Students Develop Compost Management Skills through Experiential Learning[1]

R.C. Bott[2] and E.L. Cortus[3]
South Dakota State University
Brookings, SD

Abstract

It is critical for college graduates to enter the workforce not only knowledgeable in a topic area, but also confident in their ability to apply their knowledge. Manure management is a major component of livestock production, including horses. Faculty from South Dakota State University's (SDSU) Animal Science and Agricultural and Biosystems Engineering departments partnered to develop an experiential learning opportunity for students to learn about manure management and composting. The objectives of this activity were for students to: 1) gain experience designing and constructing a compost pile, 2) critically evaluate compost progress and make appropriate management decisions, 3) maintain a logbook of management decisions and behaviors, and 4) develop an understanding of opportunities and challenges associated with manure management. This activity was integrated into an equine stable management course and an agricultural waste management course. The experience included reading assignments, discussions, a field day to construct compost piles, management, and recordkeeping. Pre-and post-tests included content questions, as well as a survey of students' views on manure management and the associated activity. Students from both classes who participated in compost management demonstrated improved performance on compost characteristic questions, and reported an increased confidence in knowledge and ability to compost.

Introduction

Roberts (2006) defined the Model of the Experiential Learning Process as a cyclic process whereby a learner is focused on an issue, emerged in experience, then reflects on the experience, and formulates generalizations before initiating the cycle again. This experiential learning process has been evaluated in various post-secondary agricultural program settings, including Environmental Farm Plan development (Stonehouse, 2000) and crop production and marketing (Rhykerd et al., 2006). Rhykerd et al. (2006) reported that the contest between four student organizations to physically produce and market corn and soybeans positively impacted the students' knowledge, self-confidence and leadership skills. Thus, experiential learning is recognized as a valuable teaching technique in post-secondary agriculture curricula, with a range of reported and potential subject matter.

With any course or learning model, numerous factors can impact the student performance and participation. Past research has examined factors such as gender, past experiences, program of study and grade scores for introductory animal science course performance (Lyvers Peffer, 2011), introductory forage management lecture or laboratory performance (Mousel et al, 2006) or goal-setting among animal science students (Splan, 2013). No specific studies on gender-related differences in context of experiential learning processes or outcomes were found, nor experiential projects related to composting or manure management.

Capstone and upper-year courses are generally designed as a platform for learners to assimilate and integrate fragmented knowledge from various components of a curriculum into a cohesive, working knowledge. This platform reinforces essential managerial skills of a specific field in addition to technical content. The managerial skills include planning, decision-making, and meeting the economic, physical and human needs of a system (Taylor and Field, 2001). Manure management on livestock operations is an example of a multi-faceted aspect that can have positive and negative economic (time, labor and equipment), environmental (water, air and soil quality), and public perception impacts. Composting is one of many forms of manure management, wherein the manure and a carbon-rich material (i.e. bedding) are broken down by microbes to form a soil-like material called compost (Rynk et al., 1992). Composting requires site-specific design, monitoring, assessment, and management (Rynk et al., 1992), and all four skill sets lend well to experiential learning.

---

[1]The authors gratefully acknowledge the assistance of R. McGrath with data compilation, C. Beste and B. Holland with manuscript review, and G. Djira for statistical analysis. Funding was provided by Ag/Bio Council for Development.

[2]Department of Animal Science; (605) 688-5412; Rebecca.Bott@sdstate.edu

[3]Department of Ag and Biosystems Engineering; (605) 688-5144; Erin.Cortus@sdstate.edu

To address these important issues, faculty members from Animal Science and Agricultural and Biosystems Engineering developed an experiential learning opportunity for South Dakota State University (SDSU) students to learn about manure management and composting. The activity involved classroom instruction (focus on an issue), field work (experience) and decision-making (reflection and generalization). The objective of this paper is to demonstrate the change in perceptions and knowledge of waste management for two groups of students with different backgrounds in two courses.

Materials and Methods

Course Background

Activities were conducted in two upper level management-focused courses on campus, Stable Management (SM) and Agricultural Waste Management (AWM) (Table 1). The majority of students were in the junior or senior level of their respective program.

The learning objectives for SM included developing an understanding of managing horses, designing and managing horse facilities, and also establishing a sound business plan for an equine operation. The compost activity was incorporated into the facility management objective of this course. The learning objectives for AWM were to understand the role of agricultural waste on the enhancement or degradation of natural resources and apply science-based principles to develop agricultural waste management plans for agricultural systems.

Compost Activity and Student Assessment

The activity was implemented in SM during the fall of 2012 and in AWM during the spring of 2013. For both courses, the learning objectives specific to the compost management activity were similar: 1) to gain experience designing and constructing compost piles, 2) to critically evaluate compost progress and make appropriate management decisions, 3) to maintain a logbook of management decisions and behaviors, and 4) to develop an understanding of opportunities and challenges associated with manure management.

The activity was conducted in a vacated, naturally-ventilated facility with concrete pens and basic office space for storage and record-keeping. The activity utilized procedures described by Rynk et al. (1992) for passive pile composting wherein the composting material was stacked and periodically turned. The periodic turning is prescribed to reintroduce air within the pile and maintain an aerobic environment. The raw materials were horse manure and straw bedding.

In the week prior to the start of the hands-on portion of the activity, informational materials were posted on the respective course websites, and students were asked to access and review the information. Students received one lecture on composting as a waste treatment method. For both classes, the pre-activity survey was distributed and completed during class time prior to the lecture.

During the first official week of the activity, SM students participated in a four-hour field day where they had interdisciplinary discussions with the Extension Equine and Extension Waste Management Specialists (who were also the respective course instructors). The first stop included a tour of the SDSU Equine Teaching Facility and observation of the raw materials available for use in compost piles, and evaluation of the current state of manure management. Students subsequently relocated to the compost activity site to plan how much manure, water, and other organic materials should be included in each compost plot. Four compost piles were constructed; pile one was a positive control managed by faculty, pile four was a negative control that students were asked to monitor, but not manage; and piles two and three were under student management. Finally, students were trained in measuring and recording ambient, core, and peripheral pile temperatures, moisture, volume, and odor. For AWM, a two-hour class was held at the compost activity site to design, construct and train in monitoring techniques. The pile management structure for AWM differed slightly from SM in that the AWM students constructed and were responsible for all four piles.

For the next 10 to 12 weeks of the activity, students were organized into groups of three, and assigned a week to observe and record information on compost progress. In both classes, students were responsible for documenting decision-making activities and subsequent actions. Periodic verbal updates on the observations and data collected were provided to the class by the students and faculty. During the last week of the activity, a group discussion on the data collected through the semester was conducted. The monitoring data were compiled by the instructors to demonstrate changes (or lack thereof) in the temperatures and sizes of compost piles.

The activity was 10% of the overall grade for each course. Student assessment was based on participation (in-class participation and evidenced by site records), a demonstration of knowledge of composting principles (evidenced by site records and calculations), and decision-making ability (evidenced by site records and decision justification). The AWM students also prepared a one-page “how-to” document. The weighting of participation, knowledge and decision-making in the activity grade were 33%, 33% and 33%, respectively for SM, and 20%, 50% and 30%, respectively for AWM.

Table 1. Course and participant information.

	Stable Management (SM)	Agricultural Waste Management (AWM)
Program	Animal Science	Agricultural Systems Technology (AST)
Optional/Mandatory	SM one of three course options required to complete a technical elective of the equine minor.	Required course for the AST major. Optional for graduate students.
Number of Students	26	25
Undergraduate/Graduate	26/0	23/2
Males/Females	2/24	24/1
Activity Period	October – December 2012	February – April 2013

Activity Assessment

To document the change in perceptions and knowledge of waste management for the two groups of participants, the activity was assessed using a pre-and post-activity survey that included participant background, perception, content and feedback style questions. Surveys were administered in class prior to commencement of compost activities (pre), and during the final week of class (post). The surveys were deemed exempt under federal regulation 45 CFR 46.101 (b) and approved by the South Dakota State University Institutional Review Board (IRB-1209015-EXM).

Open-ended participant background questions were designed to gauge the experience of the course participants in horse/livestock, land, and manure management, and were asked only in the pre-activity survey. Data were summarized for presentation purposes only, as shown in Table 2. Perception-based questions were asked using a five-point scaled response in both the pre- and post-activity surveys to gauge the importance, environmental beliefs, current knowledge and confidence in skill of the participants (Table 3). Content or knowledge-based questions were multiple-choice format, and administered in both the pre- and post-activity surveys (Table 4). The responses were anonymous and not considered in the student assessment for AWM. In SM content questions were graded and integrated into the knowledge portion of their activity grade. Finally, students were asked scaled-response (Table 5) and open-ended questions (Table 6) to obtain feedback on the activity as a component of their course.

Statistical Analysis

An exact Wilcoxon two-sample test was performed using SAS (Cary, NC) to determine differences in perception-based questions (scored on a scale of 1-5) pre- and post-activity for each cohort. A Chi-squared test was performed using the Frequency Procedure operation of SAS to determine changes in frequency of correct responses for knowledge-based questions. Differences within class for the Wilcoxon and Frequency tests were considered significant with a P-value of less than or equal to 0.05.

Results and Discussion

The survey response rate, being the number of surveys collected relative to the number of students in the course, was 100% pre and post for SM, and 72% and 88%, pre and post, respectively, for AWM.

Table 2. Livestock ownership and management experience, and agricultural land ownership/rental experience of student participants, shown as percentage of respondents within a class.

	SM		AWM	
Number of Horses/Livestock*	Owned	Managed	Owned	Managed
0	27	42	78	67
1	19	4	11	0
2 - 10	54	27	0	0
11 - 100	0	23	6	0
101 - 1000	0	4	0	22
>1000	0	0	6	11
Number of Acres**	Owned	Rented	Owned	Rented
0	46	77	44	39
< 80	38	19	17	11
80 - 160	12	4	11	22
360 - 640	0	0	22	17
> 640	4	0	6	11

* Responses to the open-ended question "How many horses do you own or help manage?" (SM) or "What type and how many livestock animals do you own or help manage?" (AWM)

** Responses to the open-ended question "How many acres do you own or rent?"

Table 4. Student performance (shown as % of students that selected the correct response) for content-based questions.

Topic	SM		AWM	
	Pre	Post	Pre	Post
Temperature and duration of exposure for pathogen destruction	8	89*	28	55**
Optimal moisture content of compost	73	100*	66	100**
Pounds of manure produced by horses daily	44	100*	NA	NA
Composting impacts	46	52	50	75
Health risks associated with manure	54	54	67	27**
Runoff prevention methods	73	88	72	64

*Represents a difference in scores in Pre- vs. Post- assessments for SM (P=0.01)

** Represents a difference in scores in Pre- vs. Post- assessments for AWM (P<0.05)

Table 3. Student response (shown as % of responses by category) to perception-based survey questions in two courses before and after compost activity.

Question	Time	SM 1	SM 2	SM 3	SM 4	SM 5	SM P-Value	AWM 1	AWM 2	AWM 3	AWM 4	AWM 5	AWM P-Value
What level of importance do you place on manure management? (1 = Low, 5 = High)	pre	0.0	7.7	34.6	34.6	23.1	0.643	11.1	11.1	38.9	16.7	22.2	<0.001
	post	0.0	7.7	42.3	30.8	19.2		0.0	0.0	4.5	27.3	68.2	
How do you rate your current knowledge of composting? (1 = Minimal, 5 = Most Knowledgeable)	pre	34.6	34.6	19.2	3.8	7.7	<0.001	11.1	44.4	38.9	5.6	0.0	<0.001
	post	0.0	3.8	30.8	61.5	3.8		0.0	0.0	22.7	63.6	13.6	
How confident are you regarding your ability to manage a compost pile? (1 = Not, 5 = Very)	pre	23.1	26.9	30.8	11.5	7.7	<0.001	11.1	27.8	33.3	27.8	0.0	<0.001
	post	0.0	0.0	34.6	65.4	0.0		0.0	4.5	27.3	36.4	31.8	
What level of negative impact does manure from your horses have on the environment? (1 = None, 5 = High)	pre	4.0	20.0	48.0	24.0	4.0	0.416	5.6	16.7	44.4	16.7	16.7	0.973
	post	0.0	19.2	42.3	30.8	7.7		0.0	31.8	31.8	13.6	22.7	
Do you perceive manure management as a challenge or an opportunity? (1 = Challenge, 5 = Opportunity)	pre	0.0	8.0	44.0	36.0	12.0	0.774	0.0	22.2	22.2	27.8	27.8	0.876
	post	0.0	11.5	46.2	26.9	15.4		0.0	9.1	31.8	36.4	22.7	
What level of positive impact does manure management have on the environment? (1 = None, 5 = High)	pre	0.0	4.0	24.0	52.0	20.0	0.109	0.0	0.0	11.1	44.4	44.4	0.430
	post	0.0	0.0	15.4	46.2	38.5		0.0	9.1	13.6	40.9	36.4	
Do you consider yourself an active steward of the environment? (1 = Yes, 5 = No)	pre	12.0	28.0	32.0	28.0	0.0	0.447	22.2	11.1	44.4	22.2	0.0	1.000
	post	20.0	24.0	40.0	16.0	0.0		9.1	31.8	36.4	22.7	0.0	

Participant Background

Differences in classes were observed in terms of gender. Table 1 describes the gender distribution for the two cohort classes. The relatively high female and high male populations of SM and AWM, respectively, were reflective of the programs in general. In previous studies, gender was not found to be a significant indicator for introductory animal science course performance (Lyvers Peffer, 2011), introductory forage management lecture or laboratory performance (Mousel et al, 2006) or goal-setting among animal science students (Splan, 2013).

However, several additional differences between classes related to students' background experience in livestock, farm and manure management were elucidated from responses on the pre-activity survey. The majority of SM students had experience with horse ownership (100%) or management (73%), although the survey did not require students to discern between self-ownership, vs. family ownership. A minority of AWM students owned (22%) or managed (33%) livestock, but for those that did, the farms were typically of larger size and number of animals compared to SM. The majority of students in both SM and AWM did not own or rent land, however, of those who did, the AWM students had a background of managing a larger number of acres compared to SM students. Genders, prior experiences, in addition to overall course objectives, are all potential sources of variation between individuals and between classes.

Using the pre-activity survey instrument, participants were asked to describe their current manure management system in an open-ended question. More than one system or technique type was present in many responses. There was no verification of the actual practice(s) mentioned by each student; rather, this question was a preliminary gauge of participant experience in a manure treatment technique (i.e. composting) versus storage (i.e. stockpiling). The dominant practices indicated by SM participants were pasture (10 indications), and stockpile and haul (11 indications); one participant mentioned composting. For AWM, there were fewer instances of past experience noted, however experience included scrape and haul (3 indications) and liquid manure storage systems (4 indications). No other forms of manure treatment were indicated.

General Participation and Student Assessment

All students participated in the initial compost pile construction activities for both classes. Based on site records, all SM students participated in weekly monitoring, whereas three AWM students did not. During the activity period there were recommendations for management actions, yet only 16 SM and nine AWM participants made physical changes (i.e. mixing, adding water) to the compost piles. Student reasons for electing not to modify piles are described in Table 6. In SM, the students averaged 92% for the overall activity, considering their participation and demonstrations of knowledge and decision-making. In AWM, the average mark was 75% for this activity, in part related to an average assessment of 50% for documented management actions and accurate record-keeping.

Table 5. Student response (shown as % of responses by category) to activity feedback questions.

Question	SM					AWM				
	1	2	3	4	5	1	2	3	4	5
I enjoyed the manure management activity (1 = Disagree, 5 = Agree)	0.0	15.4	38.5	30.8	15.4	0.0	13.6	22.7	31.8	31.8
I learned useful information about manure management (1 = Disagree, 5 = Agree)	0.0	0.0	15.4	53.8	30.8	0.0	0.0	9.1	50.0	40.9
I learned more from this activity than if it had only been discussed in lecture (1 = Disagree, 5 = Agree)	0.0	7.7	15.4	34.6	42.3	0.0	4.5	22.7	18.2	54.5

Table 6. Summary and select examples of student responses to open-ended activity feedback questions.

Question	SM	AWM
Did you as a class, compost? Explain	Yes: 16; No: 1; Partially: 7 • Yes, we composted two piles of manure. We put water on them and rotated. • I would say no. The piles did reduce in size, but did not get to that pivotal 140°. The piles usually too dry also. • To an extent yes we did compost, though the full process takes a longer amount of time	Yes: 14; No: 1; Partially: 7 • Yes, we constructed the piles and kept track of them throughout the semester • No, our pile grew apparently • According to the graph = No; according to the pictures = Yes
Did you make management decisions with your group?	Yes: 25; No; 1 • Yes, we decided that one of the piles needed additional water and another needed to be turned • No, we thought the piles looked good after we inspected them	Yes: 15; No: 3; Partially: 4 • Yes, we decided to add water and completely turn the pile, hoping to get things going • No, we really didn't need to
Did you implement these decisions? Why/why not?	Yes: 15; No: 9; Partially: 2 • We watered the piles because they were dry. • No, weren't completely confident in our decision • We did not because we didn't know how far we could go with the managing and turning would have been okay but we did not want to disrupt the current composting	Yes: 12; No: 7; Partially: 3 • Yes to get our pile to compost • Time and temperature limited abilities
What did you learn overall from this project?	• I learned that it takes a lot of work. I thought that a person could just leave the pile and it would eventually turn to compost. • I learned theoretically how to manage a composting pile and I learned practically how to do it. I am really glad to know more about it and the risk linked with not managing manure.	• Management of the pile will yield better results than filling it up and leaving it • I learned how to compost by doing it hands on. I feel that you get a better learning experience by doing projects hands on • When properly managed, composting can be an effective tool for even the biggest of operations

While the site records, calculations and justifications were evidence of reflection during the course of the activity, the post-test survey was an opportunity for summative student reflection on composting, decision-making and implementation (Table 6). From the instructors' viewpoints, for both classes, further actions on the part of participants were warranted to effectively produce a quality compost material, recognizing time, weather, material and location restraints did exist. However, Table 6 reveals that the majority of students felt their actions (i.e. turning or mixing the piles) and decisions (i.e. determined the piles needed more water) were sufficient. Instructor-led discussion at the conclusion of the activity addressed the student perceptions and need for more actions.

Change in Perceptions

Table 3 summarizes the categorical responses pre- and post-activity by students on their perceptions of manure management. Within each class, student responses were comparable for all questions pre- and post-activity with one exception. While there was no difference in responses for SM, students in AWM placed more importance on manure management in their responses on the post-survey than in the pre-survey ($P<0.001$). This could be attributed to the different focus of the respective courses on manure management in general, as demonstrated by the course objectives. The relatively neutral responses for manure management as a challenge or opportunity and positive and negative manure management impacts may be reflective of the instructors' emphasis of positive and negative aspects of manure, as well as the students' prior background and experience in livestock and land management (Table 2).

Three pre-and post-activity survey questions addressed the students' perceptions of their own skills. There was a significant increase in both current knowledge and confidence in composting post activity ($P<0.001$; Table 3) for both classes. Yet, students did not report an increase in their self-perception as stewards of the environment. The interpretation of the neutral response for environmental stewardship over time is that initially students may not be fully aware of the environmental risks and benefits to manure management, but afterwards recognize more action is required to effect change. Thus, an improvement in factual knowledge during the activity may result in a more neutral response to environmental stewardship if they felt they had more room for improvement. Increased confidence in knowledge and abilities was supported by an increase in scores on the content knowledge portion of the survey.

Change in Knowledge

Student knowledge, determined by correct responses to multiple choice questions regarding the optimum temperature ($P<0.01$) and moisture content ($P<0.01$) of compost piles and the amount of manure produced by horses increased in students of SM ($P<0.001$; Table 4). The SM students, however, did not collectively improve in their ability to correctly identify composting impacts, or the ability to identify specific health risks associated with manure. These results differ slightly from that of content knowledge responses from the AWM class. The AWM students improved in their knowledge of the optimum temperature ($P<0.01$) and moisture ($P<0.01$) needed in a compost pile and being able to identify impacts of composting ($P<0.1$), but failed to retain information regarding health risks associated with manure, or how to limit runoff from a compost pile. It was considered a success that both classes demonstrated improvement in at least three areas of content knowledge. It is possible the improvement in response rate for the temperature and moisture content questions, in part, relates to the experience of monitoring and data collection activities undertaken by the students.

Activity Feedback

Table 5 demonstrates the distribution of agreements to the activity feedback questions. In both courses, over 70% of respondents replied with a 4 or 5 (indicating general agreement) when asked if they learned useful information, and whether or not they believed they learned more during this activity than if manure management only had been covered in lecture. The responses regarding their enjoyment of the activity were distributed between categories 2 through 5.

Ultimately, the intent of college instruction is to disseminate knowledge. The impact can be considerably more profound if it is achieved in a manner that also enables students to become confident in their knowledge and abilities. While we would have expected a stronger response on enjoyment, it does appear that students believe they learned useful information given this teaching strategy. Additional open-ended feedback is provided in Table 6. The student comments acknowledged that this form of manure management takes work, and that the perceptions of work involved changed over time. Feedback presented in Table 6 also acknowledges the students' perceptions of the importance of continual management, and the practical application of theory.

Composting provided a platform for experiential learning that related to both SM and AWM. The format and premise of this activity are suitable for other manure treatment technologies, or even different groups of learners. By monitoring the change over time of their actions or inactions, participants reflect on the impacts of their decisions. To enhance the opportunity for reflection, a critical element of experiential learning (Andreasen, 2004), a future potential change in activity delivery includes a shared document or other reporting process to facilitate sharing week-to-week results.

Summary

Two groups of agriculture students participated in an experiential learning-based activity involving manure composting. The groups differed in gender, and in the scope and scale of livestock and land management experience. Also, the course material and learning objectives differed between (horse) Stable Management and Agricultural Waste Management. However, change over time in the participants' knowledge of compost processes and confidence in ability to manage compost was significant for both classes. In particular, participants' knowledge of the temperature and moisture factors that they, as managers, can monitor and evaluate increased. There was an increase in the perceived importance of manure management after completion of the activity for Agricultural Waste Management, but not for Stable Management, which was likely related to differences in overall course content. Instructors intend to place more emphasis on implementation of management decisions in the future. While access to water and climate provided challenges to the experience, they also provided an opportunity to understand real-life situations that can arise when managing a compost pile. Overall, students believed they learned more through this hands-on activity than solely through lectures.

Literature Cited

Andreasen, R.J. 2004. Integrating experiential learning into college of agriculture capstone courses: Implications and applications for practitioners. NACTA 48(1):52-57.

Lyvers Peffer, P.A. 2011. Demographics of an undergraduate Animal Sciences course and the influence of gender and major on course performance. NACTA 55(1): 26-31.

Mousel, E.M., L.E. Moser and W.H. Schacht. 2006. Impact of student background characteristics on performance in an introductory forage crops management course. NACTA 50(3): 8-12.

Rhykerd, R.L., K.W. Tudor, B.R. Wiegand, D.M. Kingman and D.G. Morrish. 2006. Enhancing experiential learning through a hands-on crop production and marketing contest. NACTA Jour.50(4): 25-30.

Roberts, T.G. 2006. A philosophical examination of experiential learning theory for agricultural educators. Journal of Agricultural Education 47(1):17-29.

Rynk, R., M. van de Kamp, G.B. Willson, M.E. Singley, T.L. Richard, J.J. Kolega, F.R. Gouin, L. Laliberty, D. Kay, D.W. Murphy, H.A. J. Hoitink and W.F. Britton. 1992. On-farm composting handbook. NRAES-54. Ithaca, NY: Northeast Regional Agricultural Engineering Service.

Splan, R. 2013. Effect of class standing, gender and academic attribution on resiliency and goal-setting strategies among Animal Science students. NACTA Jour.57(4): 24-30.

Stonehouse, D.P. 2000. Educational experience with environmental farm plans in a case-study setting. The Journal of Agricultural Education and Extension 7(1): 1-10.

Taylor, R.E. and T.G. Field. 2001. Scientific farm animal production: An introduction to animal science, 7th Ed. Upper Saddle River, NJ: Prentice Hall.

Taylor, S. and P. Todd. 1997. Understanding the determinants of consumer composting behavior. Journal of Applied Social Psychology 27(7): 602-628.