessments and Analyses (CEAA), Projects and Community Building. Lastly for Approaches,the categories were Traditional Academic, Experiential Learning, Environmental Education, Cooperative Learning and Multidisciplinary. From the curricular analysis, the Programming for Education in Agriculture and Sustainability (PEAS) tool was created to educate the user about relationships of each of theses meta-categories. From the interviews, recurrent advices in the following 4 areas emerged: Activities or Lessons, Infrastructure Design, Participant Management and, Program and Curriculum Design. Results from both methods combined allowed for a powerful decision making tool for various institutions. In addition to highlighting salient factors present, the systematic analysis of syllabi identified gaps that can improve SAE and help clarify a standard for the discipline.

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Chapter 1: The New Field of SAE

1.1. Introduction

Sustainable agriculture education (SAE) refers to any education about agriculture and sustainability. Currently, no agreed upon set of parameters define SAE, and this study attempts to mitigate this problem. Numerous programs exist for SAE, but these vary greatly, making the creation of a standard SAE program cumbersome. The goal of this project was to simplify this task for the Duke Campus Farm (DCF), which is eager to develop an SAE curriculum for its visitors.

Over the last 30 years, agricultural education and research has shifted to a more holistic approach. A 1989 report from the National Research Council's (NRC) Board of Agriculture highlighted the need to shift towards a "systems approach" in the study of, what they called, alternative agriculture (NRC, 1989). This rallying cry for more research on sustainable agriculture was heard by numerous institutions and a continually growing number of SAE programs have emerged in academic settings and beyond (Thompson, 2012). Development of a new science that incorporates large scale systems thinking applied to agriculture, Agroecology, defined as the "ecology of food systems" (Francis et al., 2003), highlights further advancement. Integrating SAE into currently existing curricula at the primary, secondary and post-secondary level as well as creating new programs explicitly for SAE at the college and university level is now a burgeoning field.

Experiential Learning (EL) is heralded as one of the hallmarks of SAE (Francis et al., 2011; Parr et al., 2007; 2011). Following in the footsteps of John Dewey and Liberty Hyde Bailey, educators in sustainable agriculture tout the importance of a hands-on approach to teaching about agriculture (Jordan et al., 2008; Quesada-Pineda et al., 2011). Farms entrenched in educational institutions provide a rich learning environment where EL can be integrated into curriculum about sustainable agriculture (Parr and Trexler, 2011; 2011). As one of these farms, the DCF is a perfect place to establish a new SAE program.

Educators differ in their opinions about the state of SAE. Stevenson (2006) argues that very little clarity exists amongst educators about what exactly constitutes SAE, while Parr et al., (2007) note a strong and continually developing canon of best educational practices and approaches for SAE Thus, these divergent viewpoints posit that, though best educational practices are available (Bawden, 1990; Francis and Carter, 2001; Lieblein et al., 2004), they differ in pedagogy, curricular design, content, materials and infrastructure among SAE programs. Another complicating factor in the development of SAE is that program designs are driven by physical landscape characteristics, such as climate, topography, soil; and socio-economic influences, such as budgets, institutional politics and student interest.

Given the interdisciplinary nature of agroecology and the complex connections between natural and social sciences, educators are still figuring out the most effective ways to do SAE. With best practices still developing, creating a program of SAE for the DCF involves assessing many different examples of programs and classes that are sometimes very different. A guided is needed not to point out the most frequently used content, tools and approaches to SAE. A guide makes the creation of such a program for the DCF easier, and importantly, also helps to outline the general field of SAE.

1.2 Background

The current industrial agro-food system is driven by the post World War II "Green Revolution," that espoused the use of petroleum-derived chemical fertilizers and pesticides to produce the most food possible (Heckman, 2006). Though we have seen steady rises in food production since, the negative human and environmental impacts of this type of food system are prominent (Horrigan et al., 2002). Industrial agriculture is responsible for roughly 70% of world water use (Gliessman, 2006) and 10% of global greenhouse gas production (Takle and Hofstrand, 2008). Fertilizer runoff from agricultural fields is responsible for a large amount of algal blooms and consequent hypoxic "dead zones," with a well-documented case in the Gulf of Mexico (Rabalais et al., 2009).

New developments in modern agriculture cause problems as well. Genetically modified seeds used in these industrial systems threaten to create voracious "super weeds" that are resistant to pesticides (Duke and Powles, 2008). Pesticides and herbicides pollute groundwater and threaten biodiversity (McLaughlin and Mineau, 1995; Relyea, 2005). Despite regulations, underpaid farmworkers are exposed to these toxic chemicals, creating a hazardous work environment and sometimes sickness and death (Moses, 1989). High-energy-density food produced in our current food system can be linked to increases in childhood obesity (Johnson et al., 2008; Scerri and Savona-Ventura, 2011). Obesity in children and adults can lead directly to a host of diseases and chronic illnesses (Heart et al., 1998) that not only impact quality of life, but also health care costs (USDHSS, 2001). The list of negative impacts continues and it is easy to support food writer Michael Pollan's claim that "the industrial food system is broken" (Pollan, 2008).

Luckily, sustainable systems of agriculture do not always have the negative impacts of conventional systems (Halwell, 2006). For example, organic agriculture typically uses less energy and is may have a higher energy use efficiency than conventional agriculture (Alluvione et al., 2011; Nassi o Di Nasso et al., 2011). Sustainable agriculture practices typically do not use synthetic fertilizers which helps them significantly out perform conventional practices in environmental impacts (Backer et al., 2009; Gan et al., 2011; Nemecek and Erzinger, 2004)

More farmers are transitioning to sustainable practices. The number of organic farms are growing in the U.S. (Parr et al., 2007) and the organic industry grew from $7.4 billion in sales in 2001 to $28.6 billion in 2010 (OFRF, 2012). The market for sustainable food is gaining substantial traction. Farmers who are not certified organic by the USDA National Organic Program, are still using sustainable practices such as no-till/reduced tillage, cover cropping, crop rotation, and integrated pest management (IPM) (Jordan et al., 2008). The prominence of these practices shows promise for our agricultural future.

Trends in education show that college and university programs in sustainable agriculture are increasing (Parr and Trexler, 2011). Student farms continue to emerge on college campuses and they help encourage people's interest in positively influence agriculture (Sayre and Clark, 2011). SAE can bring about positive change for agricultural development (Widodo, 2011) and highlight connections between a multitude of disciplines to serve as a foundation for teaching about global environmental impacts (Nelles, 2011; Orr, 1991). With SAE on the rise and its potential to influence positive change in our food system and beyond, developing more clarity about how SAE programs should operate will be an important part of creating our more sustainable future.

1.3 The Duke Campus Farm

The Duke Campus farm is a one-acre commercial production space located about 7 miles west of Duke's west campus. It has two main purposes: production and education. Though the farm has educational community events, such as volunteer days, class visits, workshops, it currently does not have a formal educational program. The intended program will serve the general audience of "visitors to the farm" that typically includes a multi-generational age range.

1.4 Study Questions and Hypotheses

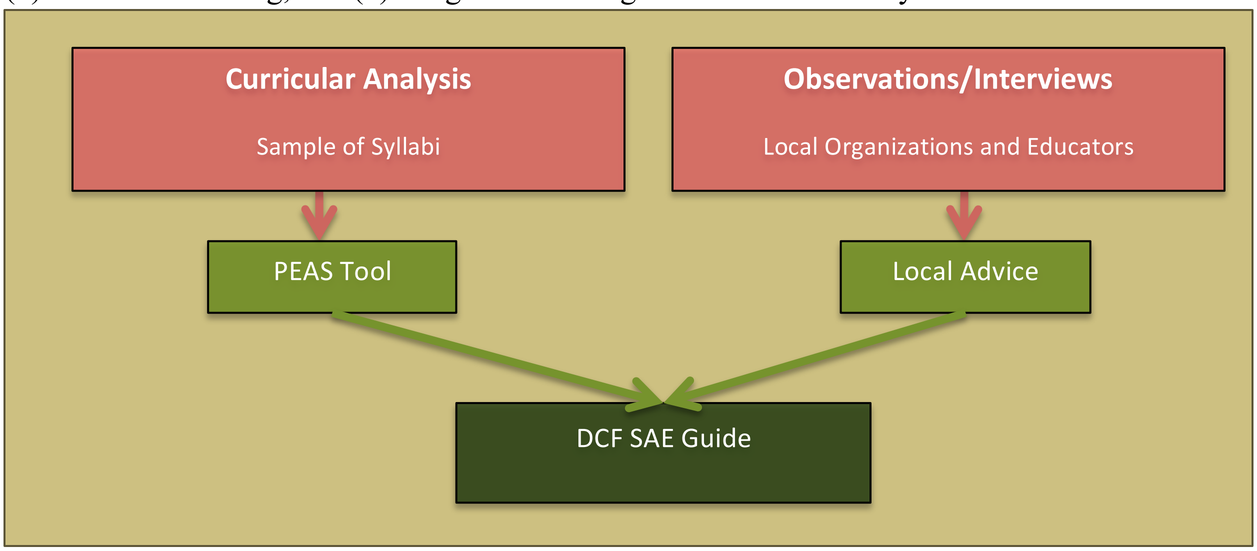
Three basic questions inform this study: 1) What is being taught in existing SAE generally? 2) How is it being taught, and 3) How can this information be simplified into a useful guide for future SAE programs?.

Two hypotheses were tested:

1. Visitors to a sustainably managed farm will better learn about sustainable management practices when an agroecology-based curriculum that focuses heavily on plant and soil science is used.

2. Demonstration plots with informational signage that each explain one sustainable practice employed on the farm are a useful way to teach about those management practices.

A curricular analysis was used to assess Hypothesis #1 and interviews along with observations were used to assess Hypothesis #2. Results of each were integrated to make the final guide, the process of which is outlined in Figure 1. For clarity, I use four distinct sections to present my findings: (1) the curricular analysis, (2) the in-person interviews and observations, (3) a brief concluding, and (4) the guide resulting from all sets of analyses.



<u>Figure 1.1: Study Outline -</u> Conceptual outline of this study. The two methods (at the top in pink) each focused on finding different information resulting in outcomes (light green) that were integrated into the final DCF guide (dark green).

Chapter 2:
The Curricular Analysis, Testing Hypothesis #1 and the PEAS Tool

2.1 Introduction

Post-secondary SAE programs (colleges and universities) differ from K-12 programs in their goals. Elementary and secondary level programs typically introduce students to growing food, nutrition, and being outside. They focus heavily on hands-on learning and nature/farming appreciation and it is rare that these programs explicitly teach about sustainability. Though sustainability concepts may be imbedded throughout a formalized structure for sustainability education in primary and secondary education is lacking. Furthermore, elementary and secondary teachers are beholden to teaching to standards and have limited resources and ability to take students outside. Many great examples of garden and farming programs have been implemented for students in elementary school, but they often ancillary because state and federally mandated curriculum takes precedence. Post-secondary programs tend to focus explicitly on sustainability concepts and engaging students in thinking critically about solving problems in our food systems. These programs tend to be more formalized and are intended to cover a multitude of issues and ideas through multiple courses. Given the logistical constraints facing K-12 program and the clarity and structure of post-secondary programs my curricular analysis focused on colleges and university-level courses. Chapter 3 focuses on the valuable work that K-12 educators are doing in the field of SAE.

The benefit of college and university syllabi is that courses are designed and taught by experts in the field. Very few textbooks exist for sustainable agriculture (Gliessman, 2006; Lyson, 2004),) and each course is designed according to the educator's understanding of the field based on his/her expertise. These educators come from diverse backgrounds within the agricultural or ecological academic field, such as soil science, crop science, agronomy, or biology. Syllabi created by these educators represent an expert's interpretation of how to teach about sustainable agriculture. Each syllabus offered a different perspective and helped to create broader categories for a unified model of how SAE can be organized.

2.2 Materials and Methods

I used two databases in my search for syllabi. The first was the USDA Sustainable Agriculture Education and Training Opportunities (SAETO) database (Thompson, 2012). This is a compilation of all post-secondary education institutions that offer courses related to sustainable agriculture. It includes public, public land-grant, and private universities as well as public, private and community colleges. The second database was the Sustainable Agriculture Education Association's (SAEA) Academic Programs web page (Parr, 2013). This resource compiles course offerings that align with the SAEA's mission and offers links to land-grant universities, four year state and private universities, private liberal arts colleges, programs outside of North America and open enrollment summer programs

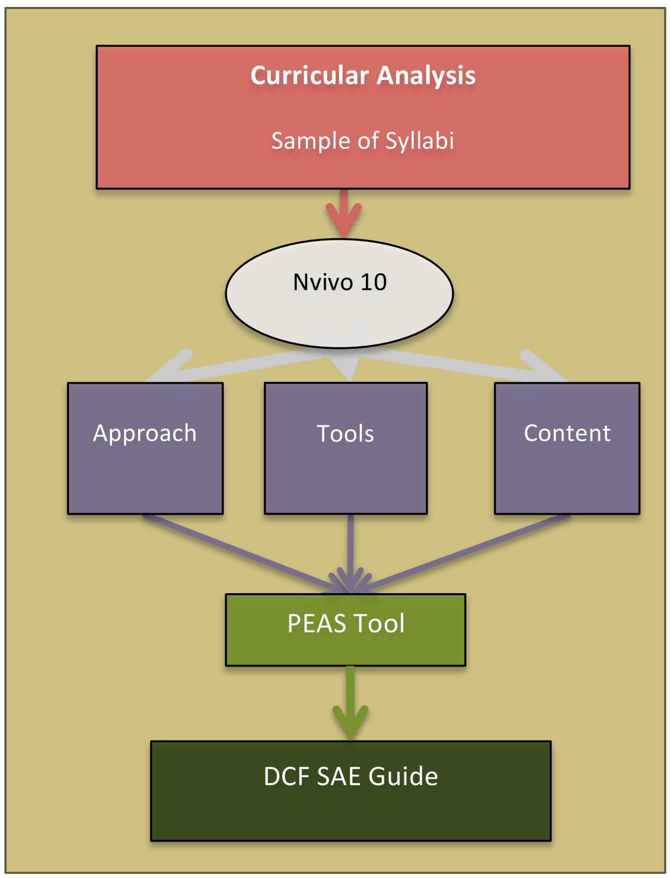
I mined the data through 3 separate "sweeps." First I compiled all post-secondary education institutions that mentioned sustainable agriculture, organic production, or agroecology in descriptions of their programs, majors, minors, concentrations/focus, certificates at the undergraduate level as well as associate's degrees, trainings, master's programs and concentrations, PhD programs and concentrations, and/or opportunities for graduate research. This yielded 111 schools. Second, I searched for institutions that had more than one course related to sustainable agriculture, preferably a suite of courses related to a program (major, minor, concentration, etc. . I assumed that syllabi developed with broad university support as part of a program would be indicative of overlap of categories in SAE. I paid specific attention to the mention of agroecology because it requires a higher level of agricultural knowledge and it is rare that all topics in agroecology can be covered in only one course. I specifically sought universities that have a program in sustainable agriculture, organic production (or a related field). These search criteria yielded 43 schools. Third, using both the USDA SAETO and the SAEA database, I gathered syllabi for these 43 schools. In cases where syllabus was not available online, I contacted 33 professors or course administrators directly. I ended with 30 schools and 120 documents.

While exploring these 120 documents, I became interested in 3 types of courses in which I was interested: courses about crop production, courses with "Agroecology" in their tile, and courses with "Sustainable Agriculture" in their title. Examples of syllabi that did not fit into those 3 course types were courses in agroforestry, composting, introductory food systems and introductory sustainability. Twenty-four documents were materials explaining program design or sample schedules, which were omitted as well. The final sample set included 58 syllabi from 30 universities.

2.2.1 Coding in Nvivo 10

I analyzed the syllabus data using Nvivo 10, a qualitative analysis software from QSR. Nvivo allows the user to manually create holding places categories of interest, called "nodes" and then place portions of text that pertains to those categories into those nodes, a process that I will refer to as "coding." There are two approaches that one can take to coding data. One can create categories of interest prior to the analysis and code to them. Or, one can, as Lyn Richards describes come "up from the data" where the researcher creates categories as they see them emerging and tests for their strength and validity by looking for repetition as the research moves on (Richards, 2009). Both of these methods were used.

I searched for three main categories of information: pedagogical approaches, pedagogical tools and content. For ease of reference, I am calling these "meta-categories." Detailed descriptions of these meta-categories are below. I read through each of the 58 syllabi multiple times, coded them to the meta-categories and created a hierarchical taxonomy within the meta-categories which I then organized into a decision making tool called the Programming for Education in Agriculture and Sustainability (PEAS). Figure 2 offers a conceptual outline of this process.



<u>Figure 2.1: Curricular Analysis Overview -</u> Conceptual outline of this curricular analysis. Syllabi were gathered (at the top in pink) and loaded into Nvivo 10 (middle white), three broad meta-categories were searched (middle purple) the results of which were developed into the PEAS (middle light green) which was integrated into the final DCF guide (dark green).

2.2.2 Coding Criteria

While the meta-categories were determined by my research questions, a simple set of coding criteria was applied within each one. Table 1 lists the frequency range for each category and offers an example of the final output. "Parent Categories" were determined with an "up from the data" approach by analyzing and assessing similarities of sub categories and generally had references from roughly 20 to 58 syllabi. Sub categories were determined in a similar fashion as the parent categories and generally had references from roughly 10 to 30 syllabi. Sub-sub categories were pulled directly from the data and were initially grouped by similarity. For example, in the chart below, the words "diversity" or "stability" or words that were similar to them, were repeated in 19 different syllabi. Sub^3 categories were determined in a similar way as the sub-sub categories but contained references from 5-10 syllabi. If a category had fewer than 5 syllabi referenced to it, then it was folded into the lowest taxonomic level in which it logically made sense.

Table 2.1 Coding Criteria Example: Explanation and examples of the coding structure based on the number of sources referenced to a category. Number range indicates the category frequency criteria and number on the right indicates actual number of syllabi in which the category was represented. .

Meta Category: Content (58)
Parent Category (~20-58 syllabi): Natural Science (40)
Sub Category (~10-30 syllabi): Ecology (30)
Sub-sub category (~10-20 syllabi): Diversity and Stability (19)
Sub^3 category: ~5-10 syllabi: Biodiversity (8)
Sub-sub category (~10-20 syllabi): Landscape Ecology (15)
Sub^3 category: ~5-10 syllabi: Disturbance and Succession (6)
Sub-sub category (~10-20 syllabi): Ecosystem Services (12)
Sub^3 category: ~5-10 syllabi: Carbon Sequestration (5)
Sub-sub category (~10-20 syllabi): Nutrient Cycles (11)
Sub-sub category (~10-20 syllabi): Population Ecology (10)
Sub-sub category (~10-20 syllabi): Community Ecology (7)
Relegated to an upper taxonomic level: < 5

Determining the difference between a sub-sub category and a sub^3 category depended on whether or not the theme fit into a higher taxonomic level or not. In the example above, "Community Ecology" was labeled as a sub-sub category even though it was only referenced in 7 syllabi because it did not logically fit into any other category and it was too significant (>5) to be subsumed by the Sub category of "Ecology."

2.2.3 Coding Methodology

Using the criteria in Table 1 and researching frameworks for pedagogical approaches (explained in section 2.8), I coded my data in four phases: initial coding, validation, recoding and ensuring connections.

First, employing the "up from the data" method as much as possible, I created node categories for any new instance of a potential category and placed it in its appropriate meta-category. Half way through the syllabi sample I had over 150 categories for "Content" and over 50 categories for "Pedagogical Tools" and I paused to reorganize my node structure.. I got rid of roughly 80 nodes by relegating their topics into an upper taxonomic level. I then finished coding the rest of the data and added new sub-category nodes when appropriate.

During the 2nd phase, I used Nvivo to run text searches for categories that I thought might be important, but initially had low frequency. In some cases a word search lead to the creation of another sub-sub category. This was the case for "Climate Change" which before the search had only 3 sources with references, but after the search had 9. I was then able to add this as a sub-sub category under "Human Impacts in the Environment." In other cases a word search lead to the integration of a node into an upper taxonomic level. This was the case with "herbicide" which only had 2 source references and therefore was integrated into the upper taxonomic level of the sub-sub category “Weed Management.” In total I ran 21 word search queries to validate nodes that were low on source references.

The 3rd phase ensured that all syllabi were coded correctly within my newly validated hierarchical node structure; I went back through and systematically performed 3 more sweeps of the data. I did one sweep just coding for content, a second sweep just coding for tools and a third sweep just coding for approaches.

The 4th and final phase ensured that connections between parent categories were present. I first looked at the relationship between Tools and Approaches and coding any tools where I thought they fit with approaches. I used the criteria outlined in the explanations of the Pedagogical Approaches listed above to aid in this effort. For example, the pedagogical tool of “Field Trip” can also be considered a “Concrete Experience” under the Subcategory of Experiential Learning in the parent category of Pedagogical Approach. I repeated this methodology for tools and content.

In most cases, word choice for categories came directly from the data, and in general the word choice of the first syllabus that I looked at which referenced a particular theme was the title that I used throughout. For example, the meta-category, Content, has the sub-category, Human Impacts on the Environment, which I came across the early in my search. This idea could be described in many different ways and therefore, it is important to note that the specific titles of the categories are merely markers for themes within the syllabi.

2.2.4 Finding Course Type Descriptions

I leveraged the course descriptions and/or objectives in each of the syllabi to understand of how Sustainable Agriculture Production and Agroecology differed in the broad academic areas that they covered. I first isolated all of the course descriptions, and then separated these descriptions out by their course type. I systematically went through each course type and looked for similarities. Not all courses that were labeled to a type contained course descriptions, so I used the course objectives if there were available. Salient features of the course descriptions were gathered with the "up from the data" approach, and the criteria for coding hierarchy were followed to distill out the major features that lined up across each type of course.

2.2.5 Content

"Content" represents the material covered in the course and helps answer the broad research question of what is being taught. This data was gathered primarily from daily or weekly schedules that were written into the syllabi. Of the 58 sources, 12, or 21%, did not have this type of schedule. In these cases, I used information in the course descriptions or course objectives to describe the content of the course. The biggest challenge of distilling all of the content was that educators described the same themes with different words. Being careful to use the data as my guide, I tried my best to not make assumptions that different wordage meant the same thing. For example, one the topic of water, one syllabus had a day for which the lecture was labeled "What is in our Water," and another syllabus contained a day for which the lecture was labeled "The Water Environment." Though both of these topics are clearly about water, they may or may not be covering the same material during their lecture. Lack of clarity about how specific content would be was a theme that I saw throughout the syllabi and I used my best judgment to discern whether or not topics were similar.

In general, if the same exact words were used across syllabi, then I coded that subject matter to the same category. However, if different wordage was used to refer to the same topic, as illustrated in the "water" example above, I initially created a separate category for it. In some cases, an idea was repeated enough times that was able to create a category for that idea. In other cases it was relegated to an upper taxonomic level. In "water" example, neither of these word groups was repeated multiple times, so they both ended up being relegated to the parent category of "water."

2.2.6 Tools

"Tools" describes specific methods, assignments or media that educators used to teach their courses. Analyzing these tools helps answer the question of how topics in sustainable agriculture are being taught. Information on Tools was gathered from throughout all areas of individual syllabi including the course descriptions, assignment explanations, and daily schedules. Every syllabus had at least some information about the tools that were used. As syllabi are inherently designed to inform students about assignments and logistical information about the course, Tools were the easiest meta-category to which to code.

2.2.7 Approach

"Approach" describes the paradigms educators are using the guide their teaching methodology. Analyzing these approaches also helps to answer the question of how sustainable agriculture course are being taught. Nineteen percent of the syllabi did not have any information about pedagogical approaches and were not included in the analysis of this meta-category.

It was rare (4%) that a syllabus made a direct reference to the pedagogical approaches employed during their class. In most cases, information about pedagogical approaches was inferred from assignments, course descriptions, course objectives, and logistical information. It was not possible to come "up from the data" given the implicit nature of pedagogical approaches, so I first sought out references for my parent categories. I found 10 pedagogical approaches and used their descriptions to guide my decisions. These 10 categories were: Experiential Learning (Felder and Brent, 2005; Kolb, 1984; Kolb and Kolb, 2005), Environmental Education (Belgrade

Charter, 1976; NAAEE, 2004) Cooperative Learning (Ballantine and Larres, 2007; Johnson and Johson, 1987; Oakley et al., 2004), Multidisciplinary (Kveraga and Jones, 2011; Pirrie et al., 1999), Learning Through Writing and Reflection (Brown, 1998; Lew and Schmidt; McClelland, 1973; Molee et al., 2010; Smith, 2002), Inquiry-Based (Boyer Commission, 1998; Walkington et al., 2011; Wilson and O'Regan, 2007), Mindful Learning (Langer and Moldoveanu, 2002; Ritchhart and Perkins, 2000), Project-Based (Kalayci, 2008; Morgan, 1983), Service Learning (Ehrlich, 1996; Felten and Clayton, 2011), and Traditional Academic. Descriptions of each one of these Approaches are below.

2.2.7(a) Experiential Learning

Born from pragmatist thinkers of the early 20th century like John Dewey and William James, experiential learning theory (ELT) recognizes the importance of the individual's learning process. Formalized in by (Kolb, 1984), ELT proposes a learning cycle that all minds must go through in order to learning (Felder and Brent, 2005; Kolb, 1984; Kolb and Kolb, 2005) This cycle has 4 distinct phases; concrete experience, reflective observation, abstract hypothesis and active testing (Kolb, 1984; Kolb and Kolb, 2005) Though all four phases of the cycle need to be fulfilled for learning to happen, a learner may have a strong proclivity towards one particular part of the cycle and this is the place at which it is best for them to start (Kolb, 1984; Kolb and Kolb, 2005) An educator that employs ELT as a pedagogical approach will recognize these differences in her or his students and offer pedagogical tools that serve all four phases of the ELT cycle (Felder and Brent, 2005)

I coded for ELT as a pedagogical approach using the 4 phases of the ELT cycle as criteria. A great example offered to me was in reference to a student riding a bike (Cagle, 2013). A concrete experience might be a student seeing someone ride a bike. Reflective observation may involve a student writing, drawing about the bike or thinking that she or he might like to ride a bike. An abstract hypothesis might be a student attempting to figure out how the gears on a bike work. And active testing would involve a student riding the bike. If I felt that a syllabus referenced any one of these phases, then I coded it to experiential learning.

2.2.7(b) Environmental Education

In 1976 the Belgrade Charter was adopted by the United Nations and it proposed:

"The goal of environmental education is to develop a world population that is aware of, and concerned about, the environment and its associated problems, and which has the knowledge, skills, attitudes, motivations, and commitment to work individually and collectively toward the solutions of current problems and the prevention of new ones" (Belgrade Charter, 1976)

In the almost 40 years since, Environmental Education (EE) in the U.S. has become a powerful tool for non-formal educational programs at places like summer camps, national parks, nature centers, zoos, public gardens, etc. (NAAEE, 2004), The North American Association for Environmental Education (NAAEE) published its Non-Formal Environmental Education Programs Guidelines to Excellence. In it they emphasize that EE is based in promoting student awareness of environmental surroundings, and using local environmental examples to help students develop skills to make connections and problem solve in larger systems (NAAEE, 2004).

I coded for EE using three main criteria: place-based learning, nature connection, and indigenous knowledge. Place based learning is education that is specific to a small localized geographical region and it generally seek to engage students with issues and research problems in that region (Smith and Sobel, 2010). Nature connection seeks to engage students within their natural environmental and promote introspective reflection on the human role in the environment (Young, 2013). Indigenous knowledge is simply using knowledge of indigenous peoples, current and historical to help better understand environmental issues in modern society. Instances that referred to any one of these 3 criteria were coded as such under the parent category of EE.

2.2.7(c) Cooperative Learning

Cooperative Learning is a pedagogical approach that relies on the power of small groups and group dynamics in education (Oakley et al., 2004). Touted for its ability to engage students and increase classroom effectiveness, Johnson and Johnson point out that it is not just a matter of putting students into small groups (1987). Referencing Johnson and Johson (1987), Ballantine and Larres (2007) note that the following factors must be present to create a true cooperative learning environment: positive interdependence, individual accountability, face-to-face interaction, social and small group skills, and group processing. Instances that referred to any one of these criteria were coded in the parent category of Cooperative Learning.

2.2.7(d) Multidisciplinary

A multidisciplinary approach is often described in the professional world as a group of people from different disciplines coming together to solve problems (Pirrie et al., 1999). Harden (1998) helped to shape and define this approach by creating an 11-stage continuum that expresses the level of integration that one must have to be truly multidisciplinary. This continuum starts with isolation, where one is limited to approaching problems using her or his own field, and ends with "transprofessional" where approaches to problem solving from multiple professions are employed and learning is integrated into the real world (Harden, 1998). Multidisciplinary education is defined when "Each profession looks at themes from the perspective of its own profession" (Kveraga and Jones, 2011). Kveraga and Jones dissuade us from thinking that multidisciplinary education refers to any time more than one discipline is represented and point out that Harden's continuum gives strict parameters to the definition of this type of approach.

In some cases, syllabi directly addressed this in their objectives and pointed out that their course would examine issues from different academic perspectives. In other cases a syllabus might mention a list of discipline (e.g. economics, ecology, chemistry and ethics) that they would use to evaluate sustainability. There were also multiple cases where a syllabus referred to "interdisciplinary" work, and though Harden creates a clear distinction between "interdisciplinary" and "multidisciplinary," I coded these cases to a multidisciplinary approach.

2.2.7(e) Learning Through Writing and Reflection,

The concept of learning through writing and reflection began as an alternative to traditional academic approaches and focuses on assessing learning though personal reflection through writing (Smith and Sobel, 2010). Students are given time in class, or assignments outside to class through which they consider what they have learned and how it relates to them. These are often in journals or portfolios (MacIsaac and Jackson, 1994). Studies generally show that this is an effective tool for assessment and that students increase their ability to go deeper into reflection as they continue to write (Brown, 1998; Lew and Schmidt; Molee et al., 2010; Smith, 2002)

As criteria for this category, I looked for references that noted student reflection, journaling, writing about oneself or instances when students were asked to consider how they would react in a non-academic way.

2.2.7(f) Inquiry Based

In 1998, the Boyer Commission (Boyer Commission, 1998) pressed the need for more research opportunities in undergraduate education. Inquiry-based learning focuses on engaging students in real research questions in order that they develop skills such as critical thinking, framing research questions, reflectivity and creativity (Walkington et al., 2011). The ultimately goal for Inquiry Based learning is for students to become researchers and bring new knowledge to the world (Wilson and O'Regan, 2007).

I coded to this category any instances of students developing research questions and following through with a study. An example of this might be giving students the broad topic of analyzing the local food system and then asking them to develop their own approach.

2.2.7(g) Mindful Learning,

Mindfulness, a popular concept today, can have multiple meanings ascribed to it from spiritualists like Tich Naht Han, to popular psychologists like Pema Chodron. It can be seen in various sectors like health and business and is often applied as solutions to social problems (Langer and Moldoveanu, 2002). In the context of education, a working definition is leveraged off of three major pivot points: looking closely, exploring possibilities and perspectives and introducing ambiguity (Ritchhart and Perkins, 2000). I used these criteria in my coding by looking for instances where students were challenged to step outside of their normal and expected academic paradigms and really explore things deeply.

2.2.7(h) Project Based,

Just as Cooperative Learning does not happen anytime that students work together, Project Based learning, has a specific set of criteria that does not make every project part of a Project Based approach. It centers around an actual issue or a problem (Morgan, 1983) that students engage with and work on during multiple class sessions, outside of class and often over the course of the semester (Cagle, 2013).Evidence shows that with the educator serving as guide, the more control that students have over the project, the more effective a project based approach will be (Kalayci, 2008).

To code to Project Based learning, I looked for instances where projects lasted for multiple class sessions or longer, students had the large majority of control and students were engaged in real world problems.

2.2.7(i) Service Learning

Though the concept of colleges and universities giving back to society is a long-standing tradition in the U.S., the concept of service learning has been a topic in education for the two decades. Service learning involves students performing tasks (service) that serve and needed purpose and are related to class subject matter and then reflecting on this work and relating it back to the course content. (Felten and Clayton, 2011). In service learning we see notes of at least two other approaches: Experiential Learning and Writing and Reflection. In fact, the roots of service learning lay in John Dewey's philosophy on integrating knowledge and skills, which is the same philosophy that drives Experiential Learning (Ehrlich, 1996).

Because it is a nuanced form of Experiential Learning and Writing and Reflection, I coded instances to Service Learning only when the words "service" or "service learning" emerged.

2.2.7(j) Traditional Academic

Though popularity in pedagogies shift, there is an enduring ethos of canonical teaching at the post-secondary level. To code to Traditional Academic, I looked for instances of syllabi referencing things that our modern cultural paradigm would expect every class to have. These were instances of reading, writing, lectures, discussions, exams, critical thinking and case studies. Because the majority of most classes are taught through some form of lecture, I elected to not code every single instance of lecture in the syllabi, and chose to code to lecture only when a syllabus explicitly mentioned the word "lecture." I also created a sub-sub category of "guest lecture" in which I placed references of outside visitors speaking to a class.

2.2.8 Cross Meta-Category Comparisons

It was important to consider instances of overlapping categories to answer my second broad question of *how* sustainable agriculture is being taught. I systematically searched my data for instances where a reference coded to a syllabus within one meta-category was simultaneously coded to another meta-category. Doing this analysis helped me generate a theory of what combinations of approaches, tools and content are being used together. This was particularly useful data helped me create the PEAS tool, because understanding the tools and approaches that are connected to a specific content area will help an educator understand how to teach about that content area.

In the frequency analysis of the meta-categories described above it was useful to look at the sources, or the syllabi themselves that held the references. When looking at the connections between meta-categories, it was more useful to look at the references, the sum of the total number of times a category was repeated within each syllabus. An instance written in a syllabus, e.g. a lecture topic may also be associated with a pedagogical approach or a pedagogical tool, depending on how the syllabus was written. This phenomenon could happen multiple times within that syllabi.

2.2.9 Creating the PEAS Tool

In response to my third broad question of incorporating my study into a useful guide, I developed the Programming for Education in Agriculture and Sustainability (PEAS) tool. Based on the frequency data of the content meta-category and the matrix comparisons of content to tool and content to approach, I developed a tool that related these three factors together.

Within each meta-category, I related the total number of sources that mentioned parent categories to the total number of the sample (N=58). This percentage represents the importance that each one of these categories was given within the syllabi.

2.3 Results and Observations

Coding for course descriptions yielded 5 themes for sustainable agriculture courses, 3 themes for Agroecology courses and 3 themes for production courses. Coding for the three meta-categories yielded. 14 parent nodes for Content, 11 parent nodes for Pedagogical tools and 11 nodes for Pedagogical Approach. A detailed description of the hierarchical node structure can be seen in Part 4 of this document. Matrix comparisons showed poor implementation of Experiential Learning, a lack of use of Environmental Education techniques. Frequencies are represented by a percentage. It was assumed that percentages of 25% and above were important.

2.3.1 Frequencies

2.3.1(a) Type of Course and Course Descriptions

An important part of the analysis was understanding the broad academic themes in each course type (Production, Agroecology, and Sustainable Agriculture). Of the total syllabi in the sample 33% were as Production Courses, 31% were labeled as Agroecology courses and 36% were labeled as Sustainable Agriculture course. Within these sub-categories, 76% of Sustainable Agriculture, 68% of Agroecology and 44% of Production actually had course descriptions. Table 2.2 indicates the main features found course description by each meta category of course type.

Table 2.2. Important Features Indicated in Course Descriptions: Similar academic content themes that were seen throughout each set of syllabi within each course type. Features are ordered by frequency with the highest occurrences first.

Sustainable Agriculture	Agroecology	Production
1. Principles of sustainable agriculture	1. Developing an analytical framework for agroecosystems	1. Fundamentals of sustainable and organic agriculture
2. Alternative Approaches to food and fiber	2. Ecology concepts applied to agriculture	2. Technical skills
3. Within the context of global and local	3. Contribute to a more sustainable society	3. Science based
4. Historical development of agriculture		
5. Tools to assess the sustainability of agricultural operations		

2.3.1(b) Content

The meta-category of content had 14 parent nodes, 40 sub-categories, 41 sub-sub categories and 14 sub^3 category nodes. Figure 2 illustrates the distribution.

Of the 14 total content parent categories, 7 were represented 50% or more of the time. These were, Sustainable Agriculture Theories and Concepts, Farm Management Practices, Production Methods – Cultural Practices, Soil, Natural Science, and economics. All other parent categories showed between 43% and 26% significance. Sequentially, these were, Human Impacts on the Environment, Water, Local Food Issues, Sustainable Food Systems, Energy Issues, Food Health and Safety and Systems Thinking

It is not necessary to layout every relationship between categories, but there are a few noteworthy ones. Sustainable Agriculture Theories and Concepts is given roughly the same amount of importance (95%) in all three Course types. However, Production courses give even more importance (100%) to both Farm Management and Production Methods. Agroecology focuses less on Farm Management as the other two. Economics is more important to Sustainable

Agriculture (57%)and Production (53%) respectively, than it is to Agroecology, where it does not show up in the 50th percentile.   Natural Science is more important to Agroecology (83%) and Production (68%) than it is to Sustainable Agriculture, where is not in the 50th percentile. Human impacts on the Environment and Local Food Issues are more important to Sustainable Agriculture courses than it is to the other two course types. Sustainable Food Systems is more important to Agroecology than it is to the other two course types.

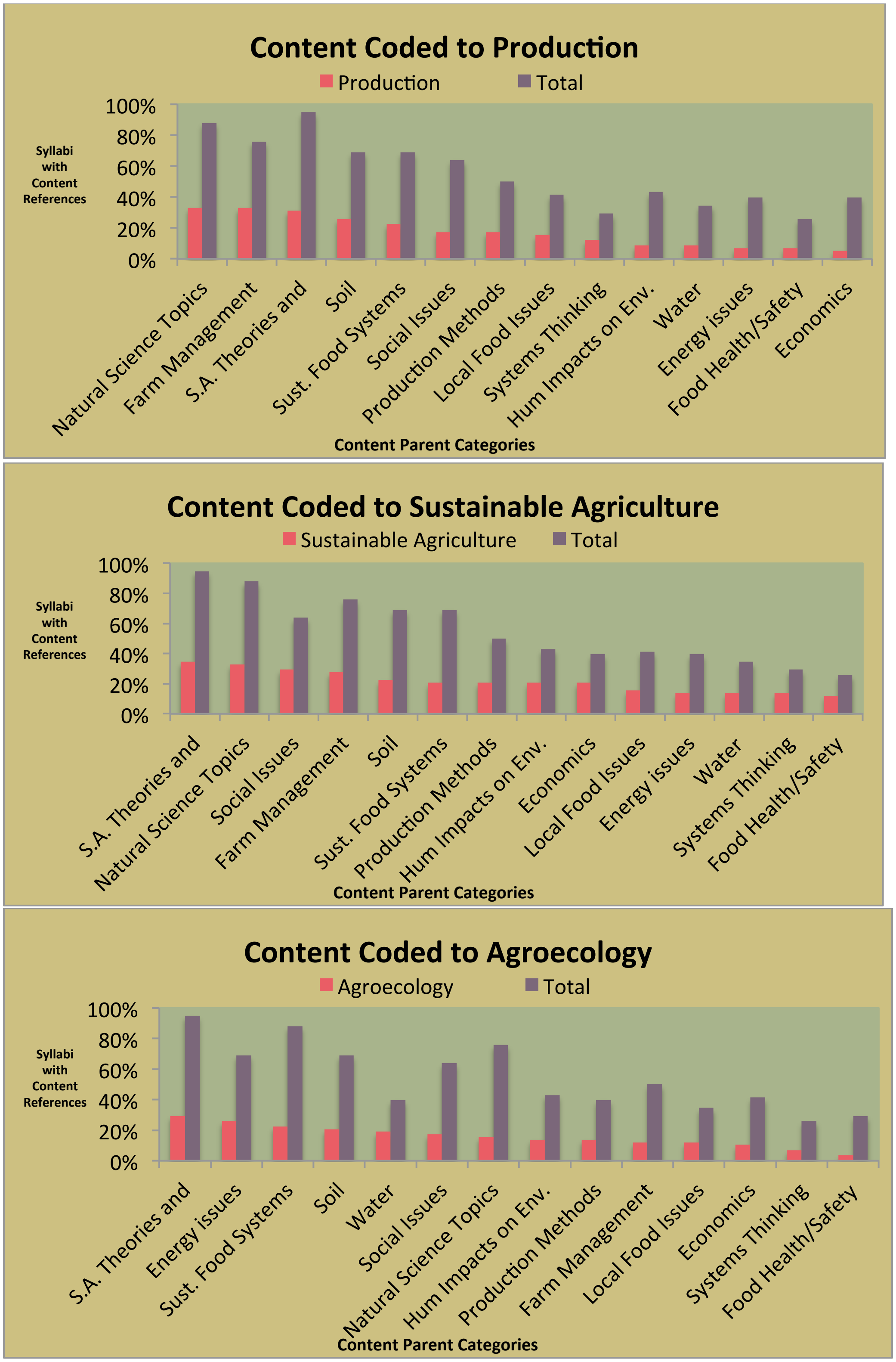


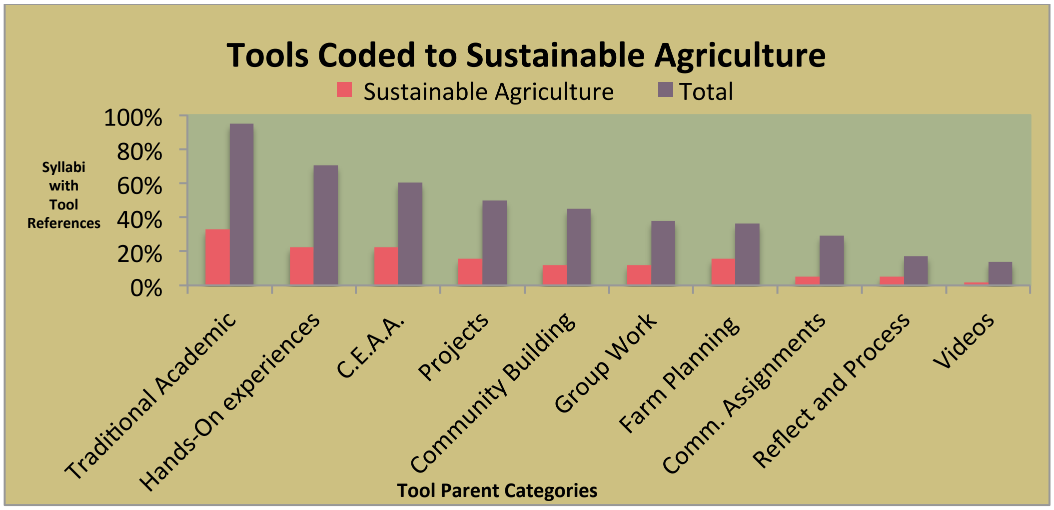
Figure 2.2 Content Frequencies By Course Type – Figure 2 - Content are expressed as a percentage of the total number of syllabi. Red bars indicate the frequency of content to the course type. Purple bars indicate the frequency of content for all three course types.

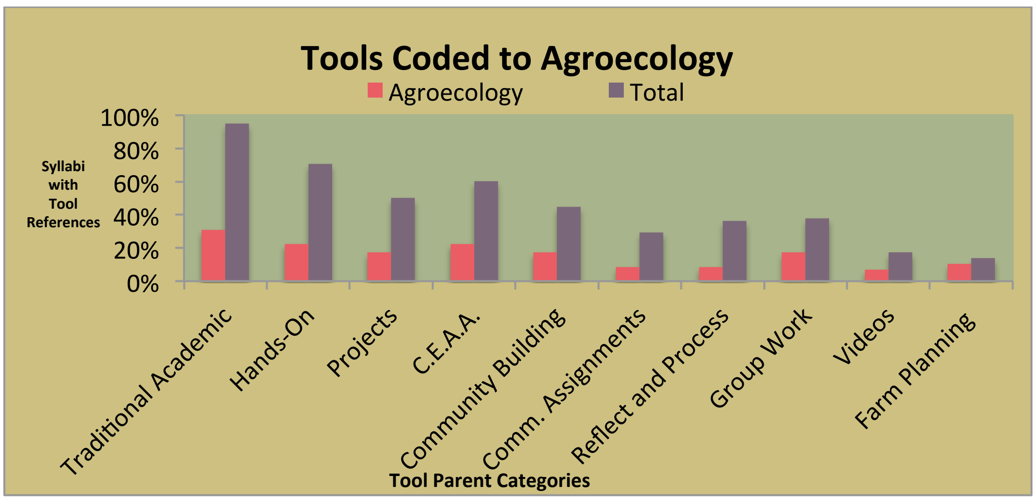
2.3.1(c) Tools

The meta-category of Tools had 10 parent categories, 23 sub-categories nodes, 7 sub-sub categories and 2 sub^3 categories. Figure 3 illustrates their distribution. Tools showing representation 50% or more of the time were, Traditional Academic, Hands-On Experiences, Comparisons/Evaluations/Assessments/Analyses CEAA) and Projects. Below the 50% percentile, within 45% and 36% representation were Communication Assignments, Group Work, Reflection and Processing and Farm Planning Assignments. Both Videos and Community Building showed little significance coming in at 17% and 14% representation respectively.

There was variation in how course types prioritized their tools. Sustainable Agriculture courses represented Hands-On Experiences and CEAA at the same rate (62%) suggesting that those tools are equally important to teaching Sustainable Agriculture. The same is true for Agroecology. Agroecology also gives Projects and Communication Assignments the same amount of importance (56%). Production gives equal importance to CEAA and Communications (47%).

Comparing the Course types, Production gives Hands-On Experiences more importance (79%) than Agroecology or Sustainable Agriculture, suggesting that Hand-On experiences are most important in Production courses. We can see a similar phenomenon with Agroecology where it gives C/E/A/As more importance (72%) than Sustainable Agriculture and Production, suggesting that C/E/A/As are most important in Agroecology courses. Projects are of similar importance to Agroecology and Production, but Agroecology gives more importance to Communications Assignments than Production.





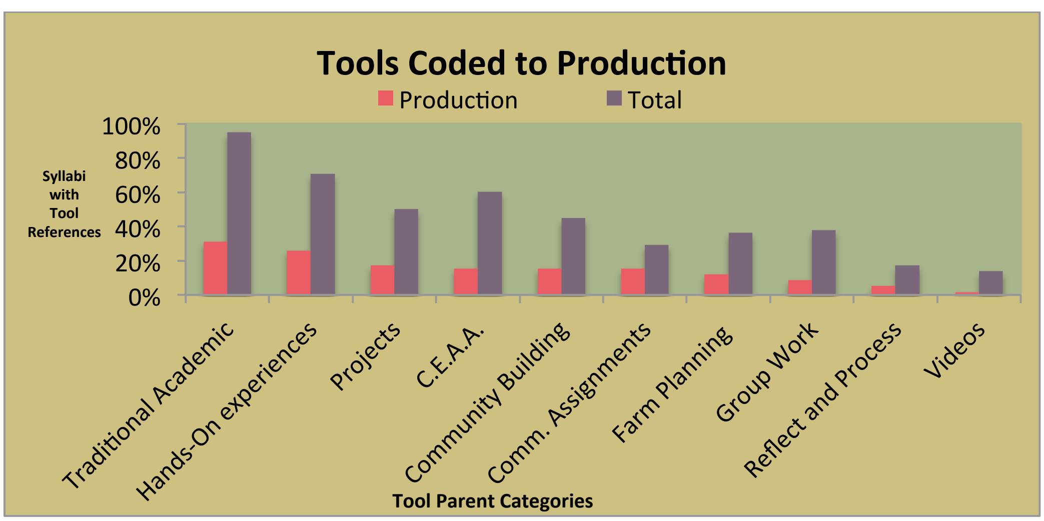


Figure 2.3 Tools Frequencies By Course Type – Tools are expressed as a percentage of the total number of syllabi. Red bars indicate the frequency of content to the course type. Purple bars indicate the frequency of content for all three course types.

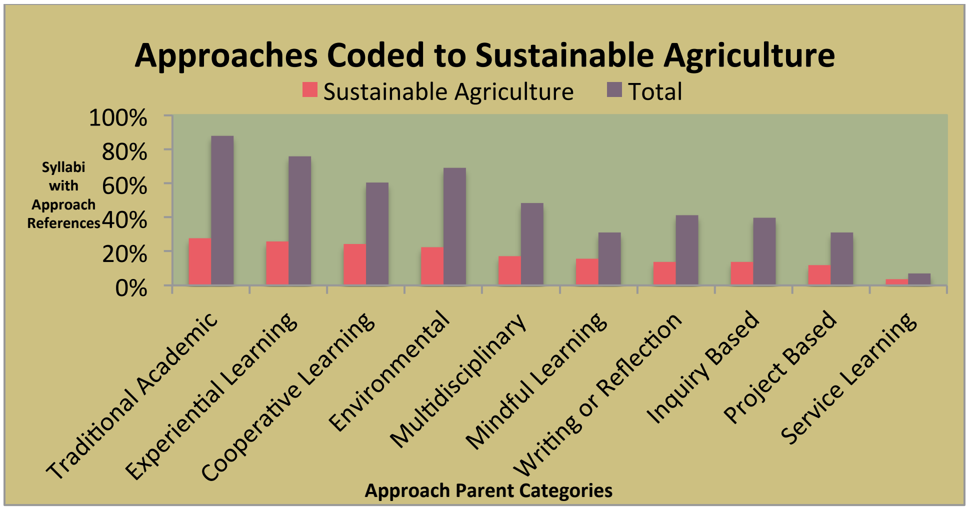
2.3.1(d) Approach

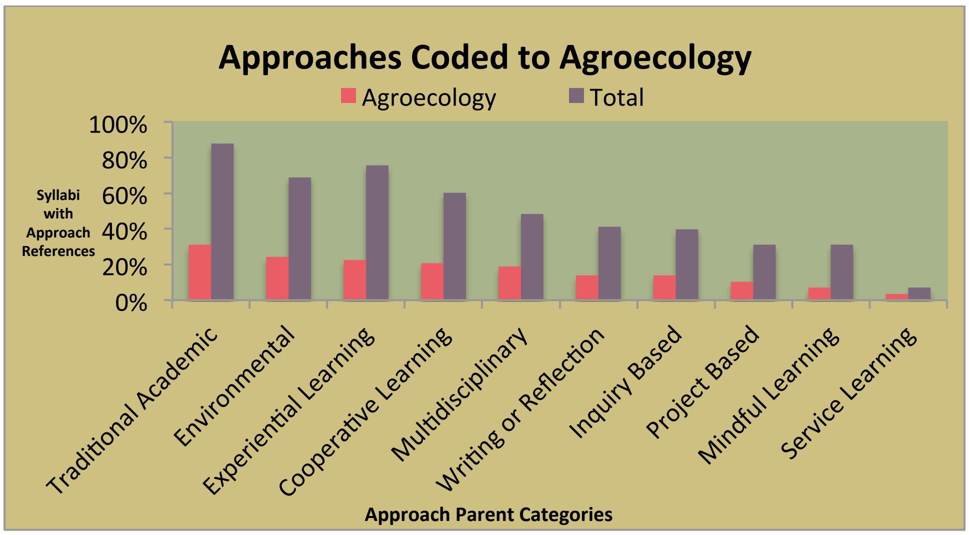
Parent Categories and sub-categories within Approach were determined prior to analysis; therefore 9 parent nodes and 7 subcategory nodes remained. Figure 5 illustrates their distribution.

Approaches within the top 50th percent were, Traditional Academic, Experiential Learning, Environmental Education and Cooperative Learning. The proceeding parent categories were all within 41% and 31% representation. These were, in order, Learning Through Writing, Inquiry Based, Mindful Learning and Project Based. It is also worth noting that Service Learning was the least significant at 7%, which was only represented in two syllabi.

There was variation in how course types prioritized their pedagogical approaches. There was a clean linear hierarchy with each course type category, with Traditional Academic up at the top of all three, and Experiential Learning ranking close to the top in all three as well.

Production places more importance on Experiential Learning (84%) than the other two course types. Environmental Education is given the most importance in Agroecology (78%) than the other two course types as well. Cooperative Learning is given the same amount of importance in Sustainable Agriculture and Agroecology (67Multidisciplinary is more important to Sustainable Agriculture (48%) and Agroecology (61%) than it is to Production, where it is not mentioned, and it is most important to Agroecology.





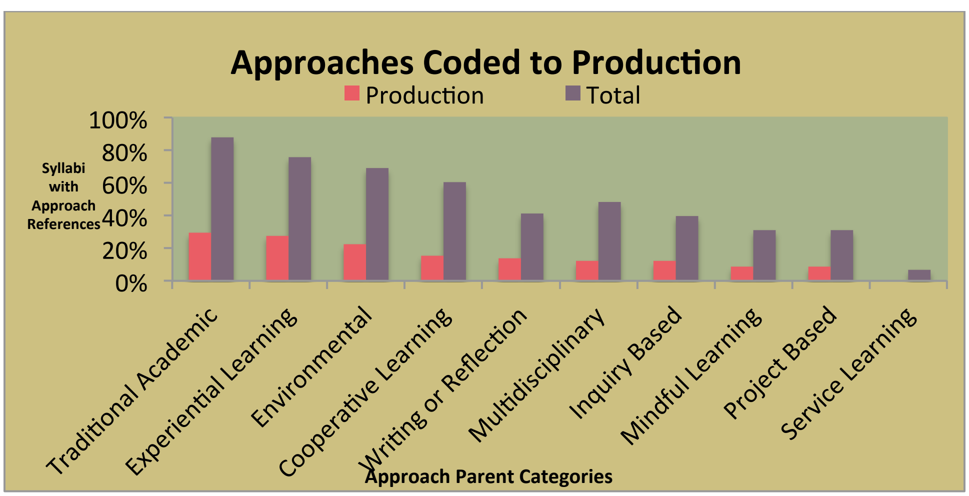


Figure 2.4 Approach Frequencies By Course Type – Content are expressed as a percentage of the total number of syllabi. Red bars indicate the frequency of content to the course type. Purple bars indicate the frequency of content for all three course types.

2.3.2 Connections between Meta-Categories to indicate Gaps

The majority of the connections between Content and Tools and the connections between Content and Approaches are outlined in the PEAS tool and are not necessary to report. However, the PEAS tool does not cover the connections between Tools and Approaches. This comparison is useful for pointing out gaps in the data. Gaps in Approaches were found in the employment of Experiential Learning and the use of Environmental Education.

Table 3 indicates the distribution of instances where a Tool was coded to the Approach of Experiential Learning (EL). Values represent the percentage of all Tools that were coded to EL. We can see that 59% of the Tools coded to EL were Hands-On Experiences. This is a significant finding because EL theory dictates that there are four different phases of the learning process and we would expect to see incidences of EL spread across a wider array of tools.

Table 2.3 Tools Coded to Experiential Learning: Instances in which any tool was also coded to experiential learning. Percentage indicates amount of the total number of references within all syllabi each tool represented.

	Experiential Learning
Tools	%
Hands-On Experiences	59%
Traditional Academic	9%
Videos	7%
Comparisons, Evaluation, Assessments, Analyses	6%
Farm Planning Assignments	6%
Communication Assignments	5%
Projects	4%
Group work	3%
Reflection and Processing Learning	1%
Community Building	0%
Total	100%

Looking further into the Approach data, there was a wide discrepancy between the 4 phases of EL. Figure 5 illustrates the 4 phases of Experiential Learning and their distribution amongst the 58 syllabi.

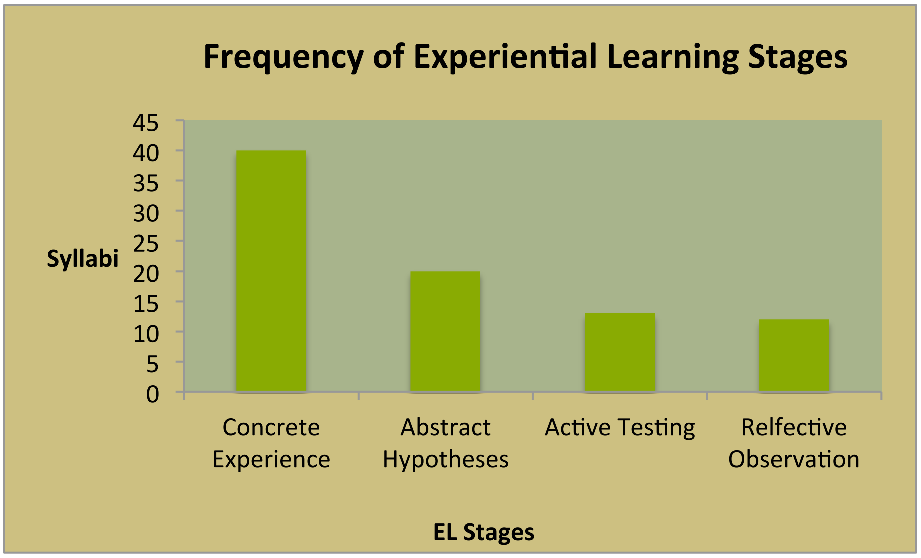


Figure 2.5: Frequency of Experiential Learning Stages: Histogram distribution of Experiential Learning phases employed throughout all syllabi

Table 4 shows the distribution of instances where a Tool was coded to the Approach of Environmental Education (EE). In this table, percentages indicate the portion of the total Tool references that EE represents. There were no cases where a tool showed 25% or higher. Environmental education isn't being applied to any tools in a significant way.

Table 2.4: **Tools Coded to Environmental Education:** Instances in which any tool was also coded to EE. Percentage indicates the portion of the total Tool references that EE represents.

	Environmental Education
Tools	%
Hands-On Experiences	21%
Communication Assignments	13%
Comparisons, Evaluation, Assessments, Analyses	13%
Videos	9%
Traditional Academic	4%
Projects	4%
Group work	3%
Reflection and Processing Learning	3%
Farm Planning Assignments	0%
Community Building	0%

2.4. Discussion

Contemporary understandings of SAE are often set in contrast to education about conventional agricultural that dominates land-grant universities (Parr et al., 2007). Educators in SAE are constantly innovating and proposing creative and effective ways to move away from not only conventional agriculture, but also the approaches and methods used to teach conventional agriculture. (Bawden, 1990, 1996; Francis et al., 2001; Lieblein et al., 2004) The goal of this study was to look within the now bustling field of SAE and distill out some major themes that have emerged in practice. The PEAS tool uses the frequency data gathered from the syllabi to systematically answer the 3 guiding questions laid out in the beginning of this paper. The frequency data can also be used to indicate gaps and areas of improvement in the field of SAE.

2.4.1 The PEAS Tool.

The PEAS tool attempts to give educators developing programs and curriculum related to SA a reference to ways in which they could design their programs by relating content, tools and approaches together in a systematic way. It is useful because it presents an organized view of options and it offers numeric data to help guide decisions. In terms of this study's guiding questions, the Content answers the question, "What is being taught?" and the Tools and Approaches answers the question "How is it being taught?"

For example, using the tool to create a course around Soil, I can see the important content to teach, which tools are associated with teaching about soil and which pedagogical approaches might be most pertinent. This would be true for any Content category in the tool. Another feature of the tool is that it gives a list of all readings within the syllabi that are associated with each content parent category and subcategory when applicable. These reading lists will be useful to help an educator gather background knowledge on a subject.

2.4.1(a) Content

The content data show 7 total Content parent categories that were in the upper 50th percentile representation in the syllabi and none that were below 25%. This suggests that my coding criteria worked well to create categories within a threshold of >25% of syllabi referenced. There are a plethora of publications that describe curriculum, and many studies about how SA should be taught (MacRae et al., 1989), but there are few published studies on what specific content should be included in SAE (Karsten and Risius, 2004; Parr and Horn, 2006; Parr et al., 2007). This study adds to a body of knowledge that is attempting to define which content should be involved in SAE.

It is useful to first consider the implications of the hierarchy of content when all course types are combined. Sustainable Agriculture Theories and Concepts emerge as the first and most important content area to teach about in SAE. The logic here is simple, enough; in order to teach about sustainable agriculture we must first define it and put into a context. As many of these courses were beginning courses, it follows that students would need an introduction to the broad concepts before diving into the specifics.

There were 6 other content categories within the top 50th percentile of syllabi content . It is an assumption of the PEAS tool that combined with Sustainable Agriculture Theories and concepts, these categories will be the most important to teach. However, with 14 total areas, a question arises about how to best use the frequency data to guide decisions. One could design a program that focused on these 14 content categories at a level appropriate to its relative importance. Alternatively, one might only focus on the upper 50th percentile, potentially making an arbitrary cut off, but optimizing time for what is most important.

2.4.1(b) Validating the Data with Another Study.

Parr et al. (2007) asked agricultural educators at land grant universities across the U.S. to rank by importance the content areas they found important for SAE. They split their content areas into 3 different categories: Natural Sciences, Social Sciences and Interdisciplinary and Applied. Organizing my Content parent categories along that same scheme we can compare the results of each of the studies. Table 5 indicates compares the two.

Table 2.5: **Comparing Content of 2 Studies**: Comparison of the content areas of Parr et al. (2007) and current study. Categories of current study were organized based on the criteria of Parr et al. for ease of comparison.

Parr et al. 2007	PEAS Tool
Natural Science 1. Ecology 2. Soil Science 3. Pests	**Natural Science:** 1. Natural Science (Ecology, Plant Science, Climate and Weather, Insects) 2. Soil 3. Water
Social Sciences 1. Policy 2. Food Systems 3. Business/Economic	**Social Sciences** 1. Social Issues (History, Policy, Justice) 2. Economics 3. Local Food Issues/Sustainable Food Systems
Interdisciplinary/Applied 1. Interdisciplinary 2. Farming Practices 3. Research Methods	**Interdisciplinary/Applied** 1. Sustainable Agriculture Theories and Concepts 2. Farm Management Practices 3. Production-Methods

The data in my study corroborates the Parr et al. study's conclusion that both natural science, social science, and interdisciplinary/applied content is important to SAE. The majority (75%) of my sub-category of Natural was taken up by the sub-sub category of Ecology, which was the highest-ranking content area in the Parr et al. study. Soil was similarly ranked as well. Though the third category is different, Insects is included in my Natural Science category and though it is not in this chart, water is ranked fourth for Parr et al. In the Social Science category my subcategory of Social Issues includes Parr et al.'s sub category of policy. Our second and third sub-categories very similar themes that are just flipped in their ranking. "Interdisciplinary", for Parr et al., refers to courses of study that bring multiple disciplines together. Both of our highest-ranking sub-categories show similarity in that Sustainable Agriculture Theories and Concepts will inevitably leverage multiple disciplines, as any sustainability education will do. The second sub-categories line up on very similar themes as well.

As a continuation of Parr et al.'s findings, my study highlights the growth and formation of SAE. Six years ago, there were fewer post-secondary programs in sustainable agriculture (Thompson, 2012), Now it seems like many of these ideas are now being put into practice.

2.4.1(c) Tools Related to Content in the PEAS Tool

Two prominent tools emerged as important within each content Category; Traditional Academics and Hands-On Experiences, representing an average of 52% and 26% of the tools used within each Content category respectively.

It is no surprise that Traditional Academic tools were represented so well. These tools, outlined in Part 4 of this paper, are things such as reading, writing, lectures and math assignments. Innovation is prevalent in many of these SAE syllabi, but they are still post-secondary level courses, most at land-grant universities, where traditional education is expected.

The frequency of Hands-On experiences is not a surprise either, given that it is highly correlated with similarly highly rated approach of EL. Also, not surprisingly, frequencies of Hands-On Experiences were high in the content categories of Farm Management and Production Methods. Hands-On Experiences also rated relatively high (between 47% and 29%) in Soil, Water, Local Food Issues and Natural Science. This study shows that SAE uses EL, and it is plausible that this is because educators recognize its effectiveness. It could therefore follow that educators would be more likely to use EL on issues that they thought were important, which would be true for Soil and Natural science, which, amongst all of the syllabi, were both represented at 69% and were in the top 5 highest content categories. If this is the case, then it remains a mystery as to why Water and Local Food Issues, which were represented at 41% and 40% respectively and ranked 9th and 10th out of 14, respectively.

Comparisons, Evaluations, Assessments, Analyses (CEAA) emerged as the third highest Tool. This category is about getting students to think critically and pull in multiple disciplinary perspectives and perhaps even multiple paradigms of thought. It is not surprising, then that the Content parent category of Systems Thinking was taught 33% of the time through CEAA. R.J Bawden writes prolifically about the power and importance of systems thinking in the goal of sustainable development in agriculture (Bawden, 1990, 1996, 1992, 2005). For Bawden, systems thinking and a holistic approach to decision making is a way to bring different modes of thought together, create agreement and shift current paradigms that tend toward instability. If we take Bawden's view, then CEAA is a very powerful tool for the goal of SAE. There is a 25% difference between the use of CEAA in Agroecology and Production, which we could interpret to just be part of the major differences between the two types of courses. However, if we adhere to Bawden, we also might point out that because systems thinking is such an important part of SAE, Production courses could stand to use this tool more.

2.4.1(d) Approaches and Content in the PEAS Tool.

Experiential Learning (EL) showed a high degree of frequency amongst all of the Content parent categories. On average, EL represented 50% of the teaching approaches applied within each content category. Environmental Education (EE) was second and Traditional Academic was third representing an average of 19% and 9% of the approaches applied within each content category. It is clear that EL is very important to SAE,

It is curious that Traditional Academics and Environmental Education ranked relatively high amongst all of the syllabi (88% and 76% respectively), but when analyzed with reference to the number of times that it occurs within the PEAS tool as related to any one specific tool (as illustrated above) they both rank so low. There are two points to make about this. The first is that though 19% and 9% are low percentages, these are significantly higher than any of the other approaches. The second is that this could be due to coding methodology. The PEAS tool shows instances where sections of the syllabi were coded to both Content and Approach. In many cases, a content area was listed with no mention of how it was being taught, which could skew the data. Furthermore, because most Content categories will be taught through some form of lecture, a standard tool for the Traditional Academic approach, the Lecture sub-category becomes somewhat moot in that it would “cancel-out” across all categories in terms of importance. If we assume that lecture is a vital part of every course taught at the college level, then it begins to matter less whether or not it is given importance in the PEAS tool.

Service Learning and Writing or Reflection were under represented in the syllabi overall and more so within the PEAS tool. Service Learning was represented in only 7% of the syllabi, indicating that very few educators are using this approach Farm Management was the only content category that had a reference to Service learning, and this made up 1% of the total references to Farm Management. Writing and Reflection was seen in 4 content categories, but only representing an average of 6% of the approaches applied within each content category. It seems that more work could be done to better integrate these approaches into SAE.

There are a few big take-homes from thinking about the Approaches through their overall frequency in the syllabi and their relationships to specific Content categories in the PEAS tool. Though the Approach of Traditional Academic is important for educating about agriculture and sustainability, ie., we see it often throughout all of the syllabi, it is not necessarily important to use it for any one subject, ie it does not show high frequency within an one Content parent category. Environmental Education (EE) and Experiential Learning (EL) are important

Approaches for SAE and they are an important aspect of teaching about many of the Content categories.

Nelles (2011) looked at how an international education organization integrated EE and sustainable agriculture and concluded that EE was not directly addressing SAE. However, many SAE ideas are commensurate with those of EE. For example, EE looks to engage participants in positively affecting the environment (NAAEE, 2004). Widodo (2011) also highlights the power that EE can have in educating elementary and secondary school children about sustainable agriculture. Many people claim that EE's goal of behavior change is not necessarily attainable (Harms et al., 2009; Heimlich and Ardoin, 2008), but it is clear that it has a lot of good things to offer for SAE. This research showed that EE is being under utilized as an approach to teaching about any specific content. Explicitly applying EE to SAE may yield a richer experience of subject matter to students.

In EL, there are many studies showing the importance of hands-on experiences in education and particularly in SAE (Francis et al., 2003; Grossman et al., 2010; Kolb and Kolb, 2005; Parr and Trexler, 2011; Quesada-Pineda et al., 2011). There is also evidence that students will remember things better when they learning something outside (Montgomery and Millenbah, 2011). Over half of the syllabi analyzed had students going on fields trips, and just under half had students participating in labs. There were also multiple mentions of participating in crop production, attending conferences and attending workshops.

Hands-on learning is inextricably linked to Experiential Learning (Kolb, 1984; Kolb and Kolb, 2005) so it makes sense that it would be ranked in a similar order as its Approach parent category analog. However, when we compare it across the course type categories, we can start to see where gaps may exists in SAE's use of EL. It is not hard to imagine why Production courses have the highest (79%) incidences of Hands-On Experience, because people are learning and practicing their skills in growing food. We then see a steady decline with Agroecology at 72% and Sustainable Agriculture at 68%. However, something interesting happens when we compare this to Experiential Learning. In Experiential learning, Production is still the highest (84%) followed by Agroecology (72%) and then Sustainable Agriculture (71%), but there is only a 1% difference between the last two. Figure 6 illustrates these relationships in a simple line graph.

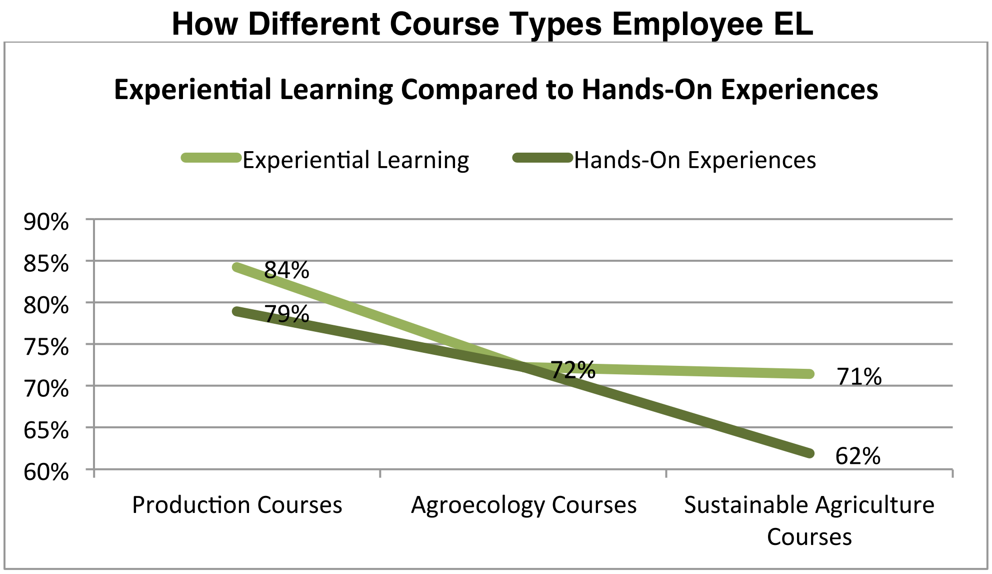


Figure 2.6 Comparing incidences of Hands-on Experiences to Experiential Learning. The light green represents the use of EL across the syllabi and the dark green represents the use of Hands-On Experiences. SA courses use EL at a higher frequency than Hands-On Experiences, indicating that other tools are being used to teach through an EL approach.

Agroecology courses and Sustainable Agriculture courses are using EL in a different way. Agroecology has a higher incidence of labs and participation in production, two truly Hands-On experiences. There are more instances of "forming abstract concepts" in Sustainable Agriculture, which though it is part of the Kolb's Experiential Learning framework (Kolb, 1984), it is not a Hands-On experience. Comparing this data with Figure 5, we can see more clearly where SAE is not addressing all of the ELT phases.

Harkening back to the roots of EL, Francis et al., invoke John Dewey when they talk about the importance of learning by doing (Francis et al., 2011). However, it is the case that educators are still working on ways to improve EL (Harms et al., 2009). While Hands-On Experiences are very important to SAE, my data suggests that some of the other aspects of the EL scheme (Forming Abstract Concepts, Testing in New Situations and Observations and Reflections) are not being used as much. There were 40 syllabi that were coded to a “concrete experience” (synonymous with “Hands-On Experience”). If EL were being fully employed we would expect to see the same number of incidences of the other three in Figure 5.

It is certainly arguable that there is no one “correct” way to teach SAE and that different learners will benefit from different pedagogical approaches (Felder and Brent, 2005). However, when we consider the frequency of use of the 10 Approaches and the 10 Tools included in the PEAS based on my interpretation of these syllabi, there are some gaps that exist in the way SAE is being used. Table 5 Illustrates some key findings of these gaps and proposes reasoning why filling these gaps may be important.

Table 2.6 Gaps in SAE: Key findings for gaps in Pedagogical Approach and tools. Percentages indicated refer to the number of references to a source of each category as compared to the total number of sources (N-58)

Approach/Tool	Gap	Reason for filling this gap
Experiential Learning (EL)	May not be addressing all aspects of Kolb's (1984) model	EL is used often in SAE, but it is not being used as well as it could be (Harms et al., 2009)
Environmental Education (EE)	EE design does not explicitly address SAE.	EE is well aligned with SAE, and could help to promote behavior change (Nelles, 2011; Widodo, 2011)
Inquiry based	Mostly under utilized in syllabi studied (40%)	Research in SA will help further sustainable development (Francis, 2010)
Mindful Learning	Mostly under utilized in syllabi studied (31%)	Shifts in agricultural sustainability are likely to come from paradigm shifts (Bawden, 1990, 1992)
Service Learning	Very under utilized in syllabi studied (7%)	Offers a powerful blend of EL, EE and Mindful Learning as well as giving real opportunity to change farming practices and educate farmers (Francis and Carter, 2001; Pretty, 1995)
Comparison, Evaluations, Assessments and Analyses	Used significantly, but not explicitly in Production courses	Systems thinking is a very important tool in SAE (Bawden, 2005)

2.5. Positionality/Critique

Qualitative research is inherently subjective All of the data in the above section is data that I created by assessing these syllabi through the lens of my background knowledge. Nvivo helped to organize them and count them, but each decision to code a reference to a particular category was a decision that I made. I tried to remain as consistent as I could with my criteria, and I believe that my methodology of doing several systematic sweeps helped to alleviate deviation from those criteria. I recognize, though, that there was variability with how I approached coding from day to day. However, I do feel confident that the overall trends in the numbers, e.g. Traditional Academic and Experiential Learning being the highest referenced pedagogical approaches, or Sustainable Agriculture Theories and Concepts being the highest referenced Content category, would still hold true.

Looking at my analysis of pedagogical approaches, I was a teacher for 6 years, so I have a strong familiarity with the "how" of teaching and I have experience creating programs and curriculum, but I don't really have experience with all of the pedagogical approaches that I was categorizing. I have large amount of theoretical and practical knowledge of Experiential Learning and Environmental Education, and of course, with Traditional Academic. It is curious that the 3 with which I am most familiar ended up ranking the highest. However, these are all popular and well studied, so it would make sense that these educators were using these methods. Furthermore, my experience with EL and EE and lack of work with Service Learning may have made me skew a bias away from coding to SL because they do have many similarities.

My biases may have been highlighted in the Content analysis as well. While I have been building a skill set and knowledge base of sustainable agriculture in the past 3 years, I have relatively little experience as compared to those educators who created these syllabi. In some cases I was not certain of the context within which certain topics in the syllabi were being used. These topics were harder to group and may have been placed in a category differently than someone with more experience in sustainable agriculture. I also have a distinct interest in natural science; particularly ecology and I may have inadvertently identified those topics more readily than other ones. For example, I do not have much experience with Economics. I created a very complex category hierarchy for the Natural Science parent category of the Content meta-category, but I did not create any category hierarchy for the Economics parent category. I am confident that the number of references and sources coded to the Economics parent category is as accurate as it could be, but I do think that more information about sub-categories, sub-sub categories and sub[3] categories could have been developed. The same is most likely true for the Water parent category.

Lastly, it is important to reiterate that this was a qualitative study done on 58 syllabi. Though I am proposing that these trends may apply to the field as a whole, at best the only thing that I can say with confidence is that this particular analysis yield these results for this syllabi this time around. Any claims that I have made about the field of SAE as a whole are entirely conjecture and extrapolation, and should be interpreted as so.

2.6. Conclusion

There was sufficient data to support the efficacy of doing SAE by teaching about sustainable management practices and soil science, proposed in Hypothesis #1. There was not any evidence that directly supported the idea that an SAE curriculum needed to be based solely in Agroecology or in plant science.

As a research methodology, the curricular analysis proved useful in two ways. The first was the analysis of the curricula itself. By applying a strict set of frequency criteria and performing many systematic sweeps of the data, I was able to create hierarchies within each of the three meta-categories. I feel confident that this taxonomy accurately reflects all of the information within the syllabi. Using the data generated from my analysis, I created the PEAS Tool, which describes the field of SAE in a way that would help someone make decisions about how to create their own SAE Program.

The second outcome of this analysis was the identification of gaps within the 58 syllabi. I was able to identify six gaps in total, though there are two that stand out significantly. The four phases of Experiential Learning are not being followed explicitly in SAE placing a limit on the effectiveness of EL. Though Hands-On Experiences are extremely important, they will not be as effective as they could be unless they are processed appropriately. Environmental Education principles are very useful for SAE, but they are under represented. More work could be done to integrate these principles into SAE practices.

As SAE grows, it will be important to assess practices within the field for usefulness and effectiveness. Many SAE educators are applying difference practices, all of which may be effective and useful, I think that more studies such as this one could be helpful in creating a more unified SAE field.

Chapter 3 – Efficiency of Demonstration Gardens in Teaching about Agricultural Sustainability

3.1 Introduction

The Programming for Education in Agriculture and Sustainability (PEAS) tool organizes the content, tools and approaches of SAE in a systematic way and provides quantitative data to aid in making decision about creating an SAE program. It is useful to answer questions of what to teach and how to teach it. However more information about teaching different age groups is needed to make a comprehensive for the DCF's multi-generational audience because PEAS tool is based on SAE at the post-secondary level only. The tool also lacks ways in which curriculum and infrastructure should be designed. The development of the DCF program entails decisions about curriculum content, infrastructure design, learning exercises and projects and lessons.

Hypothesis #2 was addressed: Demonstration plots with informational signage that each explain one sustainable practice employed on the farm are a useful way to teach about those management practices.

To address this hypothesis, I used qualitative methods of case studies and interviews, and gathered data about curriculum, infrastructure, and class observations. These data provide guidelines for suggested approaches specific to target audiences that are included in the final comprehensive guide.

3.2 Methods

I wanted data from a range of institutions and sought out specific schools based on their reputation of excellence in SAE. From these, four schools were selected based on proximity to Duke's campus, strength of programming, target school age, and willingness to participate: Central Carolina Community College in Pittsboro, the Charlotte Brodie Discovery Gardens in the 55-acre Sarah P. Duke Gardens, Duke University Durham; Central Park School for Children, Durham; and E.K. Powe Elementary School, Durham. I performed 11 interviews. All were individual interviews but CCCC where, the 3 participants wanted a group interview for ease of scheduling and synergy of responses. Interviews were semi-structured; I used a set of 15 questions, and let people talk about other things as needed. Questions focused on how educators implemented SAE and what types of things they considered important and effective. A full list of questions is in the Appendix. Interviews typically lasted between 20 and 45 min. except for CCCC, which lasted 90 min.

Observations were performed on location and involved watching a class being taught. I observed 2 classes at CCCC, Andrew McMahan's Ag Mechanics class, which lasted approximately 1 hour and Hillary Heckler's Organic Production class, which lasted approximately 2 hours. Also, I attended an "Interpretation Committee" meeting for the Sarah P. Duke Gardens staff where employees discussed signage used for all their gardens. I did not observe students in elementary school because the gardens were dormant during my winter interview period. Table 7 lists interviewees for each location, with or without observations.

Table 3.1 Interviews and Observations: Location, People, and Observations: lists the institution, under the "Location" column, the educators and their tiles in the "Contact" column and the activity that was observed under the "Observation" column.

Location	Contact	Observation
Central Carolina Community College (CCCC), Pittsboro, NC	Andrew McMahan - Department Chair, Sustainability Technologies, Biofuels and PV Instructor, Sustainable Technologies	Ag Mechanics Course
	Hillary Heckler - Student Farm Manager	Organic Production Course
	Robin Kahanowhich - Sustainable Farming Coordinator	N/A
Charlotte Brody Discovery Garden (CBDG), Duke University	Kavanah Anderson - Education Program Coordinator	1st Grade Program
	Jason Holmes - Curator Doris Duke Center Gardens	N/A
	Jan Little - Director of Education and Public Programs	Interpretation Committee Meeting
Central Park School for Children (CPSC), Durham, NC	Sue Willis - 3rd Grade Teacher	N/A
	Meg Millard - 2nd Grade Teacher	N/A
E.K. Powe Elementary School (EKPES), Durham, NC	Lynette Damon - 1st Grade Teacher	N/A
	Hannah Bohlen - 4th Grade Teacher	N/A
	Mary Dunbar - 3rd - 5th Grade Teacher (Exceptional Children's' Program)	N/A

CCCC has a two-acre plot is primarily for production and guided education. Little signage explains farm production methods, though the educators hope to add them in the future. Along with their field crops, and sparsely planted perennials, the college has a chicken coop; a mobile chicken tractor; a few hoop houses; a small compost pile; a small greenhouse attached to a central washing, processing, and community space; a small office/storage space attached to a small barn that acts as a tool and equipment (tractors, tillers, attachments, etc.) depository; and a lumber shed. The area also has multiple sitting areas that are conducive to teaching.

The CBDG is one-acre site which includes a water catchment "rain garden", a bioswale growing area on hillslopes, multiple raised beds, four 3-4 foot brick raised beds for children or for the elderly, up to 4 different “break out” spaces for smaller groups; a pergola with benches and picnic tables; a chicken coop; a washing and vegetable processing area; a large concrete and cinderblock composting area with 5 separate pile areas, and an old tobacco barn that serves as a storage area for tools and teaching equipment.

CPSC has growing spaces located around the perimeter of the school, the size of which change from year to year depending on how many teachers want to use them, and are generally no bigger than 10ft. x 5 ft. The school had raised beds, which are no longer in use due to construction, but will hopefully be used again next year. The school has a large rainwater catchment cistern, a pond, a few perennial plots of blueberries and figs and a plexi-glass root growth display case. Meg Millard is working on designing a compost system with her 2nd graders.

EKPES has two larger garden spaces, one in front and one in back, each with multiple raised beds. A smaller, newly started garden exists in the courtyard as well. Due to construction, the largest of the growing spaces, in the back of the school was not operational during the time of the interview. Plans exist for building a fence around this area and putting in a shed for tool storage.

3.3 Results

3.3.1 Institution Descriptions

3.3.1 (a) Central Carolina Community College (CCCC)

CCCC has one of the oldest sustainable agriculture programs in the country, started in 1995 (Kahanowhich 2009). The program offers a 2-year Sustainable Agriculture Associate’s degree, and certificates in Sustainable Agriculture, Sustainable Agriculture Livestock, and Sustainable Agriculture Vegetable Production. The program has five acres on campus, two of which are dedicated to production and also relies heavily on ties to sustainable farms in the community for student training. Interviewees described the program as an entrepreneurial, hands-on program that focuses on teaching people critical thinking and practical research skills. Hillary Heckler pointed out "it's not about knowing the answers it's about knowing where to go to get the answers."

3.3.1 (b) Charlotte Brodie Discovery Garden (CBDG)

At the time of the interview, the CBDG had been in operation for about 6 months. They offer three general types of programs: (1) school classes or other educational groups; (2) families that consists of individual classes or groups of classes; and (3) public "drop-in" events. The programming for children is designed for 1^{st}-8^{th} graders with a heavy focus on 1^{st}-5^{th}. The broad educational mission of the Sarah P. Duke Gardens (SPDG) is to get people engaged in and comfortable with nature and the CBDG offers a place that specifically focuses on sustainability and agriculture while adhering to this broader goal. Interviewees described their programming as "inquiry based" meaning that a problem or question is presented and participants are encouraged to figure it out. There are very few lectures and information is shared while touring and experiencing the garden.

3.3.1 (c) Central Park School for Children (CPSC)

Central Park School for Children is a pre-K-5^{th} grade public charter school. The school is year round starting in July. Teachers use the small amount of growing space to augment their existing curriculum on a voluntary basis. . A subset of schoolteachers formed an Outdoor Learning Committee that gathers resources and encourages other teachers to bring children outside whether in a garden plot or in a natural distant setting. For example, mostly in the spring, Sue Willis visits the garden once or twice a week to teach her 3^{rd} graders about soils and plants.

Multiple times a week for most of the year Meg Millard brings her 2nd grade students to her garden space to teach them about lifecycles. More generally both teachers used their garden space to teach about measurements, observation skills, healthy eating and environmental awareness.

3.3.1 (d) E.K. Powe Elementary School (EKPES)

E.K. Powe is a K-5th public elementary school. Michele Kloda, a parent volunteer, coordinates their garden space and helps teachers organize ways in which they can work the garden into their existing curricula. Similar to CPSC, teachers at EKPES use the garden space on a voluntary basis. Interviewees typically used the gardens throughout the year. Lynette Damon teaches her first graders about living organisms using visits to the garden about once a week throughout the year. Hannah Bohlen uses the garden with her 4th grade students in a small after school program and does not work it into her curricula. Mary Dunbar teaches her 3rd – 5th grade students about ecosystems in the garden primarily in the fall and with multiple visits a week in the spring. All three teachers use the garden to teach general subjects such as measurements, observations, and environmental awareness. Through diversity of planting in the garden, teachers also emphasize strongly that students try new types of food that are healthier.

3.3.2 Useful Advice

There were two major categories of advice that were useful for testing hypothesis #2; advice about infrastructure design and advice about program and curriculum design. Other areas of advice are outlined in the guide in Chapter 4.

3.3.2 (a) Infrastructure Design

Interviewees generally commented positively on the importance of effective demonstration plots as an important infrastructure teaching tool. Raised beds were generally praised. Lynette Damon spoke highly of their effectiveness when she said: “The raised beds gardens out there in the front are nice because the kids can sit on the wall while they're planting, but out here it gets really muddy.” Jason Holmes touched on the practicality of the beds for young and older people who may have trouble reaching the ground. “It is a great way to get height in your garden so you’re not bending over.” Table 8 explains the four important pieces of advice that emerged from the data.

Table 3.2 Specific Advice About Demonstration Plots: The four major pieces of advice about demonstration plots that emerged from interviews and observations.

Advice	Examples
Design plots like museum exhibit	There should be an overarching theme and each plot should be able to relate back to that overarching theme.
Make plots interactive	Involve something that moves or lifts
Design plots to not be in boxes	Think about having them mimic the landscape to create intrigue.
Provide ways for people with disabilities to access the plots	Create easy access paths and beds raised to 3 ft. high.

3.3.2 (b) Signage

Signage emerged as the second common theme in infrastructure design. Interviewees viewed the signage as highly effective as a teaching tool. A few examples of supportive comments include: “If you are bringing people through, some people are going to naturally access things by reading . . .” – by Sue Willis; and “I would include lots of written things and stuff like that. As a nation we're switching over to the common core curriculum, which is really big on nonfiction. So, including a lot of information that would be really cool, about what's growing, about what insects are around, stuff like that.” By Hannah Bohlen. Table 9 explains the nine important pieces of advice that emerged from the data.

Table 3.3 Specific Advice About Signage The nine major pieces of advice about demonstration plots that emerged from interviews and observations.

Advice	Examples
Write in a way that people with varying backgrounds can understand	Do not use too much technical "jargon" and explain simple agricultural terms
Write for your audience.	Write differently for children than you would adults, for scientists than you would for poets. If a wide variety of people will be visiting, think about having multiple explanations of the same thing.
Use signage to explain rules in a positively worded way.	Avoid writing, "Don't step on the beds." Instead, write, "Please stay on the paths."
Use signage to explain out of the ordinary things.	Make a sign for something that people might not see on other farms, or If you have interesting garden art.
Use chalkboards for communicating important information that may change.	Include things like the weekly weather, forecast, or weekly rainfall, or what you are planting or harvesting, or what pests might be out . . .
Use moveable signage to highlight seasonality.	A sign could say, "Smell Me!" that would go next to something that was in bloom, or "I'm ready!" for something that was harvestable.
Be cautious about information changing and being able to change information on signage quickly.	Design sign stands that are easily interchangeable and signs material that is easy to purchase.
Be aware of how people's questions or knowledge may change over time.	Keep up with the signage so that it reflects visitors' interests.
Using Quick Reference (QR) codes for mobile devices to link signage to a website.	Create a self-guided tour that a person with a smart phone could take scanning a code a demonstration plot.

3.3.2 (c) Program and Curriculum Design

Educators were asked what the most important management practices they think their students, or people in general, should know. Four out of five respondents answered the building of healthy soil as most important thing to teach about. Jason Holmes synthesized it well when he said that people should learn about “getting their soil right. From a management perspective, if your soil is not right, you are not going to be as you want to be.” On a functional perspective, Hillary Heckler spoke on teaching about, “. . . really health soil. . . How to achieve that in a garden or to ask your questions to ask a farmer when you’re buying.”

Respondents also mentioned these other topics but with less frequency: crop rotation, permaculture, cover cropping, composting and water.

3.4 Discussion/Conclusion

Our initial hypothesis that demonstration plots with informational signage would be an effective way of teaching was supported through these interviews. All interviewees were positive about their direct use of, or their vision of, demonstration plots. As a pedagogical tool, demonstration plots isolate an area of the garden and concentrate on one specific topic of the curriculum. A demonstration plot can function as the physical representation of one lesson in a whole curriculum. It is a small physical place in which learning topics can be discussed and referenced with hands-on learning. A series of demonstration plots that refer to each other and are based on a common theme could be will provide a way for visitors to physical walk through a whole curriculum.

Like the design of a museum exhibit, the design of demonstration plots and signage is important for their effectiveness. An effective museum exhibition has an overarching and simple theme that ties each smaller exhibit together (Serrell, 1996). Demonstration plots without signage can be useful on tours when a trained staff person can convey the salient features of the plot and interpret the key educational elements. However, this structure will not work if that trained staff person is not there. Furthermore, some learn better through reading or through visual cues. Even on a guided tour, the visual leaners will rely on signage to help anchor them to the subject matter. Signage will be a very important part of any SAE program with demonstration plots.

There was little evidence to support the assumption in our hypothesis that each demonstration plot should focus on one particular management practice employed on the farm. For example, although soil health was viewed as the most important topic to teach, it is mitigated by several factors that require several management practices. A SAE program could focus on soil health, and their demonstration plots could include a comparison of different soils to show what a healthy soil is, or steps needed in soil testing and soil quality assessment. In other words, it may not be necessary to teach about the individual management practices, rather it may be more important to teach more generally about what makes a soil healthy.

However, there was no evidence showing that using a demonstration plot to teach about one particular management practice would not be effective. A program might be able to use demonstration plots in this way as long as it was connected to a broader and larger topic as explained above. For example, a demonstration plot that focuses on cover cropping might work well as long as the signage related it back to the larger theme of building healthy soil.

The SAE program guide for the DCF suggests that demonstration plots with signage are effective teaching tools. It advises that a program should be structured around a central theme and that demonstration plots and signage should give visitors insight into a particular aspect of the program content while connecting them to that central theme. It also suggests that some of the plots can address specific management practices, but that others should address the central theme directly. Again using the soil health example, at least one plot should demonstrate and inform about what a healthy soil is and how it is defined. Subsequent plots could address related topics such as crop rotation or cover cropping, as long as the information on the signage related back to the theme of healthy soil.

Chapter 4 – Applying the Guide to the DCF

4.1 Introduction

This guide is designed to help educators design sustainable agriculture education (SAE) programs and implement them on farms, gardens or other growing spaces. Combining the extensive curricular analysis of post-secondary SAE courses with interviews and observations of local educators, this guide is designed to help the user develop ideas in the context of current major trends in SAE. It can be used to create whole programs, a suite of lessons, or just one class. The guide answers the questions: "What should I teach?" and "How should I teach it?" It has 4 main features; 1) a systematically organized view of options for teaching, 2) numerical data to help with decision making, 3) advice from local educators and 4) Readings associated with content categories. This sections outlines how this guide can be used with an example of a lesson that was created for the Duke Campus Farm.

There are two main sections of this guide. The first section covers features 1) and 2) above. It is the Programming for Education in Agriculture and Sustainability (PEAS) tool. It provides a detailed list of the hierarchy of subject matter found within each of the 14 content categories that emerged from the curricular analysis. It also provides a list of the tools and the approaches that are most connected to the content category, essentially offering options for how an educator might teach about it. Lastly, it provides a list of all the readings from the syllabi that are connected to each content category, and in some cases, sub categories. An assumption that the PEAS tool makes is the more frequently a particular content category, tool, or approach was repeated the more important it is to SAE. The Appendices give detailed explanations about each of the approaches as well as a complete list of tools and their various subcategories.

The second section of this tool is an organized list of advice from local educators. The PEAS tool is useful for thinking about what to teach and how to teach it on paper, and the advice section is useful for thinking about how a program might look like on ground and in action. Advice is listed in four different sections and educators are encouraged to read through each section and pull out what might be useful. The advice section is intentionally not ranked like the PEAS tool. Educators who are designing a class, a course, or a program will need to think about their (or their staffs) strengths as an educator(s) and their comfort level with teaching methods. The advice can be used to understand how others have taught in the past and how this might apply to a new program that an educator creates.

It is not always the case that an educator using this guide should pick that which is ranked highest in the PEAS tool. The two elements of the tool are intended to be used together.When the PEAS tool is combined with the local advice, an educator may become inspired to use an approach or a tool that is lower ranked. SAE is still being defined and it is driven by innovation and fresh ideas. This guide can serve as starting point for people who are interested in setting up a program.

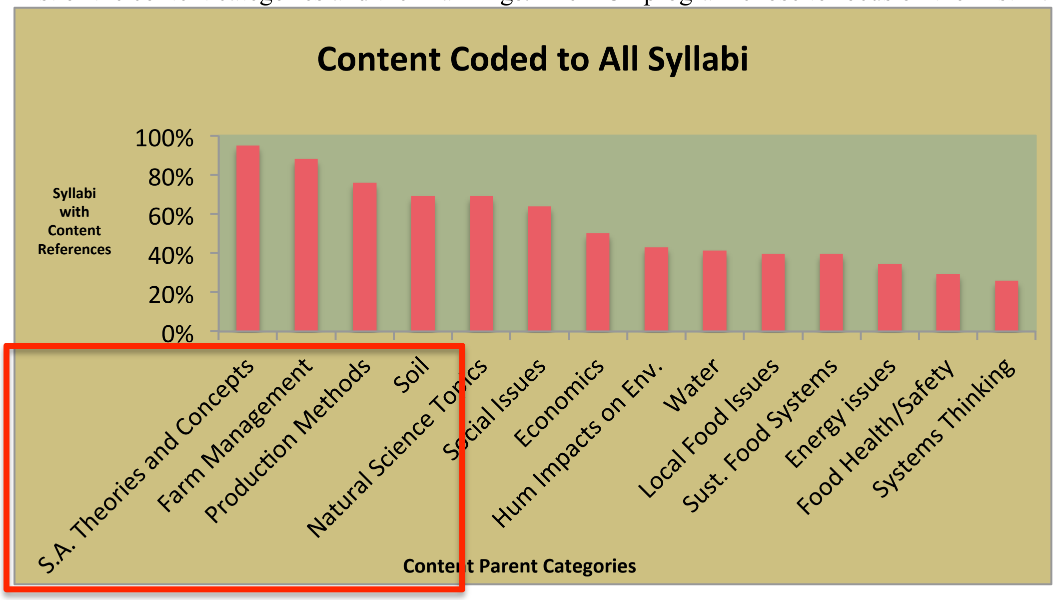
4.2 How to Use the Guide – Applying the Guide to the DCF

4.2.1 Choose the Content

When designing a program, a course, or a class, it is first important to choose which content to teach. The first page of the guide shows the different meta-categories of content, tools and approaches and how they were ranked amongst all of the syllabi. In the case of the DCF, we found it impractical to create a program that would encompass all 14 content categories, so we choose to focus on the first 5: Sustainable Agriculture Theories and Concepts, Farm Management, Production Methods, Soil and Natural Science.

Choosing Content

A list of the content categories and their rankings. The DCF program chose to focus on the first five.



4.2.2 Define Sub-categories, tools and approaches – The "What" and the "How"

The subsequent pages of the PEAS tool offers detailed information about each content category and their relationships to tools and approaches. It identifies the content sub categories about which you would like to teach, then the tools and then the approach that you might use. As an example, we can view the Content category of "Soils."

Content Sub-Categories

The PEAS tool offers an output of all the subcategories for each of the content categories.

5. Soil	
Categories	%
5. Soil	67%
Soil Management	34%
Defining Soil Fertility and Health	34%
Soil Chemistry, Biology and Ecology	17%
SOM	10%
Soil Properties	10%

The DCF decided that it would focus on all five of these sub categories: Soil Management; Defining Soil Fertility and Health; Soil Chemistry, Biology and Ecology, Soil Organic Matter (SOM), and Soil Properties.

Tools

A list of all of the tools associated with SAE and the rank of importance that it has with Soils.

Tools Associated with Soil	
Tools	%
Hands-On Experiences	21%
Traditional Academics	19%
Projects	5%
Farm Planning	3%
Videos	3%
Group Work	3%
CEAA	2%
Communications	2%
Reflecting and Processing	0%
Community Building	0%

It is evident that there are only two tools, Hands-On Experiences and Traditional Academics, that were strongly associated with Soil, so the DCF decided to use both of them.

Appraoches

A list of all of the approaches associated with SAE and the rank of importance that it has with Soils.

Approaches Associated Soil	
Approach	%
Experiential Learning	24%
Cooperative Learning	7%
Environmental Education	3%
Project Based	3%
Inquiry Based	2%
Traditional Academic	2%
Writing or Reflection	0%
Mindful Learning	0%
Multidisciplinary	0%
Service Learning	0%

There is only one approach, Experiential Learning, highly associated with Soils, so the DCF decided to employ it. To finalize Step 2, you can consult the appendices to learn more about the specific tools and approaches.

4.2.3 Apply the Advice

With the content, tools and approaches set, you can now search the advice section of the guide for useful information about implementing your education program, course or class on the ground.

In the case of DCF, it was useful to read advice about using raised beds, because we had already planned on using them. It was also useful to read advice about making demonstration plots interactive where something could either be touched or moved. This helped us decide to include multiple interactive elements of our soil plot. We decided to use plexi-glass fronts so people could see the rooting zones of the plants. We also decided to include a mason jar partially filled with our soil and water, so visitors will be able to view the sand, silt and clay make up of our soil.

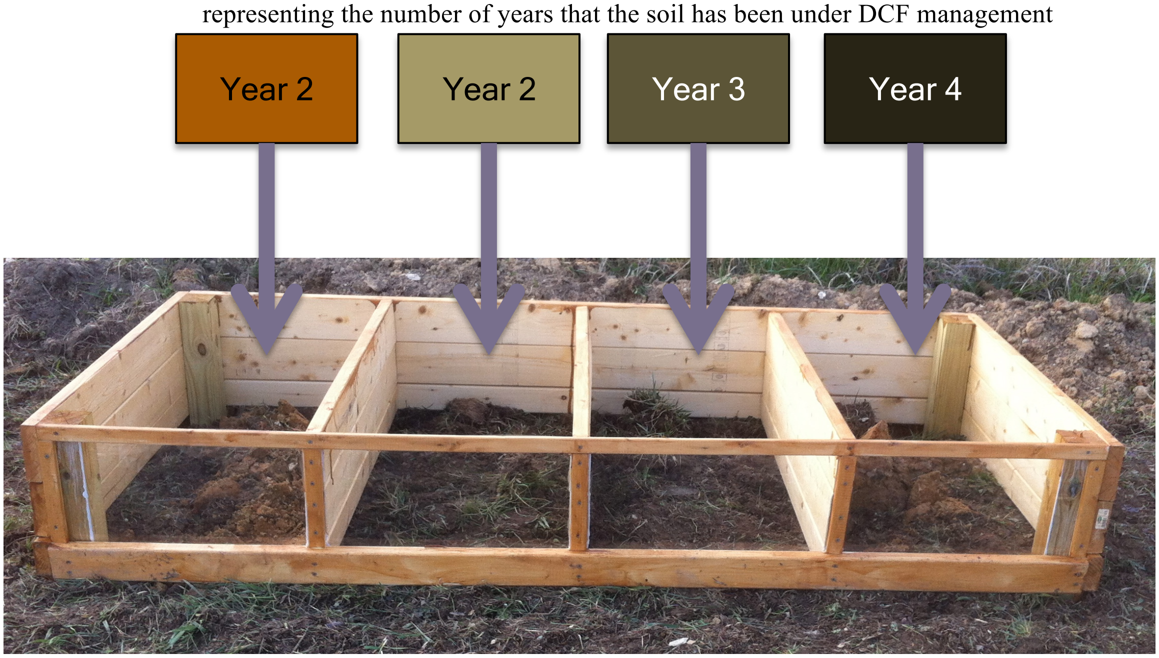
Advice about signage was particularly useful as well, from which we learned to write in a way that is appropriate for your intended audience. Because our audience is a very wide range of children to the elderly, we decided, based on this advice, to employ different levels of content coverage on the same sign. Each sign will be divided into different portions with some explanations that are easily understandable to a young inexperienced audience, perhaps a simple diagram of a soil profile, and some explanations that are more technical for an older more experienced audience, perhaps written explanation of how soil organic matter helps maintain soil structure.

4.2.4 Bring it all Together

The guide will help to make decisions, but it will not give a complete lesson plan. The specifics of the program will be up to you. In the case of how the DCF will teach about soil, I met with Dr. Dan Richter, Prof of soil and forest ecology the Nicholas School and shared the criteria that the PEAS tool developed and he helped me come up with the idea of mimicking how our soil has soil has been improved by our management practices over time. The demonstration plot will be divided into four sections and each box will have a higher concentration of nutrients and soil organic matter in it and visitors will be able to see how the rooting zones respond to these conditions. To learn the specifics about what a tour guide might say, or what to put on a sign, you can consult the associate readings in the third section. Figure __ shows the demonstration plot prior to the addition of the soil.

Combining the Soils Content with Advice to Create Demonstration Plots

Picture of the Soil demonstration plot on the DCF. Each box will have improved nutrient quality, illustrated here as representing the number of years that the soil has been under DCF management



4.3 The Guide in the Context of SAE

SAE is still relatively new and increasingly important as a growing population, dwindling natural resources and climate change are altering the needs of agriculture and requiring innovation and more sustainable production. It is also an extremely complex field as it sits at the intersection of many disciplines; Agronomy, Horticulture, Ecosystem Science, Ecology, just to name a few. Though the discipline of Agroecology works to define the science of sustainable agriculture, there is not yet a unified and agreed upon way to teach about the field. There are many different examples educators who are doing wonderful work at the post-secondary and k-12 level, but there is still a high amount of diversity in what is being taught and how it is being taught. Demand for, and interest in, SAE is on the rise and many places, such as student farms on college campuses, are eager to create programming. However, creating programming in the context of SAE involves assessing a large amount of different examples, which is difficult and time consuming. This guide is an attempt at a decision making tool that helps ease the decision making process.

Educators should be able to use it to help decided what to teach and how to teach it. The PEAS tool, which resulted from the curricular analysis, presents an organized view of the options of what to teach and how to teach it. Advice from interviews with local educators brings tested logistical considerations to the PEAS tool. My hope is that this guid will be useful for educators and also for the field of SAE. As SAE continues to grow, as more educators innovate along their content, tools and approaches, continued analysis of the field through curricular analysis and interviews will help to create a more focused and unified field of SAE. Food security in the future will depend on more sustainable agricultural practices. Education programs on farms, as well as other places, can be a powerful step to raising awareness about our food system and creating positive change.

Chapter 5 –The Sustainable Agriculture Education Program Guide for the Duke Campus Farm

5.1 The PEAS Tool

1. Sustainable Agriculture Theories and Concepts

Content Categories	%
1. Sustainable Agriculture Theories and Concepts	**93%**
Sustainable Agriculture Concepts	**91%**
Organic Concepts	41%
Organic Regulation Certification, and Transition	26%
Agroecosystems	40%
Agroecosystem analysis	22%
Global Sustainability and Ag	26%
Can Sustainable Agriculture Feed the World?	7%
Future and Sustainable Ag	22%
Food security,	17%
GMO and Biotech	16%
Population and crop production	12%
Consumer and Market Trends	12%
Transitioning to Sustainable Ag	10%
Cuba	9%
Urban agriculture	9%
Sustainability Concepts	**43%**
Triple Bottom Line	29%

Tools	%
Traditional Academics	48%
CEAA	31%
Hands-On	16%
Projects	7%
Communications	5%
Videos	5%
Farm Planning	3%
Group Work	2%
Reflecting and Processing	0%
Community Building	0%

Approaches	%
Experiential Learning	28%
Environmental Education	14%
Traditional Academic	14%
Cooperative Learning	9%
Mindful Learning	5%
Multidisciplinary	5%
Project Based	5%
Inquiry Based	3%
Writing or Reflection	0%
Service Learning	0%

2. Farm Management

Content Categories	%
2. Farm Management Practices	**88%**
Disease and Pest Management	**53%**
Pests and Pest Management	47%
Pesticides	16%
Integrative pest management	10%
Weed Management	**38%**
Farm Business Management	**36%**
Marketing	17%
Diversified Small Farm	5%
Value added products	5%
Farming for Profit	3%
Cropping Systems	**34%**
Crop rotation, cover cropping.	22%
Intercropping	17%
Nutrient Management	**33%**
Composting	24%
Mulching	7%
Farm Design	**26%**
Whole Farm Planning	5%
Tillage	**24%**
No-Till	7%
Agroforestry	**22%**
Industrial Agriculture	**22%**
Permaculture	**21%**
Harvest and Post Harvest	**19%**
Season Extension	**16%**
Greenhouse	10%
Conservation and Enhancement of Biological Control	**14%**

Tools

Tools	%
Traditional Academics	29%
Hands-On	34%
CEAA	9%
Farm Planning	10%
Projects	9%
Communications	2%
Videos	3%
Group Work	5%
Reflecting and Processing	0%
Community Building	0%

Approaches

Approach	%
Experiential Learning	45%
Environmental Education	19%
Project Based	7%
Cooperative Learning	5%
Multidisciplinary	5%
Traditional Academic	5%
Inquiry Based	2%
Service Learning	2%
Writing or Reflection	0%
Mindful Learning	0%

3. Production Methods

Content Categories		%
3. Production Methods		**74%**
Individual Crop Production Methods		**64%**
General Crop Production		43%
Transplants and Seeds		24%
Specific Crops		43%
Organic Crop Production		33%
Biodynamic Principles / Practices		10%
Animal Production Methods		**45%**
Alternative Animal Systems		26%
General Animal Production		21%
Dairy		7%
Organic Animal Production		14%

Tools	%
Traditional Academics	28%
Hands-On	24%
CEAA	2%
Farn Planning	0%
Projects	5%
Communications	2%
Videos	0%
Group Work	2%
Reflecting and Processing	0%
Community Building	0%

Approach	%
Experiential Learning	28%
Traditional Academic	12%
Environmental Education	10%
Cooperative Learning	3%
Inquiry Based	2%
Writing or Reflection	0%
Mindful Learning	0%
Multidisciplinary	0%
Project Based	0%
Service Learning	0%

4. Natural Science Topics

Content Categories		%
4. Natural Science Topics		**69%**
Ecology		**52%**
Diversity and stability		33%
Biodiversity		14%
Landscape Ecology,		26%
Disturbance and succession		10%
Ecosystem Services		21%
Carbon Sequestration		7%
Nutrient Cycles		19%
Population Ecology		17%
Community Ecology		12%
Plant Science		**26%**
Genetics		14%
Plant Nutrition		12%
Plant Pathogens		5%
Climate and Weather		**16%**
Insects		**9%**
Beneficial insects		5%
Plant – Arthropod Interactions		3%

Tools	%
Traditional Academics	26%
Hands-On	21%
CEAA	9%
Farm Planning	2%
Projects	2%
Communica tions	2%
Videos	0%
Group Work	2%
Reflecting and Processing	0%
Community Building	0%

Approach	%
Experiential Learning	22%
Environmental Education	10%
Cooperative Learning	5%
Traditional Academic	5%
Inquiry Based	2%
Mindful Learning	2%
Multidisciplinary	2%
Writing or Reflection	0%
Project Based	0%
Service Learning	0%

5. Soil

Content Categories	%
5. Soil	**67%**
Soil Management	34%
Defining Soil Fertility and Health	34%
Soil Chemistry, Biology and Ecology	17%
SOM	10%
Soil Properties	10%

Tools	%
Hands-On	21%
Traditional Academics	19%
Projects	5%
Farm Planning	3%
Videos	3%
Group Work	3%
CEAA	2%
Communications	2%
Reflecting and Processing	0%
Community Building	0%

Approaches	%
Experiential Learning	24%
Cooperative Learning	7%
Environmental Education	3%
Project Based	3%
Inquiry Based	2%
Traditional Academic	2%
Writing or Reflection	0%
Mindful Learning	0%
Multidisciplinary	0%
Service Learning	0%

6. Social Issues

Content Categories	%
6. Social Issues	**62%**
History	47%
Policy	31%
Equity and Fairness	33%
Social Justice	17%
Labor Issues & Worker Rights	5%

Tools	%
Traditional Academics	17%
Hands-On	3%
CEAA	2%
Farm Planning	0%
Projects	0%
Communications	0%
Videos	0%
Group Work	0%
Reflecting and Processing	0%
Community Building	0%

Approaches	%
Experiential Learning	7%
Environmental Education	5%
Project Based	3%
Mindful Learning	2%
Multidisciplinary	2%
Traditional Academic	2%
Cooperative Learning	0%
Inquiry Based	0%
Writing or Reflection	0%
Service Learning	0%

7. Economics

Content Categories	%
7. Economics	48%

Tools	%
Traditional Academics	26%
Hands-On	14%
CEAA	2%
Farm Planning	10%
Projects	5%
Communications	3%
Videos	2%
Group Work	0%
Reflecting and Processing	2%
Community Building	0%

Approaches	%
Experiential Learning	21%
Environmental Education	16%
Traditional Academic	12%
Inquiry Based	7%
Project Based	7%
Cooperative Learning	5%
Multidisciplinary	5%
Writing or Reflection	3%
Mindful Learning	3%
Service Learning	0%

8. Human Impacts on the Environment

Content Categories	%
8. Human Impacts on the Environment	41%
Climate Change	16%
Environmental Issues in Modern Agriculture	12%
Land use change	7%

Tools	%
Traditional Academics	17%
Hands-On	9%
CEAA	10%
Farm Planning	5%
Projects	2%
Communications	5%
Videos	2%
Group Work	2%
Reflecting and Processing	2%
Community Building	0%

Approaches	%
Experiential Learning	9%
Cooperative Learning	5%
Environmental Education	3%
Writing or Reflection	3%
Project Based	3%
Inquiry Based	2%
Mindful Learning	2%
Multidisciplinary	2%
Traditional Academic	2%
Service Learning	0%

9. Water

Content Categories	
	%
9. Water	41%
Irrigation	10%

Tools	
	%
Traditional Academics	9%
Hands-On	9%
CEAA	2%
Farm Planning	2%
Projects	0%
Communications	0%
Videos	3%
Group Work	0%
Reflecting and Processing	2%
Community Building	0%

Approaches	
	%
Experiential Learning	10%
Environmental Education	3%
Writing or Reflection	2%
Mindful Learning	2%
Project Based	2%
Traditional Academic	2%
Cooperative Learning	0%
Inquiry Based	0%
Multidisciplinary	0%
Service Learning	0%

10. Sustainable Food Systems

Content Categories	
	%
10. Sustainable Food Systems	40%

Tools	
	%
Traditional Academics	21%
Hands-On	5%
CEAA	5%
Farm Planning	0%
Projects	2%
Communications	2%
Videos	0%
Group Work	0%
Reflecting and Processing	0%
Community Building	0%

Approaches	
	%
Multidisciplinary	9%
Experiential Learning	7%
Traditional Academic	5%
Cooperative Learning	2%
Environmental Education	2%
Mindful Learning	2%
Project Based	2%
Inquiry Based	0%
Writing or Reflection	0%
Service Learning	0%

11. Local Food Issues

Content Categories	%
11. Local Food Issues	**40%**
Community-Based Food Systems	14%
Community Supported Agriculture	3%

Tools	%
Traditional Academics	16%
Hands-On	17%
CEAA	3%
Farm Planning	3%
Projects	2%
Communications	0%
Videos	2%
Group Work	3%
Reflecting and Processing	0%
Community Building	0%

Approaches	%
Experiential Learning	19%
Environmental Education	16%
Traditional Academic	7%
Cooperative Learning	5%
Writing or Reflection	3%
Multidisciplinary	3%
Inquiry Based	2%
Project Based	2%
Mindful Learning	0%
Service Learning	0%

12. Energy Issues

Content Categories	%
12. Energy issues	**33%**
Energy	14%
Biofuels	12%

Tools	%
Traditional Academics	7%
Hands-On	3%
CEAA	2%
Farm Planning	2%
Projects	0%
Communications	0%
Videos	2%
Group Work	0%
Reflecting and Processing	0%
Community Building	0%

Approaches	%
Experiential Learning	5%
Environmental Education	2%
Traditional Academic	2%
Cooperative Learning	0%
Inquiry Based	0%
Writing or Reflection	0%
Mindful Learning	0%
Multidisciplinary	0%
Project Based	0%
Service Learning	0%

13. Food Health and Safety

Content Categories	
	%
13. Food Health and Safety	29%
Nutrition and health	17%
Food Safety and Quality	7%
Food labels	5%

Tools	
	%
Traditional Academics	10%
Hands-On	5%
CEAA	0%
Farm Planning	0%
Projects	3%
Communications	2%
Videos	0%
Group Work	0%
Reflecting and Processing	0%
Community Building	0%

Approaches	
	%
Experiential Learning	5%
Cooperative Learning	2%
Environmental Education	2%
Mindful Learning	2%
Inquiry Based	0%
Writing or Reflection	0%
Multidisciplinary	0%
Project Based	0%
Service Learning	0%
Traditional Academic	0%

14. Systems Thinking

Content Categories	
	%
14. Systems Thinking	26%

Tools	
	%
Traditional Academics	5%
Hands-On	2%
CEAA	3%
Farm Planning	0%
Projects	0%
Communications	0%
Videos	0%
Group Work	0%
Reflecting and Processing	0%
Community Building	0%

Approaches	
	%
Experiential Learning	12%
Multidisciplinary	3%
Cooperative Learning	0%
Environmental Education	0%
Inquiry Based	0%
Writing or Reflection	0%
Mindful Learning	0%
Project Based	0%
Service Learning	0%
Traditional Academic	0%

5.2 Advice from Local Educators

1. Activities or Lessons

General Advice on Activities and Lessons

Advice	Examples
Students can benefit from taking things home with them.	Planting seedlings in small containers
Art projects can be great ways to engage students	Gluing designs on paper made out of seeds
With most grades, getting quantitative data, taking measurements, can be a very effective way to leverage the teaching power of a growing space.	Take measurements of plants, or rainwater, or soil depth
Cooking and eating, even if it is just herbs from the garden will usually engage even the most timid student.	Have students gather produce on the farm for a snack
Making written work, like brochures with facts about a plant, or poems, or stories can engage students.	Send students off to their own section of the farm to write a poem
Farms can be very useful for developing observational skills in students	Give students time to sketch or draw

Specific Advice on Lessons and Activities:

Advice	Examples
Drip Drop	An activity to demonstrate hydrology that the Charlotte Brodie Gardens does where students (usually 2nd and below) pretend to be a drop of water and follow the slopes of the land.
Write a letter to Congress	Pick an important agricultural issue and have participants write to their elected official about it
Salad Parties	These are where students grow their own food and then eat it. Call it a salad party and they will love it. This would be particularly good for students who were able to visit the DCF multiple times in a growing season. Once to plant, once to see it in progress and one last time to harvest.
Build your own soil	Find things around the farm of different particle sizes and combining them together to make soil.
Bug Identification	Hang up a clothesline with pictures of bugs that you might find on the farm, hand the cards out and have the kids find the bugs.
Insect houses	Cut a potato in half and carving it out so it makes a home will attract roly-polies and other small critters.
Seed dissection	A large seed like a sunflower seed, or corn. It can also be interesting to sprout seed and then dissect them.
Soil/plant growth experiments	Plant in different soil types to see different results of plant growth

Advice on Lesson Ideas for Adults

Advice	Examples
Offer science based classes	A class on soils, or on human impacts on the environment
A lesson on energy and energy loss	Bake potatoes and then build a shelter for the potato and measure the heat loss.

2. Infrastructure Design

Raised Beds and Demonstration Plots

"The raised beds gardens out there in the front are nice because the kids can sit on the wall while they're planting, but out here it gets really muddy." – Lynette Damon

"It is a great way to get height in your garden so you're not bending over." – Jason Holmes

Specific Advice About Demonstration Plots

Advice	Examples
Design plots like museum exhibit	There should be an overarching theme and each plot should be able to relate back to that overarching theme.
Make plots interactive	Involve something that moves or lifts
Design plots to not be in boxes	Think about having them mimic the landscape to create intrigue.
Provide ways for people with disabilities to access the plots	Create easy access paths and beds raised to 3 ft. high.

Signage

"If you are bringing people through, some people are going to naturally access things by reading . . ." – Sue Willis

"I would include lots of written things and stuff like that. As a nation we're switching over to the common core curriculum, which is really big on nonfiction. So, including a lot of information that would be really cool, about what's growing, about what insects are around, stuff like that." Hannah Bohlen.

Specific Advice About Signage

Advice	Examples
Write in a way that people with varying backgrounds can understand	Do not use too much technical "jargon" and explain simple agricultural terms
Write for your audience.	Write differently for children than you would adults, for scientists than you would for poets. If a wide variety of people will be visiting, think about having multiple explanations of the same thing.
Use signage to explain rules in a positively worded way.	Avoid writing, "Don't step on the beds." Instead, write, "Please stay on the paths."
Use signage to explain out of the ordinary things.	Make a sign for something that people might not see on other farms, or If you have interesting garden art.
Use chalkboards for communicating important information that may change.	Include things like the weekly weather, forecast, or weekly rainfall, or what you are planting or harvesting, or what pests might be out . . .
Use moveable signage to highlight seasonality.	A sign could say, "Smell Me!" that would go next to something that was in bloom, or "I'm ready!" for something that was harvestable.
Be cautious about information changing and being able to change information on signage quickly.	Design sign stands that are easily interchangeable and signs material that is easy to purchase.
Be aware of how people's questions or knowledge may change over time.	Keep up with the signage so that it reflects visitors' interests.
Using Quick Reference (QR) codes for mobile devices to link signage to a website.	Create a self-guided tour that a person with a smart phone could take scanning a code a demonstration plot.

Teaching Space

"There are a lot seating areas and gathering spaces that were designed into [the Charlotte Brodie Discovery Gardens]. That helps us work with really large groups. . . . ."
– Kavanah Anderson

Specific Advice about Teaching Space

Advice	Examples
Create different spaces for multiple smaller groups	Areas should be differentiated by something that will block vision and/or sound
More space is always welcome	Clear out multiple spaces for groups
Outdoor classrooms with chalkboards are very useful	A covered area for shade
Keeping thing accessible for those with physical disabilities should be a priority	Even paths and high raised beds

3. Participant Management

Specific Advice about Participant Management:

Advice	Example
Splitting students into smaller groups can be very useful	Groups of 5-7 are ideal
It is particularly useful to have parent volunteers come with large groups and with younger groups.	Think about making a chaperone requirement for large groups
Students may need some centering exercises from time to time to help them stay focused.	This can be a calming thing, or it can be a time when they get to move around
It can be useful to "pulse in and out of the classroom."	This means multiple times of going into the growing space, and experiencing something and then going back to a classroom to learn about it.

4. Program and Curriculum Design

Age Group Advice

Advice	Example
DCF should be familiar with the State Standards for all grades, particularly in the subjects of science and math.	Talk with teachers ahead of time to understand what students are learning. Read the DCPS science and math standards for each grade
Younger kids, 3rd and below, can benefit from props	Giant pictures of bugs that might be found on the farm would help them.
Older kids, 4th and above, can deal with things more conceptually	Present larger ideas, or complex problems to be sovled
2nd graders learn about life cycles in their science classes	Often taught through insect life-cycle or plant life-cycle.
Younger kids, 2nd/3rd and below, tend to have shorter attention spans	Plan for shorter lessons with more hands-on time
Younger kids, 6th and below, will benefit from having moving parts or watching something move in a demonstration. They are less likely to pay attention when everything is still.	Create demonstration plots that have moveable parts. Create quick science experiments that are interactive
4th graders in DPS don't' really have any science that could connect to the garden. They do, however, focus heavily on history, and brining history into an on farm lesson might be a good idea.	Learn about the local history of the farm and how that integrates with the time period that students are studying
Keeping things hands-on and active for kids makes it more likely that they will be able to focus.	Take breaks for interactive teaching elements in between lectures or discussions.

Content

Educators were asked about what the most important management practices about which they think their students, or people in general should know. Four out of the five people who gave an answer for this question talked about how building healthy soil was the most important thing to teach about. Jason Holmes, synthesized it well when he said that people should learn about,

".. getting their soil right. From a management perspective, if your soil is not right, you are not going to be as successful as you want to be."

And from a more functional perspective, Hillary Heckler spoke on teaching about, ". . . really health soil . . . How to achieve that in a garden or to ask your questions to ask a farmer when you're buying."

Other things people mentioned with much less frequency were: Crop Rotation, Permaculture, Cover Cropping, Composting, and Water.

Program Goals

There was a large emphasis on developing observation skills in students:"So we have gone outside and just listened. And you know how many sounds are you hearing that natural sounds and whatever sound to you? Observing nature." – Meg Millard

Specific advice about program goals

Advice	Examples
Teaching through inquiry can be very effective	Asking participants to figure out a solution to a problem instead of telling them the answer
Building a knowledge base within participants of where they can get answers to their future questions	Provide resources for them to access after they leave
Giving people time to play in the dirt	It is important that people engage with the growing process. Have them plant, weed, harvest, or do something to get their hands in the dirt

Program Planning

Specific Advice about things to think about when starting to plan a new program

Advice	Examples
Often, starting with a hands-on experience can get people learning quickly	Start a lesson with a mindful observation of eating something that grows on the farm
Always plan for people to have different levels of entry into you programming	Some might be deeply invested in learning about things, and others may just be there to see if they are interested in the subject
Classes that meet more than once can be better for learning retention than classes that just meet once	Provide multiple classes on the same subject
Programming should always be adaptable.	Groups may come in and already know a lot about the subject material. Make sure that you have a backup plan.
Particularly with adults it is useful to ask around and see what people want to learn about before setting programming.	Survey people in the community before a season of workshops or classes.

5.3 Reading Associated with Content

Sustainable Agriculture Theories and Concepts

Sustainability Concepts

Plan B 4.0: Mobilizing to Save Civilization by Lester R. Brown.

Ishmael by Daniel Quinn,

Operationalizing the concept of sustainability in agriculture: characterizing agroecosystems on a multi-criteria, multiple scale performance space. 2001. M.Giampietro and G. Pastore. In Agroecosystem Sustainability: Developing Practical Strategies. ed. S.R. Gliessman. p.177-202.CRC Press, Boca Raton, FL

Earles, R. 2005. Sustainable agriculture: An introduction. ATTRA Publication no. IP043. National Center for Alternative Agriculture, U.S. Department of Agriculture, Butte, MY.

Jordan, C. F. 1998. Working with nature: resource management for sustainability. Taylor and Francis, New York, NY

Leopold, A. 1949. A land ethic. In R. Nash (Ed). American environmentalism: readings in conservation history. McGraw-Hill, New York, NY. P. 171-174.

Sustainable Agriculture Concepts

Oppenheim (2001). Alternative Agriculture in Cuba.

Trewavas (2001). "Urban myths of organic farming."

NCAT

Sustainable Agriculture: An Introduction - IP043

Applying the Principles of Sustainable Farming - IP107

Hurt, R. Douglas. 2002. Problems of Plenty: The American Farmer in the Twentieth Century. Ivan R. Dee: Chicago.

Canby, Peter. 2010. Retreat to Subsistence. The Nation. June 16. Available at: http://www.thenation.com/article/36330/retreat-subsistence

DeVore, Brian. 2002. “Why Do They Do It?” (pp. 107-118) in Jackson, Dana L. and Laura L. Jackson (eds). The Farm as Natural Habitat. Washington DC: Island Press.

Jackson, Laura. 2008. Who Designs the Agricultural Landscape? Landscape Journal 27: 1-08.

Leopold, A. First published in 1939. Farmer as Conservationist. Pp. 161-175 in Aldo Leopold: For the Health of the Land, Previously Unpublished Essays and Other Writings. 1999. J.Baird Callicott and Eric T. Treyfogle (eds). Washington, DC: Island Press.

Leopold, Aldo. 1949. Illinois Bus Ride. Pp. 117-119 in Sand County Almanac.

The Omnivore's Dilemma, by Michael Pollan

Reconciling agricultural productivity and environmental integrity:

Energetics and ecosystem integrity: The defining principles of sustainable agriculture. 1991. T. Crews, C. L. Mohler, A. G. Power. American Journal of Alternative Agriculture. 6(3): 146-149

P.Allen, D. Van Dusen, J. Lundy, & S. Gliessman. 1991. American Journal of Alternative Agriculture. 6(3): 34-39.

Raman. 2006. Agricultural Sustainability: principles, processes, and prospects. Hawarth Press.

Pollan. 2006. The Omnivore's Dilemma. Random House

Leopold, A. 1949. A land ethic. In R. Nash (Ed). American environmentalism: readings in conservation history. McGraw-Hill, New York, NY. P. 171-174.

Lyson, T.A. 2004. Civic Agriculture. Tufts University Press, Lebanon, NH. P. 12-24. Magdoff, F. 1992. Building soils for better crops. University of Nebraska Press, Lincoln, NE. <http://www.sare.org/publications/bsbc/bsbc.pdf>

Pringle, P. 2003. Food, Inc. Simon and Schuster, New York, NY. p. 243. (selected pages).

Lehman (2002). This American meal... ▸" 01(b) Reganold et al. (1990). Sustainable agriculture.

Hurt (2002). Chapter 8. Days of uncertainty. From American Agriculture, A Brief History.

King (1911). Farmers of Forty Centuries.

Pollan (2008). (excerpt). In Defense of Food, an Eater's Manifesto

Why don't we have more sustainable farmers? By Dick Levins 2000 (handout)

Cox T.S., Picone C. and Jackson W. (2004) Research priorities in natural systems agriculture. Journal of Crop Improvement 12: 511.

Civic Agriculture: Reconnecting Farm, Food and Community. 2004. Thomas A. Lyson. Tufts University Press, Medford, MA. ISBN 1-58465-414-7.

Agroecosystems

Gliessman, Stephen R. 1998. Agroecology: Ecological Principles in Sustainable Agriculture. Boca Raton, FL: Lewis Publishers (NOTE: this is a rental textbook) Additional information, incl. case studies may be found on the agroecology website maintained by the Agroecology program at UC-Santa Cruz (http://www.agroecology.org/).

Clemens and Anil Shresta. 2004. New Dimensions in Agroecology. Haworth Press. 3. Current articles and related readings may be assigned as deemed appropriate as supplemental reading for this course. Students are encouraged to bring appropriate material and share it with the class.

Miguel Altieri. 2002. Agroecology: The science of natural resource management for poor farmers in marginal environments. Agriculture, Ecosystems and Environment 93: 1-24.

Defining Agroecology:

Swinton, Scott. 2008. Reimagining farms as managed ecosystems. Choices. 23(2): 28-31.

Gliessman, S. 2004. Chapter 2, Agroecology and agroecosystems. In D. Rickerl and C. Francis, (ed.) Agroecosystems Analysis. American Society of Agronomy, Madison , WI .

Flora, C. Chapter 7, Community dynamics and social capital. In D. Rickerl and C. Francis, (ed.) Agroecosystems Analysis. American Society of Agronomy, Madison , WI .

Kirschenmann, F. Chapter 11, Ecological morality: a new ethic for agriculture. In D. Rickerl and C. Francis, (ed.) Agroecosystems Analysis. American Society of Agronomy, Madison , WI .

Leopold, Aldo. 1993. The farmer as a conservationist. In S. L. Flader and J. Baird Callicott, (ed.) The river of the mother of God and other essays. The University of Wisconsin Press, Madison , WI .

Francis, C.A. and Porter, P. 2011. Ecology in sustainable agriculture practices and systems. Critical Reviews in Plant Sciences. 30:1, 64-73 DOI: 10.1080/07352689.2011.554353. URL: http://dx.doi.org/10.1080/07352689.2011.554353

Agroecosystem Analysis Models:

Conway, G. 1990. Concepts. Ch 2. In Agroecosystem analysis for research and concepts. Winrock Int. Inst. for Agriculture. Morrilton, AK .

Bland, B. 2005. A framework for enquiry into agricultural systems.

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Francis, C. 2005. Cobweb polygons (spider diagrams) for visual display of sustainability.

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Michigan Field Crop Ecology E2704 - Michigan Field Crop Pest Ecology

The Properties of Agroecosystems. G. R. Conway. 1987. Agricultural Systems. 24:95-117.

Detritus Food Webs in Conventional and No-tillage Agroecosystems. Hendrix, P.F., R. W. Parmelee, D.A. Crossley Jr. D.C. Coleman, E.P. Odum, and P. M. Groffman. 1994. Bioscience. 36, No. 6: 374-386.

Agroecology: The ecology of sustainable food systems. S Gliessman. 2nd ed. CRC Press • Crop Ecology: Productivity and management in agricultural systems. RS Loomis & DJ Connor. 1992. Cambridge University Press.

Ecological Principles of Agriculture, by Laura Powers and Robert McSorley.

Agroecology: The Ecology of Sustainable Food Systems, by Stephen Gliessman.

Gliessman, S.R. (2006) Agroecology: Ecological Processes in Sustainable Agriculture (Second Edition). CRC Press.

Altieri, M. A. (1995). Agroecology: the science of sustainable agriculture. Westview Press: Boulder, CO, USA.

Clements, D., & Shrestha, A. (Eds.). (2004). New dimensions in agroecology for developing a biological approach to crop production. Food Products Press: Binghamton, NY.

Gliessman, S.R. (2007) Agroecology: the ecology of sustainable food systems. Second Edition. CRC Press: Boca Raton, FL.

Vandermeer, J. H. (2009). The ecology of agroecosystems. Jones & Bartlett Publishers: Sudbury, MA.

Wezel, A., S. Bellon, T. Dore, C. Francis, D. Vallod & C. David (2009) Agroecology as a science, a movement and a practice. A review. Agronomy for Sustainable Development 29: 503-515.

Méndez, V. E. (2010). Agroecology. In B. Warf (Ed.), Encyclopedia of Geography. Thousand Oaks, CA: Sage Publications (in press).

Rosset, P., & Altieri, M. A. (1997). Agroecology versus input substitution: a fundamental contradiction in sustainable agriculture. Society and Natural Resources 10: 283-295.

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De Schutter, Oliver, U.N. Special Rapporteur on the Right to Food. Agroecology and the Right to Food. Special Report A/HRC/16/49. 20 December, 2010. Available at: http://www.srfood.org/index.php/en/documents-issued

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Alkon, A. and T. Mares (2012) Food sovereignty in US food movements: radical visions and neoliberal constraints. Agriculture and Human Values 29(3): 347-359.

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Extension: Considerations for Design - IP416

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Organic Greenhouse Vegetable Production - IP078

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Enhancing the competitive ability of crops.

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1. Notes on Organic Farming and Gardening (Required)

An Overview of Organic Crop Production (Read What is Organic Agriculture through Summing Up- follow the arrows to get from one to the next)

http://attra.ncat.org/attra-pub/organiccrop.html

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Hidden treatments in ecological experiments: re-evaluating the ecosystem function of biodiversity. Huston, M.A. 1997. Oecologia 110:449-460. on the web:

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Michael Pollan Botany of Desire

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National Center for Appropriate Techonology (NCAT)

SOIL AND FERTILITY MANAGEMENT: A Brief Overview of Nutrient Management in Pastures - IP221

Sustainable Soil Management - IP027

Drought Resistant Soil - IP169

Agroecology: The Ecology of Sustainable Food Systems, 2nd edition, by Stephen Gliessman

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An Essay on Farm Income by Dick Levins (link) http://agecon.lib.umn.edu/cgi

The Real Costs of Globalization to Farmers, Consumer and Our Food System by John Ikerd http://www.sfa-mn.org/pages/realcosts.html

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Water

NCAT

Soil Moisture Monitoring: Low-Cost Tools and Methods - IP277

Maintaining Irrigation Pumps, Motors, and Engines - IP299

Measuring and Conserving Irrigation Water - IP280

Energy Saving Tips for Irrigators - IP278

Keeping the Stygian Waters at Bay by Dan Ferber 2001 (handout)

A Sustainable Agriculture Project at Chesapeake Farms: a six-year summary of weed management aspects, yield, and economic return by Van Gessel et al. 2004 (handout)

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and Erin Macdougall. 2009. Aligning Food Systems Policies to Advance Public Health

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Appendix 1. – Description of Approaches

1. Experiential Learning

Born from pragmatist thinkers of the early 20th century like John Dewey and William James, experiential learning theory (ELT) recognizes the importance of the individual's learning process. Formalized in by (Kolb, 1984), ELT proposes a learning cycle that all minds must go through in order to learning (Felder and Brent, 2005; Kolb, 1984; Kolb and Kolb, 2005) This cycle has 4 distinct phases; concrete experience, reflective observation, abstract hypothesis and active testing (Kolb, 1984; Kolb and Kolb, 2005) Though all four phases of the cycle need to be fulfilled for learning to happen, a learner may have a strong proclivity towards one particular part of the cycle and this is the place at which it is best for them to start (Kolb, 1984; Kolb and Kolb, 2005) An educator that employs ELT as a pedagogical approach will recognize these differences in her or his students and offer pedagogical tools that serve all four phases of the ELT cycle (Felder and Brent, 2005)

I coded for ELT as a pedagogical approach using the 4 phases of the ELT cycle as criteria. A great example offered to me was in reference to a student riding a bike (Cagle, 2003). A concrete experience might be a student seeing someone ride a bike. Reflective observation may involve a student writing, drawing about the bike or thinking that she or he might like to ride a bike. An abstract hypothesis might be a student attempting to figure out how the gears on a bike work. And active testing would involve a student riding the bike.

2. Environmental Education

In 1976 the Belgrade Charter was adopted by the United Nations and it proposed:

"The goal of environmental education is to develop a world population that is aware of, and concerned about, the environment and its associated problems, and which has the knowledge, skills, attitudes, motivations, and commitment to work individually and collectively toward the solutions of current problems and the prevention of new ones" (Belgrade Charter, 1976)

In the almost 40 years since, environmental education (EE) in the U.S. has become a powerful tool for non-formal educational programs at places like summer camps, national parks, nature centers, zoos, public gardens, etc. (NAAEE 2004), The North American Association for Environmental Education (NAAEE) published its Non-Formal Environmental Education Programs Guidelines to Excellence. In it they emphasize that EE is based in promoting student awareness of environmental surroundings, and using local environmental examples to help students develop skills to make connections and problem solve in larger systems (NAAEE 2004).

I coded for EE as a pedagogical approach using three main criteria; place-based learning, nature connection, and indigenous knowledge. Place based learning is education that is specific to a small localized geographical region and it generally seek to engage students with issues and research problems in that region (Smith and Sobel, 2010). Nature connection seeks to engage students within their natural environmental and promote introspective reflection on the human role in the environment (Young 2013). Indigenous knowledge is simply using knowledge of indigenous peoples, current and historical to help better understand environmental issues in modern society.

3. Cooperative Learning

Cooperative Learning is a pedagogical approach that relies on the power of small groups and group dynamics in education (Oakley et al., 2004). Touted for its ability to engage students at and increase classroom effectiveness, Johnson and Johnson point out that it is not just a matter of putting students into small groups (1990). Referencing Johnson and Johnson (1987), Ballantine and Lares (2007) note that the following factors must be present to create a true cooperative learning environment: positive interdependence, individual accountability, face-to-face interaction, social and small group skills, and group processing.

4. Multidisciplinary

A multidisciplinary approach is often described in the professional world as a group of people from different disciplines coming together to solve problems (Pirrie et al., 1999). Harden (1998) helped to shape and define this approach by creating an 11-stage continuum that expresses the level of integration that one must have to be truly multidisciplinary. This continuum starts with isolation, where one is limited to her or his own field, and ends with "transprofessional" where all multidisciplinary learning is integrated into the real world (Harden 1998). Multidisciplinary education is defined when "Each profession looks at themes from the perspective of its own profession" (Kveraga and Jones, 2011). Kveraga and Jones (2011) dissuade us from thinking that multidisciplinary education refers to any time more than one discipline is represented and point out that Harden's continuum gives strict parameters to the definition of this type of approach.

<u>5. Learning Through Writing and Reflection</u>,

The concept of learning through writing and reflection began as an alternative to traditional academic approaches and focuses on assessing learning though personal reflection through writing (Smith and Sobel, 2010). Students are given time in class, or assignments outside to class through which they consider what they have learned and how it relates to them. These are often in journals or portfolios (MacIsaac and Jackson, 1994). Studies generally show that this is an effective tool for assessment and that students increase their ability to go deeper into reflection as they continue to write (Brown, 1998; Lew and Schmidt; Molee et al., 2010; Smith, 2002)

<u>6. Inquiry Based</u>

In 1998, the Boyer Commission (Boyer Commission, 1998) pressed the need for more research opportunities in undergraduate education. Inquiry-based learning focuses on engaging students in real research questions in order that they develop skills such as critical thinking, framing research questions, reflectivity and creativity (Walkington et al., 2011). The goal for Inquiry Based learning is for students to become reseachers and bring new knowledge to the world (Wilson and O'Regan, 2007)

<u>7. Mindful Learning</u>,

Mindfulness, a popular concept today, can have multiple meanings ascribed to it from spiritualists like Tich Naht Han, to popular psychologists like Pema Chodron. It can be seen in various sectors like health and business and is often applied as solutions to social problems (Langer and Moldoveanu, 2002). In the context of education, a working definition is leveraged off of three major pivot points: looking closely, exploring possibilities and perspectives and introducing ambiguity (Ritchhart and Perkins, 2000).

<u>8. Project Based</u>,

Just as Cooperative Learning does not happen anytime that students work together, Project Based learning, has a specific set of criteria that does not make every project part of a Project Based approach. A project based approach centers around an actual issue or a problem (Morgan, 1983). Students engage with and work on this problem during multiple class sessions, outside of class and often over the course of the semester (Cagle, 2013).

Evidence shows that with the educator serving as guide, the more control that students have over the project, the more effective a project based approach will be (Kalayci, 2008).

<u>9. Service Learning</u>

Though the concept of colleges and universities giving back to society is a long standing tradition in the U.S., the concept of service learning has been a topic in education for the two decades. Service learning involves students performing tasks (service) that serve and needed purpose and are related to class subject matter and then reflecting on this work and relating it back to the course content. (Felten and Clayton, 2011). In service learning we see notes of at least two other pedagogical approaches; Experiential Learning and Writing and Reflection. In fact, it is well accepted that the roots of service learning lay in John Dewey's philosophy on integrating knowledge and skills, which is the same philosophy that drives Experiential Learning (Ehrlich, 1996).

<u>10. Traditional Academic</u>

Though popularity in pedagogies shift, there is an enduring ethos of canonical teaching at the post-secondary level. To code to Traditional Academic, I looked for instances of syllabi referencing things that our modern cultural paradigm would expect every class to have. These were instances of reading, writing, lectures, discussions, exams, critical thinking and case studies

Appendix 2. – Hierarchy of Tools

Pedagogical Tools		Sources 58	References %
1. Traditional Academic		54	93%
Lecture		45	78%
guest lectures,		21	36%
Reading		43	74%
Reading Articles		23	40%
Unspecified readings posted to course website		15	26%
Reading Textbooks		16	28%
Gliessman		10	17%
Reading Humanities or Journalistic		12	21%
Reading Instructional Media		12	21%
Discussion		29	50%
Writing		29	50%
Reaserch Paper or Term Paper		8	14%
Online discussions and assignments.		4	7%
Exams		23	40%
Case Study		21	36%
Synthesis		7	12%
Critical thinking		6	10%
2. Hands-On experiences		42	72%
Field Trips		31	53%
Lab		25	43%
Participation in production		11	19%
Conferences		5	9%
Workshops		4	7%
3. Comparisons, Evaluations, Assessments and Analyses		36	62%
Measuring Sustainability		18	31%
Agroecosystem analysis		12	21%
Comparisons to Natural Ecoystems		6	10%
consider multiple perspectives		6	10%
4. Projects		28	48%
5. Communications Assignments		27	47%
Presentations		25	43%
Interviews		7	12%
Student-Led Discussions		5	9%
debate		1	2%
6. Group work		23	40%
7. Reflection and Processing Learning		21	36%
Journaling		12	21%
Personal Connection to SA		9	16%
8. Farm Planning Assignments		17	29%

9. Videos		10	17%
10. Community Building		8	14%

Appendix 3. –Interview Questions for Administrators, Professors, or Teachers.

1. Can you describe your overall program or curriculum? What are your goals, what do you hope that students get out of it?

2. What do you see most of your students doing with the knowledge that they gain about sustainable agriculture?
    a. How do you design your program, courses, and content to reach those goals?

3. Can you tell me about the pedagogy that drives your program?

4. Can you tell me about the curriculum design that drives your program?

5. Can you tell me about the content that drives your program?

6. Can you tell me about how the physical infrastructure works with your program?

7. Are there infrastructure elements that you would like to change that you think would better facilitate a learning environment?

8. Do you measure the effectiveness of your program?
    a. If so, how?

9. What are your most successful practices in SAE?
10. How do you define sustainable agriculture?

11. Are there any areas where you'd like to see improvement in your program/curriculum?

12. Are there ways in which students learn when not being guided by a teacher?

13. What are some things that you think all people should know about sustainable agriculture?

14. My proposed concept is demonstration plots with information posters, each teaching about a different management technique. What do you think about this?

15. What are the management practices that you think most people would need to learn about in order to manage their farm/ garden more sustainably?

16. Who are the key people here that I might talk to about my project?

Appendix 4

Consent For Personal Interview – Professor / Teacher

Creating a Sustainable Agriculture Education Curriculum for the Duke Campus Farm

Duke University Nicholas School of the Environment

About the Study

I am a 2013 Master's of Environmental Management candidate at the Nicholas School of the Environment at Duke University. This study is being conducted as a part of my Master's Project. My advising professor is Dr. Chantal Reid. This study will span a 3-4 month long period and will culminate in a report that will be presented to my colleagues and professors at the Nicholas School as well as interested parties in your institution. The final product of this study will be a curriculum and infrastructure design that will be implemented on the Duke Campus Farm.

Reason for the Study:

This study will research current methods used in sustainable agriculture education (SAE) to develop a SAE curriculum for the Duke Campus Farm (DCF).

Your Role in this Research

This study involves research of different sustainable agriculture education programs. You are being asked to participate in an interview. The interview will take about 30 minutes. In this interview I will ask you about the pedagogy, curricular design, curricular content, infrastructure design, metrics for goals outcomes and perceived effectiveness of your SAE program or curriculum. You are being asked to sit with me and respond to questions while being recorded by an audio recording device (no video will be taken) as well as my own hand-written notes. I will transcribe your interview and keep a record of it so that I can analyze it for information, trends, and insights. Your interview can be kept anonymous in the final report if you so desire. The audio file will not be included in the final report. If you do not wish for the audio recording, then I will take hand written notes during the interview.

Your participation in this research is voluntary. I am not able to offer you monetary compensation.

Confidentiality and Discontinuation

You have the option of maintaining your confidentiality. If you so desire I will change your name and the name of your organization in the final report.

You have the option to end the interview at any time and you are free to skip questions you don't want to answer. If you to choose to stop the interview before we reach the end of it, then any information you have given prior to stopping will be used unless you do not want it to be used.
You have the option to refuse this interview.

Benefits and Risks

There are no direct benefits to you for participating in this research. I do not anticipate any risks to you as a result of participating in the research. There are also no perceived risks for you in participating in this study.

Contacts for more information

You are welcome to have access to my final report and any information used to complile the report, as well as access to the SAE curriculum developed for the Duke Campus Farm. You are also welcome to visit the DCF upon the completion of this project to view the curriculum and infrastructure design that is created out of this study.

Please contact Damon Cory-Watson for more information about the study (information below), or Dr. Chantal Reid (information below). If you have questions about your rights as a participant in this research, you may contact the Chair of the Duke University Institutional Review Board (information below).

Please complete the information below.

I have read the information in this consent form and have been given the opportunity to discuss it and ask questions. **Please check or "X" the box if you agree and leave blank if you disagree.**

[ ] I allow for audio to be recorded during the interview
[ ] I allow my name and the name of my school to be used in the research

Name (printed)___________________________________
Signature: ______________________________
Date:__________________

Professor:	Researcher:	Duke Univeristy Institutional Review Board:
Chantal Reid	Damon Cory-Watson	919.684.3030
chantal@duke.edu	dtc8@duke.edu	ORS-info@duke.edu