Students, Worms and Manure: A Research Methodology Practicum[1]

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Abstract

Practicum courses can bridge the gap between knowledge gained in a classroom and application in "real world" work environments. Students often ask, "Why do I need this course?" While many courses may seem unconnected to them, practicum can serve as a unique tool connecting information and application. Ideally, practicum reinforces learning outcomes specific to the student's major. We developed a practicum course where students could gain a holistic sense of work in the field of environmental science research. The purpose of the practicum was to involve students in scientific research; including, conducting a literature review, participating in experimental design, collecting field samples, and analyzing data. Student behaviors and perceptions of the experience were observed during a 10-week practicum course. Overall, student responses to the experience were positive, and students appeared to enjoy working in the field and the lab. Students perceived the value of well-organized experiences that highlighted timely issues in environmental science.

Introduction

Students in the Associate of Applied Science Degree programs at The Ohio State University Agricultural Technical Institute (Ohio State ATI) enroll in at least one credit hour of Practicum as part of their program of study. The purpose of Practicum is to provide a "real world" work experience in a student's field of study to deepen their comprehension of current practices before entering the workforce. Ideally, local industries and/or government agencies would offer these unique types of field and laboratory experiences at a level of understanding needed by our students. Due to time and distance constraints, matching students with outsourced "real world" experience is not always possible. Therefore, most practicum courses at Ohio State ATI are developed "in-house."

Ohio State ATI is not a typical, two-year degree-granting institution. It is organized within the College of Food Agricultural and Environmental Sciences at The Ohio State University. Furthermore, many of our students come from agricultural backgrounds and major in programs focused on natural resource management, crop and livestock management, agricultural businesses, and engineering technologies. The Practicum courses associated with these majors must be responsive to the types of students enrolling at Ohio State ATI.

In Spring Quarter 2008, we developed a Practicum course for students in the Environmental Resources Management program. The objective was to provide a guided research experience, which was timely, directly related to the students program of study, and interesting for the students. The Practicum focused on a "hot topic" in environmental science: The effects and fate of antibiotics, used in animal production to enhance performance, on the environment (Chander et al., 2008; Sassman and Lee, 2007; Davis et al., 2006). Monensin, an antibiotic administered to beef and dairy cattle (Bos taurus) to improve performance (Bretschneider et al., 2008; Duffield et al., 2008), is used in the feed ration at Ohio State ATI's Dairy Facility. For students to form a complete picture of environmental or natural resources research, similar to what they may be involved in as research technicians, we developed a simple study to evaluate the fate of Monensin in fresh dairy manure applied to soil in an existing stand of white Dutch clover (Trifolium repens). The students participated in all aspects of field and laboratory work, implementing standard research protocols.

During the 10-week Practicum, we observed the students' reactions to various tasks and ideas. This paper qualitatively reports on student perceptions of the Practicum experience. Furthermore, we address the shortcomings and advantages of this type of course.

Methods

The Monensin Study

The students collected manure within 24-hours of excretion from Holstein and Jersey dairy cows, which consume Monensin as part of a feed ration at the Ohio State ATI Dairy Facility. We applied the manure to a site at the Ohio State ATI Land Laboratory, using a split plot randomized complete block design to determine treatment differences (Little and Hills, 1978). Main treatment plots included three dairy manure application rates of 0, 22, and 44 Mg ha-1. We randomized subplots within main plots to evaluate time effect from 0, 4, 8, 12, and 16 days after dairy manure application. The students collected two representative soil samples (the surface

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5 cm) from each plot area on the assigned dates. The soil samples were frozen until all samples were ready for analysis. At the time of soil sampling, they counted the number of earthworms in each plot using the formalin method of extracting earthworms from the soil described by Raw, (1959). All worms surfacing within ten minutes were counted, washed, and returned to the ground. We analyzed the results using a single factor analysis of variance.

The students determined the Monensin levels in the manure and soil samples by a modification of the pre-derivatization method developed by Dusi and Gamba (1999). The samples were extracted with methanol, filtered, cleaned through solid-phase extraction, derivatized using DNP, separated by reverse-phase liquid chromatography, and visualized at 392 nm. The second set of soil samples were air dried, ground, and sent to the Service Testing and Research Laboratory at the Ohio Agricultural Research and Development Center in Wooster, Ohio for nutrient analysis.

Student Participation

Four Environmental Resources Management students participated in the Practicum as part of their course of study. The class demographics included one non-traditional first-year student, two non-traditional second-year students, and one non-traditional third-year student (double major). Each student completed at least one full year of course and laboratory work in chemistry and soils, preparing the students (an average GPA of 3.15) for the intensity of the experience.

The Practicum course covered a ten-week period. The students met with us once per week for three hours. We covered four main tasks: preparation, application, collection, and analysis.

During weeks one to four, the students prepared for the experiment by performing a literature review, becoming familiar with the theory and utilization of the HPLC, and generating a plot map. At the first meeting, we introduced the students to the subject of Monensin and discussed the purpose of the study. The students were given a variety of pertinent journal articles to review. At the second meeting, the students reported and discussed the findings of the journal articles. During week three, we explained the basics of HPLC. The students gained "hands-on" experience with the HPLC by injecting samples of standards and interpreting chromatographs. For week four, the students generated a map to plot the randomized block experiment. Using a measuring tape, marking paint and flags, the students measured off and marked the test plots at the Ohio State ATI Land Laboratory.

The students obtained and applied the manure samples in one day of week five. In the morning, two students using shovels collected 18 L of fresh manure from the Ohio State ATI Dairy Facility floor into a large plastic tote. In the afternoon, two students applied 0.8 L and 1.6 L fresh manure to the 22 Mg ha-1 and 44 Mg ha-1 plots, respectively. We used the density of the manure to calculate a volume of manure needed to meet the mass rate. Due to the small volume and thick consistency, the students used graduated cylinders to measure the volume and hand applied the manure to the plots.

Every four days following manure application, two students traveled to the Ohio State ATI Land Laboratory, collected two soil samples, and counted earthworms in the appropriate plots. Upon returning to campus, the students replenished the "supplies" for the next group and placed the soil samples in the freezer until analysis.

During weeks eight, nine, and ten, the students analyzed the raw manure and soil samples to determine the level of Monensin. Using the secondary samples, the students air-dried, ground-up and packaged the soil samples for nutrient analysis. As a final project, the students reported the Practicum experience with a short paper.

Results and Discussion

Students seemed enthusiastic about the project throughout the 10-week quarter. They kept to the schedule we outlined and completed the preliminary assignments and activities during the first four weeks. Students incorporated the knowledge they gained reviewing our Research, Creative, and Other Scholarly Activities grant proposal and key journal articles into their written reports. By providing students with a few key scholarly papers, it gave them a springboard to other published works and to think critically of their own ideas. We believe this is important for students to understand how their effort fits or relates to the work of other researchers.

In week four, students learned about randomization by preparing a map of the physical layout of plots at the field site. With the physical plot outlines drawn on a map, students then randomized treatments by assigning each treatment a number and then drawing numbers from a hat. This was repeated for the 0, 22, and 44 Mg ha-1 manure application rates based on sampling date. Students assessed worm numbers beginning at day 0 until day 16, sampling at four-day intervals.

Students divided up the field work evenly between themselves with our guidance. In week five, this included collecting fresh dairy manure and spreading it over the soil at the correct rate and place. The smell of the dairy barn overwhelmed one student who volunteered to collect manure. We asked her to wait for us outside while we collected the appropriate volume of fresh manure for the experiment. The lanes were scraped twice per day, removing any manure older than 12 hours. The students collected manure approximately an hour after the morning scraping was completed. This brings up an issue of student sensitivity to any environmental conditions which may render them unable to complete the assigned task. In the future, we will give greater attention to assigning students tasks better suited to their strengths. This was the only incident where a student was unable to complete part of the study.

Worm collection went as planned. The method used to extract the earthworms, as described in the previous section, worked well. Student observation of worm numbers from each of the sampling periods and for each treatment is provided in Table 1. We were pleased with how conscientious the students were as they prepared, collected, and cleaned up after sampling the field plots. Additionally, we continued to inform them of the care needed when handling and transporting chemicals from the lab to the field.

Generally, we accompanied the students as they collected soil samples and conducted worm counts. Yet, the students were capable, after instruction, of sampling and counting on their own, as was proven on day eight of the sampling period when two students worked on their own. Additionally, a student volunteered to help sample and count worms on day 12 which occurred on a Saturday. The every-four-day sampling and counting periods resulted in students rearranging their schedules to be available outside of the time normally set aside for Practicum. We realize this might not always be a viable way to conduct a course, where students are generally aware that Practicum is a three-hour event taking place on the day and time assigned to them when they registered for the course. Yet, the students were willing to adjust their schedules to complete the research project.

The HPLC analysis of the manure and soil samples required one of the authors to spend a significant amount of time completing the analysis. Although the students helped, they were not able to dedicate the time required to perform the analysis in a concise manner as the samples were thawed from the freezer. An example of a student-generated curve identifying Monensin in manure samples is included as Figure 1.

At the conclusion of the study, students were asked to complete a lab report which included a literature review, materials and methods, results and discussion, and summary sections. We provided guidance with the statistical analysis of the worm counts by completing an ANOVA of mean worm numbers per manure rate applied to the plots. We also helped the students identify the important peaks in the UV visualization of Monensin. A few of the student comments about the Practicum experience are included in the following quotations shared with permission by the students:

"As for comments I think Practicum in general is the biggest waste of time at ATI. That being said, this Practicum was better because I felt there was a clear project to work on. Much more organized than other Practicums I have been in and talked about with other students. Also, I was able to use something that I had learned at ATI (the HPLC stuff) and apply it in a real project."

"The data that we found from the field is pretty inconclusive. The P-value of 0.1896 shows that there is no significant difference between the three plots. This experiment will need to be duplicated to gain more insight as to whether the Monensin is leaching into the soil in concentrations that are detrimental to the worms and other soil life. The derivatization of the Monensin and the double filtering of the soil were two positive things that came out of our work this quarter. The methods for these that were developed this quarter seem valid enough to be repeated in later trials of this ongoing investigation."

"Overall, I found this Practicum to be very interesting. It helped that it was pretty simple, also. Since getting out of the dairy business, I was unaware of the addition of Monensin to feeds and the impact it has on the environment. Hopefully, this study will help to determine just what those impacts are."

"Dr. Gerber and I also learned that the soil and manure needed double filtering."

From our experiences with the students in the classroom, laboratory, field, and in their writing, we think the students valued the learning experience we developed for them. The first quote highlights a persistent issue students bring up with us and why we sought to implement something different than what students had experienced in the past. Although the evidence is anecdotal, we do hear complaints about how the Practicum experience is not meeting student expectations. A well-crafted survey may be needed to administer to a larger segment of the student body to better quantify student perceptions of Practicum.

The first quote also highlights the student's perceived lack of clear organization in other Practicum courses they and others were associated with in the past. This Practicum experience was purposefully planned to help the students complete a

Table 1. Earthworms in test plots. Student-generated table showing the number of earthworms surfacing in a 10 minute period after formaldehyde treatment

	Manure applied to forage crop			
Days after treatment	**0 Mg ha^{-1}**	**22 Mg ha^{-1}**	**44 Mg ha^{-1}**	
0	35	35	27	Earthworms surfacing
4	13	31	17	
8	27	27	35	
12	17	29	76	
16	23	56	61	

simple, yet thorough look at "doing science" in a ten-week quarter. Although students were not required to write and receive funding or conduct a statistical analysis to complete the project, the students were introduced and experienced real situations and conditions they will likely face later as they work as technicians for researchers and government agencies. The first quote also highlights a real need we as faculty should consider, and that is to provide opportunities for students to meaningfully practice what they learned in the degree program.

To our interest, we read in the second quote the insight the student had into the inconclusive nature of the results. The student highlighted the need to repeat the study or develop and test a new hypothesis. This is an important part of the scientific method that we had not strongly emphasized during the course, yet the student reasoned the real need to check results in order to validate them.

The third quote identified another of our goals, which was to provide a real-life experience that was timely to the state-of-the-industry and to the scientific community. Students involved in industrial production, whether it is food or otherwise, may not be aware, as this student was not, of the many social and environmental issues related to it. We were pleased the Practicum experience we developed introduced this student to a different side of a field they were already familiar with.

The fourth quote highlights a very practical principle the students learned. A published method or procedure may not be valid in the work being conducted. As the students matriculate through Ohio State ATI and begin work professionally, hopefully, they will realize some of the materials and methods they studied and learned about while at college may no longer be valid. Yet, they need a careful way to assess validity and to make changes where appropriate. This is part of the scientific method and the "doing science" that interested the students picked up on and it stuck with them enough to write it in their report.

Summary

The educational goals for the project were to provide students a learning experience in the context of "doing science." Application of scientific principles in a Practicum experience provided our students with a "hands-on" approach of conducting a prepared research project through a 10-week quarter. Students learned how to follow a protocol for research objectives and collect and record quantitative data. Importantly, students were given the opportunity to be self-learners and motivators, as they were required to complete parts of the project on their own after instruction.

Students enjoyed a Practicum experience with clear objectives and purpose. Work or field experiences are not always so well developed and students may question the purposefulness of the activities they are engaged in. We were able to develop a 10-week Practicum course which provided students with experiences relevant to the careers graduates of the Environmental Resources Management program are moving into.

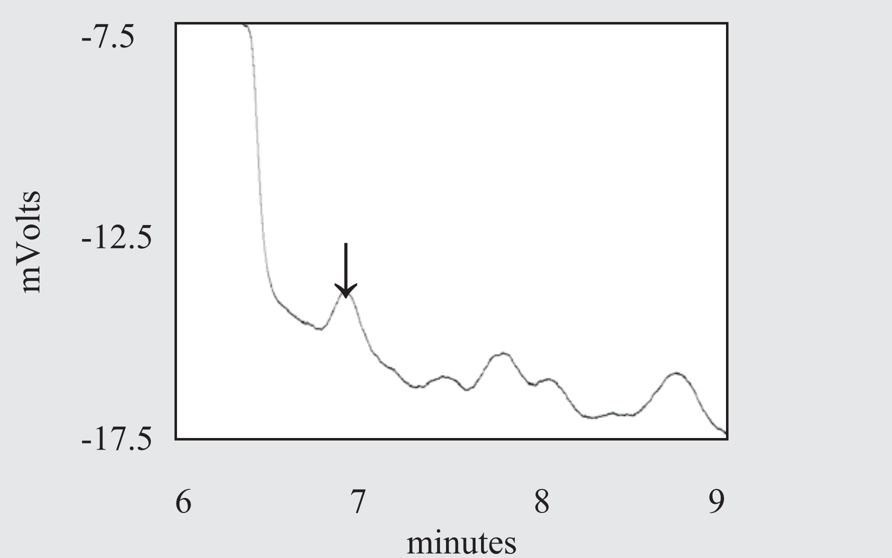

Figure 1. HPLC Chromatograph of Monensin. Student-generated chromatograph from manure. The peak under the arrow indicates position of Monensin

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