Environmental engineering fact sheets teach more than just facts

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Abstract

Active learning has become the new rule in effective education. As educators, we couple this idea with the need for our students to develop technical communication skills. The result is the use of a classroom management tool such as WebCT as a forum for having students teach each other based on fact sheets they have developed. These fact sheets are formatted in a manner similar to what organizations such as the U.S. Environmental Protection Agency make available for the general public. The goals of these fact sheet assignments are to force students to critically think about what information is pertinent and then how to present that information. Not only are they required to work on written communication of facts, but also on their oral communication skills. The classroom management tool allows for setting up groups, communication among group members without necessarily meeting face-to-face, and posting of presentation material as well as the fact sheets themselves for the class to refer to on future dates, at their leisure, and in review for examinations over the material. In preparation students are required to pay particular attention to referencing information and evaluating the reliability of their sources. They are also afforded the opportunity to be creative in the presentation of their research while actively learning about their own topic as well as the topics classmates have researched. The format for submission is emailing a final draft of the fact sheet to a reviewer, whether the instructor or the teaching assistant, who then posts the edited version for class review. The presentations, however, are uploaded by the students, are presented via the course management tool, a computer, and projector, and are then reviewed. This process allows the grader to review the written presentation skills at their leisure, while concentrating on oral skills during the performance.

I. Introduction

Description of the course:

Environmental Engineering (CE 2633) is a sophomore/junior-level course in the Civil Engineering curriculum. This course introduces students to considerations of air pollution, solid and hazardous waste management, and water quality. The semester begins with a general discussion of environmental engineering that includes the science basis, environmental legislation, and risk and environmental impact assessments. The remainder of the semester is split into the air, solid/hazardous, and water sections where discussions are focused on concerns, specific legislation, analysis, and treatment or control measures.

Use of the course in the curriculum:

CE 2633 Environmental Engineering is a prerequisite for Water and Wastewater Treatment (CE 3633). During the past three semesters there has been a jump in the number of students enrolling in environmental engineering such that the average enrollment during the last three semesters has been 30 students. (Enrollment by semester: Fall 2000 – 19; Spring 2001 – 30; Fall 2001 – 19; Spring 2002 – 39; Fall 2002 – 31; Spring 2003 – 34) Most of the students enrolling in the course are taking either their first strictly engineering course or are in their first semester of taking “upper level” engineering coursework. Therefore, before this course, few of their previous courses have required application of principles to engineering problems.

During the Spring semester of 2001, the course began requiring students to research an environmental concern, prepare a short report or pamphlet, and present their findings to the class. Unfortunately this occurred at the end of the semester which meant that the presentation was viewed by the class, but the report was only seen by the professor and often the feedback given to students on the quality of the research effort and usefulness of the information presented was provided toward the close of the semester or after the final grades had been submitted if the students choose to inquire. Although the exercise was good from the experiential learning standpoint, it was not properly exploited for all the information it could provide to both the individual student and the class in general. Students should get more practice with the various aspects of technical communication (both oral and written)¹ and more feedback from the instructor and from their peers on the success of those efforts. To this end, students were assigned the task of producing fact sheets during various sections of the revised course. The first assignment called for students to work in groups, to prepare both the fact sheet and the more formal presentation of their findings on *air pollution detection and/or control*. A second assignment called for them to individually produce a fact sheet on the *state of recycling* of an assigned material. Preparation of the latter fact sheet allowed students to improve their efforts based on their group experience earlier in the semester.

II. Objectives of Assignment

A. *Technical Communication Skills Development and Feedback*

The impetus for the use of the fact sheet is citation of pertinent examples such as those provided by the U.S. Environmental Protection Agency² that are intended to provide a general audience with an understanding of certain technical information. As students prepare to present their research findings to the class they are expected develop some of the following communication skills that will be useful to them when they become practicing engineers.

- Critically thinking about how much of the information gathered is pertinent.
- Critically thinking about how to present that information succinctly.
- Paying particular attention to how and when to reference information and sources.
- Consideration of the various formats you have to present the information, namely:
 - A one-page fact sheet;
 - A PowerPoint presentation; and
 - An oral presentation (with a brief question and answer, Q&A, session).

In addition to preparing and presenting their own topics students were asked to evaluate both the presentation and content of information provided by their peers. Evaluation forms were provided to the class and they were encouraged to actively participate in the Q&A session.

B. Use of WebCT Course Management Tool

The course management tool WebCT was critical to the success of this project because it allowed for

- Students to personally communicate with only their group members through the web;
- Groups to submit their fact sheet drafts to the instructor for review;
- Groups to upload their PowerPoint presentations to the web-platform for ease of presentation;
- Other students in the class access to the corrected versions of the fact sheets as well as the PowerPoint presentations for future (exam preparation) reference; and,
- The instructor/grader to pay attention to oral communication skills during the day of the presentation and to review written (slide show) presentation skills afterwards

III. Implementation

A. Fact Sheet

The *air pollution detection and/or control* fact sheet assignment was posted on WebCT in HTML format (Figure 1). The information provided to the class at the start of the assignment follows:

Fact sheets should:

- Be a single page;
- Provide an illustration/picture of how "it" actually looks;
- Contain pertinent information which includes:
 - Physical description of control mechanism, of phenomenon being observed, or of principle parts of the object,
 - Operation (how the technology works), and
 - "Its" significance to air quality.
- Contain reference information about your sources;
- List group member names and each of their contributions; and,
- Be presented orally to the class (particularly discuss the usefulness of your fact sheet to the study of air quality)

B. Slide Show

Students were encouraged to use PowerPoint for preparing their presentation slides. Use of the Presentations tool in WebCT allowed for each of the groups to upload their presentations to a group folder. During the days of the presentations, using a computer connected to the Internet and a projector, groups were able to log onto WebCT and present their slide shows without having to fumble with changing disks on the computer or many of the other breakdown and setup activities typically associated with in-class presentations.

Format:

<p>Civil and Environmental Engineering, UTSA CE 2633 Environmental Engineering <Title of Fact Sheet> <i><Group member, contribution to fact sheet preparation></i></p> <p>Physical Description (and Illustration): <i><The physical description should explain what is being presented in the illustration></i></p> <p>Operation (how the technology works): <i><present chemistry basis, equations, or subjects which improve understanding of how this technology can be or is being used></i></p> <p>Significance to Air Quality: <i><the big picture of why awareness of your process/object is important to this discussion topic></i></p> <p>References <i><bibliographical information to help readers know where they can find more information if they are interested></i></p>
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Group Assignments

Control Technology	Other
Electrostatic Precipitator -- Group 1 (October 3 presentation) <ul style="list-style-type: none"> Group member names 	Fuel Cell -- Group 6 (October 8 presentation) <ul style="list-style-type: none"> Group member names
HEPA filter -- Group 2 (October 3 presentation) <ul style="list-style-type: none"> Group member names 	Hybrid Cars -- Group 7 (October 8 presentation) <ul style="list-style-type: none"> Group member names
Conventional Scrubber -- Group 3 (October 3 presentation) <ul style="list-style-type: none"> Group member names 	Stratospheric Ozone Hole -- Group 8 (October 8 presentation) <ul style="list-style-type: none"> Group member names
Catalytic Converter -- Group 4 (October 3 presentation) <ul style="list-style-type: none"> Group member names 	Saharan/African Dust -- Group 9 (October 8 presentation) <ul style="list-style-type: none"> Group member names
Baghouse -- Group 5 (October 8 presentation) <ul style="list-style-type: none"> Group member names 	

Figure 1: Web Page Assignment made available to the students in the class.

The increased luxury of posting the slide presentations on WebCT was the ability of both the instructor and the students in the class to return to the presentations to review them at future

dates. Additionally, because the presentations are housed in individual group folders, group members themselves can repeatedly modify the presentation at any time yet only the group and the instructor are allowed such privileges.

C. Oral Presentation

The oral presentation served multiple purposes:

- It allowed students to demonstrate their understanding of the material.
- It demonstrated, in a snapshot, the dynamics of the group.
- It forced students who are not normally vocal in class to gain the experience of presenting material to an audience of peers.
- It also provided other members of the class the opportunity to hone their evaluation and questioning skills.
- Finally, the oral presentation was used as a platform for the instructor to point out pertinent information either about presenting, about research, or about the subject matter itself.

During the various days of presentations, there was dialogue about the subjects in between presentations. Students in this class began to critically evaluate the reliability of their sources, especially those found on the World Wide Web.

IV. Results and Assessments

A. Good and Bad Examples of Fact Sheets

The fact sheets submitted by the students varied in the degree in which they followed the assignment guidelines and the creativity shown by the group in presenting their research. The definitions of good and bad examples used here is more of an evaluation of how closely the submissions came to meeting expectations and the vision of what might come out of the assignment.

A bad example of the assignment (Figure 2) is one in which some of the stated requirements of the assignment are not met. One obvious shortcoming is the lack of member roles listed with the names of the group members. This example illustrates almost a complete lack of creativity on the part of the group. It also demonstrates the fact that these students did not take the assignment “personally.” In an active learning setting, students are expected to take some pride in the products they produce as part of a course. Such pride provides a basis for motivating students to put significant effort into the interaction between the instructor and the students. A good student and, arguably a good engineer, is one who takes the basic requirements of a project and goes a step further with the product produced. Such extra efforts win contract bids and create a reputation for the type of work expected. These points and lessons are the kind of feedback the instructor is able to provide to students as a result of this assignment.

The good example provided here (Figure 3) demonstrates both the creativity and comradery of the members of the group. This is a good illustration of not only a group taking pride in their product, but also of one going far beyond the expectations of the assignment. There were similar efforts put into fact sheets that looked more closely like the assignment provided on WebCT.

“Bag House”

By: Group member 1, Group member 2, and Group member 3

What is a Baghouse?

The Baghouse is a generic name for Air Pollution Control Equipment (APC) that is designed around the use of engineered fabric filter tubes, envelopes or cartridges in the dust capturing, separation or filtering process. Baghouses are not "big vacuum cleaners". The fact that a system can be engineered for almost any dust producing application under almost any set of circumstances puts them into a totally different class. Because of the wide range of available fabric filter media, the baghouse has proven that it will remain a prime player in the worldwide quest for cleaner air. Baghouses can be found in virtually every industry: foundry and steel operations, pharmaceutical producers, food manufacturers, and chemical producers. The range of uses is staggering. They exist in nearly every country in the world.

Multi-compartment top
removable pulse jet system

Operation:

Baghouses work like a large vacuum cleaner and catch particles of ash before they get to the incinerator stack. However, some critics say that the reduced amounts of pollutants released by newer incinerators are still unsafe. The baghouse filters fine dust that passes through cyclones. This permits recirculation of cleaned air where allowed with an open or closed panels. A filterkop dust collector will clear the air of very fine dusts, and keep it that way. This utilizes a permanent fabric filter system (baghouse). The filterkop removes very “fines” as small as 0.3 microns from the airstream, and returns cleaned air back to the workplace, or vents it as desired. The system requires no cartridge filters, or cartridge replacement expense. The dust laden air enters the inlet duct, and circulates upward and through the cloth filter tubes. Dust is then collected by the tubes, and clean air exists via the tube walls and through the baghouse outlet to the outside atmosphere, or back to the plant interior, where permitted. A motorized shaker removes dust from the tubes which falls into the hopper bottom and into one or more collection drums.

Significance to Air Quality:

Baghouses are very important to the air quality as they pick up very small dust particles. Efficiencies approach 100 percent removal of particles as small as 0.01 μm ; substantial quantities of particles as small as 0.01 μm are also removed. The disadvantages are they can be expensive and very large. They also can be harmed by corrosive chemicals in the flue gases, and they do not operate well in moist environments. They also pose some potential for fires or explosions if the dust is combustible.

References

For more information: <http://www.baghouse.net>

Figure 2: A “bad” example of the type of air pollution control fact sheet expected from the students in the Environmental Engineering class.

CATALYTIC CONVERTERS

SYSTEM FUNCTION

The centerpiece of the U.S. motor vehicle emission control program is the catalytic converter. Most modern cars are equipped with a three-way catalytic converter. "Three-way" refers to the 3 regulated emissions that it helps to reduce - CO, volatile organic compounds (VOCs) and NOx molecules. The converter uses 2 different types of catalysts, a reduction catalyst and an oxidation

catalyst.

The reduction catalyst is the first stage and uses platinum and rhodium to reduce NOx emissions. The oxidation catalyst is the second stage and reduces unburned hydrocarbon and CO emissions.

$$2 \text{NO} \rightarrow \text{N}_2 + \text{O}_2$$
$$2 \text{NO}_2 \rightarrow \text{N}_2 + 2\text{O}_2$$
$$2 \text{CO} + \text{O}_2 \rightarrow 2 \text{CO}_2$$
$$\text{NO} + \text{CO} \rightarrow \text{N} + \text{O}_2$$
$$\text{NO} + \text{H}_2 \rightarrow \text{N} + \text{H}_2\text{O}$$

ANATOMY OF A CATALYTIC CONVERTER

A catalytic converter is made up of five key components. These are — the substrate, the washcoat, the catalysts, the mat and the can — must be properly configured to vehicle-specific parameters in order to achieve maximum emissions conversion. A mat surrounding the catalyzed substrate provides thermal insulation and protects against mechanical shock and chassis vibration. These components are encased in a metal can with end cones, which link to the exhaust pipe to complete the catalytic converter package.

Substrate -- A ceramic honeycomb-like structure

with thousands of parallel channels that provide a large surface area for the application of washcoat and precious-metal catalyst to convert the engine exhaust to less harmful components. This is the clean-air enabler at the heart of

the catalytic converter.

Mat -- A wrapping surrounding the catalyzed substrate that provides thermal insulation and protects against mechanical shock and chassis vibration. Mats are available in a variety of mat densities, thick-nesses,

and compositions.

Can -- A metal package that encases the catalyzed substrate and mat, and integrates it into the exhaust system.

Washcoat -- A coating that increases the surface area of the substrate for catalysis, which helps control emissions conversion across the fluctuations of engine operations and facilitates the application of precious-metal catalysts onto the surface of the ceramic.

Catalysts -- Catalytically active precious metals and other components are incorporated into the washcoat. The treated washcoat is then applied to the ceramic substrate, where the catalytically active materials convert noxious emissions into less harmful gases and water vapor.

SIGNIFICANCE TO AIR QUALITY

Vehicles sold today now emit 96% less CO, 98% less HCs, and 90% less NOx than vehicles sold in the early 1970s. Improvements in air quality are ongoing, since new vehicles are equipped with the latest emission control technology and older cars are

scrapped. 85% of automotive air pollution comes from the oldest 50% of vehicles on the road today. Fuel economy began a dramatic, continuous rise beginning with catalyst-equipped 1975 model automobiles that were meeting much tighter

emission requirements. This was largely because the use of the catalyst to control emissions allowed manufacturers to design for efficiency. Because the catalyst is poisoned by lead, the use of catalytic converters helped bring about the elimination of gaso-

line containing lead, which has been found to be a serious health hazard.

Today, a catalytic converter is an integral part of a vehicle's computerized engine system designed for optimal fuel economy, performance, and emission control.

References: http://www.corning.com/environmentaltechnologies/auto_emissions | <http://www.howstuffworks.com> | <http://www.meca.org/catalystfact>

Figure 3: A "good" example of the type of air pollution control fact sheet expected from the students in the Environmental Engineering class.

B. Oral Presentations

The group dynamics suggested by the fact sheets were verified during the oral presentations. In this setting students had not been assigned roles within their groups and had not been coached prior to giving their presentations. Most of the groups chose to have each member of the group present during their time. It was obvious to the audience when a group member was basically presenting the information that he/she had personally researched. There were a few groups who choose to have a spokesperson, who then deferred some questions to the person or persons most prepared to provide the pertinent information.

Questions posed by their peers were insightful. Because the students presented information not also researched by other members of the class, there was a genuine interest in getting answers to the questions posed as opposed to trying to determine the extent to which the research was conducted. The latter type of Q&A session is more likely when students are asked to present information on a subject also researched by other members of the class, as was the case with the preparation of the *state of recycling* fact sheet assignment later in the semester.

C. Written Evaluation of peers

Peer evaluation was done in two ways as part of this assignment, class evaluation of the group (Table 1) and group member evaluations of each other (Figure 4). One evaluation was conducted during the oral presentation. Each student was expected to evaluate at least one of the groups presenting. As a result of the size of the class each group was critiqued by at least three of their peers and the instructor/grader on their presentation style as well as on the information presented. These comments were compiled and returned to the groups electronically through WebCT. Members of each group were then asked to evaluate their own effort in the group and to grade themselves first and then the other members of the group on contributions to group success and completion of the project.

When the groups were asked to evaluate each other they had to follow this format:

1. *What did you contribute to the group project? (be specific in describing effort)*
 2. *How well did you get along with your group members?*
 3. *Were there any problems encountered by the group? How were these resolved?*
 4. *How would you rate yourself (first) and then each of your group members?*
- Please comment and justify ratings.*

Group Member Name – Grade: Comments

Figure 4: Format for the group member evaluations.

Table 1: Class evaluation of the selected groups

Evaluation Categories	Comments
The Talk: Technical level relative to audience: 1. Apparent interest to the audience: 2. The title was informative: 3. The amount of the material presented (quantity): 4. The introduction: 5. Conclusion relative to talk: ...	Baghouse ok 1. relevant – Kirby Vacuum cleaner good example 2. yes 3. good 4. put the most energetic/strongest speaker in the beginning to get attention 5. ok
	Catalytic Converter simple yes ok 1. very interesting yes good Broke down each part of catalytic converter - why the name? Catalyst explained. Catalysts are inhibited by lead (coated) - purposes for unleading, typically last 50,000 miles - what are resulting products 2. yes appeared to have thoroughly researched the topic. yes 3. Enough info. good 4. good good - strongest speaker began presentation 5. good yes - not really a conclusion...
Preparation: 1. The talk appeared well prepared: 2. Visual aids (clear, relevant, number): 3. The speaker was prepared to answer questions:	Baghouse 1. yes Should have walked through operation rather than just reading. Different styles (ran through). 2. ok 3. did ok with what you had - deferred to website - good technique, but could have done more research. Applications (industries typically using technology) =>not very good answer. -X Treatment of dust collected (not sure)- X
	Catalytic Converter 1. yes yes 2. very good. Good. need bolder font, too many words on slides. Did the best they could to bring a visual, due to regulations. 3. yes. yes.
Style: 1. Speaker's general style: 2. Use of visual aids: 3. Interaction with the audience: 4. Nervousness shown by the speaker: 5. The speaker stayed within the time limits:	Baghouse 1. try not to read so much (1 st guy) 2. ok - not anything extraordinary... 3. 4. no 5. I think so.
	Catalytic Converter 1. very good. good 2. yes. good 3. yes. yes 4. Negligible. no 5. a little over, but we had time

Ranking 1 to 5: Speaker did an excellent job. (5) Speaker did well. (4) Speaker was average. (3) Speaker was weak. (2) Speaker needs to work on this area. (1)	Baghouse 3.8 4 3	Catalytic Converter 5 5 5
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D. Evaluation of assignment

At the end of the semester as part of the course evaluation students were asked to evaluate the fact sheet assignment on whether they felt like it had been an effective exercise and provide suggestions for changes and improvements to the assignment. Table 2 provides the questions asked and some of the answers posed by the students.

Table 2: Student feedback on the fact sheet assignment from the end-of-semester course evaluation

Group versus individual assignment preference? <ul style="list-style-type: none"> • Prefer assigned tasks/individual project where groups of people have the same task and check each other • Working with each other allowed us to help each other with understanding • A little of both. Thought instructor should choose groups, mix it up, and change the group dynamic for each assignment • Individual because sometimes the group does not do their job • Group, but I like working alone also
Enjoyed doing both types of assignments versus one or the other? <ul style="list-style-type: none"> • Both seemed to work fairly well in THIS class • I enjoyed both • Prefer doing assignments on own, but believe it necessary and useful to work with others • Both. There is a time and a place for one to try to figure out on their own
Appropriate/inappropriate group evaluation sheets? <ul style="list-style-type: none"> • Appropriate to voice view on what really went on • Appropriate because it forced all to do an equal share • Neither, not a true reflection of group process. Most people do not want to make someone else look bad
Assignment helped/hindered your understanding of the topics? <ul style="list-style-type: none"> • Helped, but was a little broad/abundance of information with the air section • Helped • Neither

V. Conclusions and Future Work

From the viewpoint of the instructor this exercise worked well and was of great benefit to the students. However, the course evaluations provide more information on the usefulness of the exercise to the students. From the standpoint of trying to learn the material, the students seem to agree that much was learned. From the standpoint of trying to learn group dynamics, many of the students found the experience less desirable.

In future semesters the course will likely also incorporate a lecture from the UTSA Communication Department on the benefits and considerations of technical communication. This presentation should make the students are more keenly aware of, going into similar assignments, what is expected of them and allow them to produce higher quality presentations.

Some of the suggestions for the future presented by the students include:

- Not so much work where you are just trying to finish rather than taking a little more time to figure out the profess of solving it
- More presentations
- Mixing up groups may lead to more “truer” results in instructor continues evaluations
- Switch groups and assign people
- Maybe a check point in class of where the groups should be
- Maybe include a couple more fact sheets in the semester

These suggestions suggest a continuing need to determine the most appropriate ways to provide students with a better active learning experience.

References

1. *The essence of technical communication for engineers: writing, presentation, and meeting skills*. Herbert L. Hirsch, New York: IEEE Press, c2000.
2. URL: <http://es.epa.gov/techinfo/facts/facts.html>; “EnvironSense P2 Fact Sheets”, updated July 9, 1997.

Author Biography

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