Environmental Resource Management Issues in Agronomy:
A Lecture/Laboratory Course

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ABSTRACT

Environmental Sciences Technology T272 is a course with a laboratory addressing problems in soil and water quality and organic wastes utilization to serve students from associate degree programs in laboratory science and environmental resources management at a 2-year technical college. Goals are to build basic lab skills and understand the role and importance of sample collection to address several environmental issues in agronomy. Prerequisites are basic mathematics and one quarter of college chemistry. Students collect and perform tests on water samples from small watersheds, sample soil at prescribed distances to confirm source of contaminant (road salt), and collect and evaluate three species of livestock manure. Field trips are conducted to water and wastewater facilities of a small city and to the USDA-ARS North Appalachian Experimental Watershed in Coshocton, OH. Written reports on these activities are prepared in the style of scientific journal articles or posters. This course presents opportunities to teach simple statistics such as sample mean, standard deviation, and simple fitting of data points to a linear regression model. Students struggle with the expectation that reports are presented in journal article or poster style, but overall response to the course has been positive.

The course grade is determined from the following: a 1-hour midterm exam and a final exam (short essay, lab skills, and multiple choice) each counting 20% of the grade. Three field trip reports comprise a total of 10% of the grade. These include water sample collection, a visit to our municipal water supply and wastewater plants, and a trip to the North Appalachian Experimental Watershed in Coshocton, OH. Attendance and participation comprise 20% of the grade. Three major reports on water quality, soil analysis, and manure analyses comprise the final 30% of the grade.

LECTURE TOPICS

The lecture topics (Table 1) related to water quality include nutrients (N and P), salinity causes and correction, sediments, biochemical oxygen demand (BOD), and pesticides in surface water. Soil management topics include erosion control, salinization, and nutrient management. Water and wastewater treatment processes are presented in one lecture for each topic. We conclude with organic by-products manure and biosolids. These subjects completely fill the available class sessions. We could productively use lecture times to discuss the outcomes of laboratory results and their meaning and interpretations before the written lab reports are due. This would require that less lecture content be presented. We use one class period for the hour exam and Memorial Day claims a class period almost every year because this course is scheduled during Spring Quarter. It would not be possible to do the field sampling of soil, water, and manure during the coldest months of December to March in our state’s climate.

LAB ACTIVITIES

Lab activities include soil sample collection, air-drying, grinding, and sieving. Soil analyses include soil pH, SMP buffer pH, and 1 M ammonium acetate–extractable Na. Methods are taken with some modification with standard soil test methods for the North East Region (Sims and Wolf, 1995). Results from one recent year are in Table 2. Soil pH, exchange-

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Abbreviations: BOD, biochemical oxygen demand; SEI, student evaluation of instruction.

able sodium (Na), and soil buffer pH findings support the hypothesis that closer proximity to the highway results in higher soil pH and Na levels, presumably from deicing salt splash off the road. Water samples are collected from small watersheds on the campus farm (Fig. 1). In additional lab sessions, water quality analyses performed by the students include pH, electrical conductivity, total solids, nitrate-N, and water-soluble phosphate. Water quality results assembled by one class are presented in Table 3. We note the locations where nitrate-N exceeds the public drinking water standard of 10 mg L$^{-1}$ of nitrate-N and where phosphate levels are high enough to support algae growth (0.015 mg L$^{-1}$). Students engaged in water sample collection activities are depicted in Fig. 1. Manure sampling activities include collection of fluid and solid manure at the school swine, dairy, and beef operations. Manure analyses include pH, solids and moisture content, electrical conductivity, total and organic N by the macro Kjeldahl method, and the impact of manure on dissolved oxygen in water. The results of recent class work related to chemical properties of manure and the impact of several levels of manure in water on dissolved oxygen levels are presented in Table 4. Students see big differences in the characteristics of liquid swine and dairy vs. straw-packed beef manure. The depletion of the level of dissolved oxygen in samples of diluted manure may be more dramatic and straight-forward than listing of a BOD number in mg L$^{-1}$. Students are surprised by the very high salinity of the liquid manure samples (Table 5). We usually have to dilute liquid manure 5- to 10-fold with deionized water to bring readings on scale with our conductivity meter.

Two lab periods are devoted to field trips to the Wooster, OH (city of 25 000), water and wastewater treatment plants and to the USDA North Appalachian Experimental Watershed in Coshocton, OH. At Coshocton, USDA-ARS scientist Dr. Martin Shipitalo explains their research on soil and water quality. Figure 2 is a collage of pictures from the field trip to the North Appalachian Experimental Watershed and some of the soil sample collection activities in outdoor lab sessions.

Analytical skills presented and or used in labs include the use of specific ion (pH and nitrate) electrode, spectrophotometer (P with blue color reagents), electrical conductivity, gravimetric measurement of solids, macro Kjeldahl (N), and

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Table 1. Lecture topics covered in the course in two 50-minute periods per week.

<table>
<thead>
<tr>
<th>Lecture topics</th>
<th>No periods</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction/course expectations</td>
<td>1</td>
<td>discuss syllabus, raise environmental concerns</td>
</tr>
<tr>
<td>Ecology concepts</td>
<td>1</td>
<td>discuss producers, consumers, decomposers, energy flow food chains and web</td>
</tr>
<tr>
<td>Water properties</td>
<td>1</td>
<td>discuss physical and chemical properties of water</td>
</tr>
<tr>
<td>Water quality issues in agronomy</td>
<td>3</td>
<td>role of nutrient enrichment, sediments, organic matter and pesticides</td>
</tr>
<tr>
<td>Water supply preparation and wastewater treatment</td>
<td>2</td>
<td>basics of drinking water preparation and wastewater treatment</td>
</tr>
<tr>
<td>Soil resource properties and sources of resource degradation</td>
<td>3</td>
<td>brief overview of soil properties, soil erosion, salinization, and disturbance by activities such as resource extraction</td>
</tr>
<tr>
<td>Livestock manure traits and disposal/utilization concerns</td>
<td>2</td>
<td>nutrient contents, salinity, and BOD in manure</td>
</tr>
<tr>
<td>Biosolids</td>
<td>1</td>
<td>land application restraints and guidelines metals, microbes, soil properties affecting application</td>
</tr>
<tr>
<td>Pesticide issues</td>
<td>2</td>
<td>pesticide toxicity and persistence, restricted and general use materials, and persistence in environment</td>
</tr>
<tr>
<td>Exam and final exam</td>
<td>2</td>
<td>multiple choice, essay and calculations, interpretation of instrument standard curves, and lab data</td>
</tr>
<tr>
<td>Holiday or flexible topic depending on academic calendar</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Table 2. Soil test results from class lawn sampling.

<table>
<thead>
<tr>
<th>Student no.</th>
<th>Site distance†</th>
<th>pH</th>
<th>SMP buffer</th>
<th>Soil Na</th>
<th>Bray P</th>
<th>m</th>
<th>mg kg$^{-1}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.8</td>
<td>7.80</td>
<td>7.00</td>
<td>400</td>
<td>8.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1.5</td>
<td>7.50</td>
<td>6.80</td>
<td>575</td>
<td>13.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>2.3</td>
<td>7.35</td>
<td>6.91</td>
<td>360</td>
<td>10.30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>3.0</td>
<td>7.16</td>
<td>6.80</td>
<td>295</td>
<td>9.30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>4.5</td>
<td>6.66</td>
<td>6.65</td>
<td>189</td>
<td>3.37</td>
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<td></td>
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<tr>
<td>6</td>
<td>6.0</td>
<td>6.23</td>
<td>6.20</td>
<td>141</td>
<td>2.43</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>7.6</td>
<td>5.60</td>
<td>6.30</td>
<td>92</td>
<td>22.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

† Distance in meters (m) from U.S. highway adjacent to the campus lawn boundary.

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Table 3. Water quality data from class reports.

<table>
<thead>
<tr>
<th>Sample locations</th>
<th>pH</th>
<th>Electrical conductivity</th>
<th>Total solids</th>
<th>Soluble P</th>
<th>NO$_3$N</th>
<th>dS m$^{-1}$</th>
<th>mg L$^{-1}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.66</td>
<td>2.80</td>
<td>573</td>
<td>0.005</td>
<td>4.9</td>
<td></td>
<td></td>
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<tr>
<td>2</td>
<td>6.97</td>
<td>0.41</td>
<td>333</td>
<td>0.016</td>
<td>12.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>7.78</td>
<td>3.80</td>
<td>313</td>
<td>0.001</td>
<td>10.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>7.37</td>
<td>0.50</td>
<td>327</td>
<td>0.004</td>
<td>1.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>7.77</td>
<td>0.46</td>
<td>373</td>
<td>0.011</td>
<td>4.2</td>
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<td></td>
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<tr>
<td>6</td>
<td>7.30</td>
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<td>367</td>
<td>0.043</td>
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<td></td>
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<td>7</td>
<td>7.08</td>
<td>0.36</td>
<td>320</td>
<td>0.044</td>
<td>9.1</td>
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<tr>
<td>8</td>
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<td>533</td>
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<tr>
<td>9</td>
<td>7.90</td>
<td>0.77</td>
<td>480</td>
<td>1.440</td>
<td>0.8</td>
<td></td>
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</tr>
</tbody>
</table>

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Fig. 1. Students collecting water samples.
The atomic absorption spectrophotometer (Na). The water, soil, and manure analyses results give the students factual information to assemble, discuss, and interpret (York, 1988).

LAB REPORT EXPECTATIONS

Lab reports are required to be typed or completed on word processors. The use of word processor spell and grammar check functions is encouraged. Points are deducted for errors in grammar and spelling. The format of the lab reports is as follows: Introduction—covers the subject and purpose of the report; Methods and Materials—describes procedures, example calculations, and equipment used; Results and Discussion—includes the entire class findings; Conclusions—describes broad outcomes and knowledge gained; and References—relates to methods used or knowledge of the subject being investigated from relevant literature. This is basic science writing style format.

DISCUSSION OF LAB REPORTS IN JOURNAL FORMAT

Students have found preparation of reports in journal article style very challenging. In recent years, a term paper was dropped from class expectations so students could focus their time and effort on three major lab reports: soil testing, water quality, and manure characteristics. Only a few students have accepted the offer of a no-risk evaluation of their reports before they are due, so they could correct any instructor concerns. No students have responded to the encouragement that students share drafts of their reports with their classmates to gain insights from review by peers before submitting the report for a grade. Poster paper format (Hess and Brooks, 1998) was tried in 2000 and 2004 and was much more popular with students and earned higher student evaluation of instruction (SEI) scores and comments in spring 2000 than the recent years when traditional journal style written reports were required (Table 5). The poster is a popular communication vehicle that should be pursued with all the care and attention to detail in its writing of written lab reports. Posters use bulleted phrases that do not teach traditional science writing, but they incorporate visual images, which give extra power to the message. In 2004 students were required to purchase and use a simple returnable 35-mm camera or their own camera to document sample collection, lab activities, and field trips. This gave them visual images for posters or reports.

STUDENT PARTICIPANTS AND THEIR EVALUATIONS

Table 5 shows students’ objective responses from five questions on The Ohio State University Student Evaluation of Instruction instrument. These scores from the Environmental Science T272 are lower on the average than the same instructor’s evaluations in Introductory Soils and lower than The Ohio State University faculty averages. Part of the depressed SEI scores in Environmental Science T272 could be attributed...
to high expectations for the written lab and field trip reports. Another factor may be that lecture content does not adequately focus on the outcome and interpretation of the laboratory activities and preparation of reports. Not all students will take time to write written comments.

Selected student comments from Spring 2001, 2002, and 2004 are shared here. There were no written comments from the class of three students in 2003.

**ENV SCI T272 Student Comments Spring 2001**

The Teaching/Learning Process Is a Two-Person Partnership: Evaluate Your Effort and Your Instructor’s Effort Below

A. Your attendance in class, faithfulness and timeliness in doing class assignments, willingness to ask questions in class or in the instructor’s office, and time spent reading and studying to prepare for exams and quizzes.

- I have been very exceptional.
- My attendance was good and time was well spent.
- I could have done better on the homework assignments; just due to lack of time on my part.

B. Your instructor’s attendance, preparation, organization, and ability to present and explain course material.

- I was here everyday—most of the material was well presented.
- Good but goes off on tangents.
- The instructor’s attendance, preparation, and organization and overall teaching was excellent.
- Organization is the only thing. The books could have been more organized. A section where all labs are outlines and all extra information. The lectures could have been grouped better.
- Was fine, he had a lot of energy.

C. Did you feel you learned something useful in this course? If so, why? If not, whose effort was short—yours or the instructor’s?

- really, no information was really covered that I didn’t already know.
- I feel that I have learned a lot through labs and lecture.
- Yes, I’ve not had a class like this so I could only learn something new.
- Yes, I didn’t know as much about soil as everyone else.

D. Look at course goals on the syllabus. Were they accomplished? Why or why not?

- Yes, we did almost all of the things stated on the syllabus.
- Yes, they were accomplished and learned well.
- A and D are the only two I question. The lecture time should be discussion time, more class participation, especially since it was a small class. Force us to talk and discuss.
- Yes, we sure did all he wanted.

**ENV SCI T272 Student Comments Spring 2002**

Comments about the Course

- Pretty good course—learned a lot about some of the topics and from the teacher.

**CONCLUSIONS**

Both lecture and laboratory sessions can be a vital part of teaching environmental issues in agriculture. Outdoor laboratory sessions should include sample collection and preparation for analysis. Laboratory analysis of soil, water, and manure samples permits teaching analytical techniques and skills. Tasks related to assembling and interpreting the data build technical writing and oral communication skills. Student reactions to this course are below average for the instructor in other agronomy classes and for the average of all university faculty evaluations. The reasons may be too much
course content for the limited lecture discussion time and instructor expectations may be too high for the writing assignments.

ACKNOWLEDGMENTS

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REFERENCES