



## Session No. A407

### Learning Through Research

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#### Introduction

Certainly, most teachers work to make their classes comprehensible, relevant, and applicable. In teaching a new senior level undergraduate class ("Hazardous Waste and Pollution Control") in the Department of Environmental Sciences, this instructor sought to incorporate these traits and impart the fundamentals of industrial hazardous waste treatment and pollution control, while providing practice on environmental permitting requirements for industrial and commercial properties. Students came from disparate backgrounds. All were enrolled in one of three tracks in the Department of Environmental Science: environmental planning and policy, environmental science, or environmental safety and health. The course was taught through guided research on a specific industry; the end product was a permit application for an air permit and wastewater discharge permit, and the completion of a hazard waste manifest.

#### Objectives

The course (ESH 450 Hazardous Waste and Industrial Pollution Control) had, as its purpose, the exploration of the technical and regulatory requirements of the environmental permitting process, including air permitting, NPDES (National Pollutant Discharge Elimination System) permitting for wastewater, and hazardous waste permitting. Emphasis was on identifying and applying requirements for industrial ventures. Learning was achieved through a semester-long industrial case study.

The objectives of the course were: at the completion of the course, the learner will be able to:

Identify the air, NPDES and hazardous waste requirements for a new source (using Maine and EPA standards).

Outline/define the data needed to complete each type of permitting requirement.

Access and/or describe the data necessary to complete permit applications, and how to obtain it.

Draft a work plan for a comprehensive permit for a new industrial source.

This course, "Hazardous Waste and Pollution Control," was added to the curriculum on the recommendation of the Department of Environmental Science Advisory Committee. This 15-member external advisory committee has as its mission: "to provide guidance to the professors and endorsement to the program. Guidance shall include advice on issues of student preparation including curriculum content and delivery and shall assure relevance of the



program to employers in the State of Maine and the New England region. Endorsement shall include support of direction and activities, including the pursuit of program accreditation. Additionally, the Advisory Committee will serve as advocates of the program, by providing internships, practicum experiences, guest lectures and field trip experiences, as practicable to the students enrolled in the program.” (D’Orsie)

Representation rotates on approximate three-year staggered terms. Representation includes: industries, regulatory and governmental agencies, consulting, non-profit endeavors and other academic institutions.

The Advisory Committee strongly recommended that the curriculum be amended to teach students the fundamentals of obtaining permits for industrial and commercial ventures under the Clean Air Act, the Clean Water Act, and the Resource Conservation and Recovery Act.

An additional objective of the course was to engage these upper-level students in their own learning by journaling. To meet this end, every few weeks during class time, the students were given their individual journaling packages and an opportunity to write. The journaling package was a set of eight questions that outlined the steps necessary to teach adults (Laird):

1. Preparing learners for the program
2. Establishing a climate conducive to learning
3. Involving learners in mutual planning
4. Involving learners in diagnosing their learning needs
5. Involving learners in forming their learning objectives
6. Involving learners in designing their learning plans
7. Helping learners carry out their learning plans
8. Involving learners in evaluating their learning outcomes

These steps evolve from the six core assumptions of teaching adults (Laird):

1. Adults need to know why they need to learn something before learning it.
2. The self-concept of adults is heavily dependent upon a move toward self-direction.
3. Prior experiences of the learner become a rich resource for the learner.
4. Adults typically become ready to learn when they experience a need to cope with a life situation or perform a task.
5. Adults’ orientation to learning is life-centered and they see education as a process of developing increased competency levels to achieve their full potential.
6. The motivation for adult learners is internal rather than external.

## Design

The students were informed that this course was a new course, in an experimental format, emphasizing active learning. Eight students started the class; seven finished. One dropped the class “because it wasn’t what he expected.” Class met once a week for approximately 3 hours.

Each student selected (by “drawing”) an industry to study and permit. These included: seafood processing, potato processing, dairy processing, paper manufacture, metal finishing, and power production. Class activities were: required readings (text and reserve book); review of the Maine Department of Environmental Protection website on air, water and waste permitting; guest lectures (five) from the Maine Department of Environmental Protection and Maine industry; lecture; mentoring sessions, term (“language”) familiarization via weekly crossword puzzles; video material on wastewater treatment;



written assignments followed by professor comments and re-writes; and student presentations. The final project deliverable was defined as a notebook, as described in Table 1, presented at the end of this paper.

There were no examinations; all evaluation was by alternate means. Each student had the opportunity to earn 100 points by the following: completing the definition-of-terms crossword puzzles; providing facility descriptions; selecting and describing three process units, one for each media (air, water and waste), showing successful mid-term progress on evaluating air, solid and water regulatory and best practices requirements for his/her industry; and completing a final project notebook (See Table 1 for Table of Contents.)

## Resources

Two books provided the textual basis for the course. The text was: LaGrega, M.D., Buckingham, P.L., and Evans, J.C. (2001), *Hazardous Waste Management* (New York: McGraw-Hill Companies, Inc.). On reserve at the campus library were two copies of: Wang, L.K., Hung, Y.T., Lo, H.H. and C. Yapijackis. (2004), *Handbook of Industrial and Hazardous Wastes Treatment* (New York: Marcel Dekker, Inc.). In general, the students disliked both books, stating that they were too advanced.

The instructor was readily available for individual consultation. The instructor was experienced in applying for and obtaining air and wastewater permits, and completing hazardous waste manifests; she had about thirty years' experience in practicing environmental safety and health engineering.

Three class periods were devoted to well-qualified and well-prepared speakers from the Maine Department of Environmental Science. One session each was devoted to air permitting, wastewater permitting, and hazard waste activities, including manifesting. Additionally, another class provided an opportunity for individual mentoring with the teacher and another 25-year veteran of the industrial environment, a fellow Certified Industrial Hygienist and Certified Safety Professional. Because the instructor had to miss one class, the students enjoyed yet a different 25-year veteran of the industrial environment who lectured and coached on individual projects, again a fellow Certified Industrial Hygienist and Certified Safety Professional. Both of these men are active, as is the instructor, in the Maine Chapter of the American Society of Safety Engineers and the Down East Industrial Hygiene Association.

## Adult Learning and Reflection

Jonathan Klane (Klane), a noted adult safety trainer, provided an excellent summary of adult learner likes and dislikes in a recent publication. These "likes" include: active involvement, specificity, engagement, flexibility, accommodation, asking questions, group work, sharing experiences, self-directed and learner-centered. The instructor endeavored to include as many of these features as possible in the course. Nevertheless, both the instructor and students struggled with the course, as is demonstrated by the following student comments. Before the students' comments are the steps being considered by the student in his/her writings.

### **Preparing Learners for the Program:**

- I would feel like a lost dog if I wasn't being informed ahead of time about the entire project description, and just moving step-by-step.
- I don't think that I was prepared for how much work was going to be (required.)



- My experiences have helped me thus far. My relative lack of chemistry has slowed the learning process. The approach to the class was explained up front. My closest educational experience was my MBA, which relied on the case method. Much self-study and application of concepts and skills.
- I don't feel I was as prepared as well as I could have been, looking back at the semester as a whole. The level of unclarity at the beginning of the semester was almost overwhelming.
- It is extremely helpful for us to be able to understand what will be expected and how exactly we will go about achieving those ends.

Establishing a Climate Conducive to Learning:

- I feel the climate here is conducive to learning. Having guest speakers from the DEP enhances to learning process. It's like having additional professors!
- The individual meetings with mentors worked quite well. I came into the session this week feeling very uncertain, but I'm leaving with a very definite direction.
- I think that selecting an industry and process provides a specific objective to be met. I am concerned that I am not learning the necessary scope/breadth of subject material to further my understanding of this complex topic. I like the lecturers from the DEP as they provide a good perspective of what is required for permits.
  - I definitely feel like this is a good opportunity to learn because I've been given so much free reign, it's just really hard to be self-directed.
- I would call this an learning environment, sometimes it just feels like a slightly haphazard one because I am not sure where I should be and it is weird learning some of the things that I won't be tested on and won't help me in my project.
- Guest lecturers were well prepared, self-study was realistic, good guidance on where to find permits and rules.
- This was an environment conducive to learning, it just needs to be more focused and the material should be more pertinent to the class. A two-hour lecture on something that will in no way help our final grade sometimes feels like a waste, even if the material is interesting or would be helpful in the real world.

Involving Learners in Mutual Planning:

- As long as some of the deadlines remain rather flexible depending on how I am doing, then that is fine.
- Deadlines are helpful for me in this class. Reminding students of what's due is so helpful for me. Not at all classes are all like this so it helps me out a lot.
- We were able to schedule our own unit process deadlines. This gave us the option of taking on the easiest or most difficult first depending on our confidence level.
- Dr. D has asked the class on many occasions how we feel about our progress and where we are. The dates set out in the syllabus for deadlines have been revised according to our needs and ideas, which is great!
- There were many opportunities to ask questions of the guest speakers, cover ideas, and thoughts and progress with the professor.

Involving Participants in Diagnosing Their Learning Needs:

- More time needs to be spent on this. For example, early on, the expectation of creating projects was communicated, but given the skill level of the class, more practice is needed. Many permits will require calculations; mass flows, energy balances, but the skill set in this class lacks. Should we spend more time on this? It's probably beyond the scope of most students here.



- I'm not sure how well this goal was accomplished. I don't think the course material lends itself to this goal, with a huge variance in backgrounds and experience level there's a limit to how much the learning needs can be individualized.
- Breaking down steps to the lowest and simplest form is the easiest way to work.
- I think the learning experience got simplified from the initial thoughts of the course. Appeared we would do some P+ID's; mass energy flows, then we did not require these in our reports. Technology descriptions were simplified.
- Wow! I've realized that I have a lot of gaps in my knowledge while taking this course.

Involving Learners in Forming Their Learning Objectives:

- I have come to realize the wide berth we actually have on our projects. Though we are assigned an industry there are almost endless possibilities on how we apply our process units to the permit application process. We also have the choice of many different pollution control devices to employ in our factory. It's good to have this experience with choosing actual control technologies.
- Our objectives are fairly pre-set, but we have been given plenty of opportunities for assistance whenever it may be necessary.
- We did not really touch upon this.
- I think our objectives were definitely set from the start.

Involving Learners in Designing Their Learning Plans:

- I think this is a great idea – choosing your own location, chemicals etc. It allows you to choose a topic that really interests you. It is something you want to work with.
- We have a great deal of leeway in designing our learning plans. We choose what permits we apply for and for what process. There are many options so that we decide what process we learn.
- Our objectives were already formed by the class, so it seems like our plans aren't really up to us in the overall picture. However, what we focus on is completely up to us, but I don't think I've had much guidance to structure my research.
- The coaching and feedback sessions (1:1 and written) were good to get objectives and guide the student for their specific industry.
- In addition to having a choice on permits we have to decide what pollution control devices to use. This means we can research as much or as little as we decide. For those interested in control technology, it offers us a chance to browse what's out there.
- By being given the freedom to search and ask and hunt for answers has been a good thing.

Helping Learners Carry out Their Learning Plans:

- The mentoring session was an excellent way to help us progress.
- Anything I need help with, I am confident I will be given that help.
- I think there is too much self study to this point, especially as it relates to learning about waste technologies. Would like the opportunity to review these using case study methods. Understanding real examples used in BACT, BMP's etc. Review textbook readings for clarifications.
- As long as I can continually re-do assignments I will be alright.
- In the past two weeks we got an updated syllabus and an outline for how our projects should look. The outline is a very nice resource to have on such a large project and takes some of the pressure off as far as planning how to present our data.
- Doing a much better job here. Still would like to see more case studies. Examine real permits, navigate EPA and DEP sites.
- Again, while compiling the final project the outline was essential. Without the outline it would have been very difficult to compile the information in a logical format.
- I think we finally made it sensible!



#### Involving Learners in Evaluating Their Learning Outcomes:

- Good, again as long as I can continually redo things based on feedback I have gotten.
- I'm not certain that I really did evaluate my learning. We did have the chance to give input on how to improve the course. I feel that this is an important part of feeling like an active part of the process, it was good to be able to give that input.
- This opportunity for feedback has been very cathartic.
- We need more structure.
- Thank you for doing it this way. My education has greatly benefited from this.

## **Effectiveness**

From both the students' and instructor's viewpoints, the class was moderately successful. Everyone suffered frustrations. The instructor's viewpoint was, "one skill that you will need when you start working is the ability to apply for the environmental permits necessary for an industrial or commercial new source or modification. In this class, I will coach you through the process for a hypothetical new industrial venture in Maine." The students' viewpoint leaned toward, "If permits are important, then show me step-by-step how to get one."

The instructor made two poor assumptions in designing the course:

- The instructor assumed, based on personal working experience, and the comments of the Advisory Committee, that knowing how to obtain environmental permits was a critical skill for an environmental science student. The students, for the most part, lacked industrial exposure; consequently, they did not see the relevance. Most assumed, when they graduated, that they would work for state or local government or a non-profit environmental agency. Environmental permitting didn't seem to fit into their limited career plans. Additionally, the activity had no direct application to a situation they currently faced.
- The instructor assumed that, somewhere in the students' prior educations, all had been introduced to the concepts of heat and material balance, and the fundamentals of process engineering. (Matter is neither created nor destroyed; energy is neither created nor destroyed; work flows from one process or activity to another.) Chemistry and mathematical skills were apparently too weak to comprehend the text and the reference book.

As a result, the instructor had to simplify the project so that learning could occur.

All was not lost; the students did emerge from the class with some significant learning for environmental scientists:

- Environmental permits are needed for all major projects that affect the air and water or generate waste.
- Completing permits applications is time-consuming, detailed and labor intensive. Permit acquisition may be the critical path item on a project's construction schedule. A permittee may have to hire an environmental engineering consulting firm to complete the permit application.
- States have wonderful resources in the Department of Environmental Protection (or similarly named agency); these professionals are extremely helpful in the process of permit application.

## **Implications**

Several lessons emerge from this experience that have shaped curriculum revision. This class was dropped from a senior-level class to a junior-level class. About half the class will be devoted to the fundamentals of industrial processes. More information will be presented in lecture format. Although some video materials were used, additional sources are being investigated. A least one field trip will be included.



**Table 1.**

Final Project Deliverable (Tabbed Notebook) Hazardous Waste and Pollution Control

I. Description of “Type of Facility”

- a. Narrative description
- b. Process flow diagram (comprehensive) to accompany “Type of Facility”

II. Process Units Selected for this Project

- a. Unit selected for “air emissions”
  - i. Narrative description
  - ii. Process flow diagram for this unit
  - iii. Requirements that specifically apply to your unit

Copies (first page only) of federal and state requirements that specifically apply to the unit you selected (For example: If your permit application were for a hydrocarbon storage tank:

**Title 40: Protection of Environment**

[PART 63—NATIONAL EMISSION STANDARDS FOR HAZARDOUS AIR POLLUTANTS FOR SOURCE CATEGORIES Subpart G—National Emission Standards for Organic Hazardous Air Pollutants From the Synthetic Organic Chemical Manufacturing Industry for Process Vents, Storage Vessels, Transfer Operations, and Wastewater](#)

- iv. completed permit application form (Maine)
    - v. For blanks you don’t know how to fill out ... a work plan as to how you would find out that information
  - b. Unit selected for “MEDPES”/water discharge
    - i. Narrative description
    - ii. Process flow diagram for this unit
    - iii. Requirements that specifically apply to your unit.

Copies (first page only) that may apply to your unit. For example, the wastewater treatment plant for a synthetic organic chemical manufacturing facility projects certain requirements. (See above)

Classification of your receiving water body

- iv. A completed permit application form (Maine)
    - v. For blanks you don’t know how to fill out ... a work plan as to how you would find out that information
  - c. Hazardous Waste Manifest
    - i. Narrative description
    - ii. Process flow diagram for this unit
    - iii. Requirements that specifically apply to your unit
      - 1. Why is this material classified as a hazardous waste?
    - iv. Completed hazardous waste manifest
    - v. For blanks you don’t know how to fill out ... a work plan as to how you would find out that information

III. References



## Bibliography

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- Laird, Dugan, updated by Naquin, Sharon and Holton, Elwood III. Approaches to Training and Development. Cambridge, MA: Perseus Books Group, 2003.