A Course Portfolio for Chemistry 2230/2240
(Organic Chemistry Laboratory)

Bryan Klassen
Chemistry Department
May 21, 1998
# Table of Contents

Table of Contents ................................................................. ii

Cover letter ................................................................. iii

Teaching philosophy ....................................................... 1

Syllabus for Chemistry 2230 (Organic Chemistry Laboratory) .... 6

Comments on the Syllabus .................................................. 9

Teaching strategies ......................................................... 11

Reflections on student feedback .......................................... 15

Odds and ends ............................................................. 17
To the Reader:

Several different audiences are intended for this teaching portfolio. This portfolio is intended primarily for me to use in developing my organic chemistry labs. Next, it is meant for peers who are willing to offer constructive criticism of my goals and methodology. Further, selected portions are intended for my students. They will receive a picture of what I seek from the course and will, I hope, offer constructive ideas of their own in response. Finally, the portfolio may be presented to the rank and tenure committee as evidence of the maturation that has accompanied my teaching here at Xavier. This document can provide a perspective from which student evaluations will become more meaningful, particularly if students have been asked to comment on specific portions of the course.

I have taught at three different colleges in as many years. At all campuses, I was a junior faculty member and spent much of my time trying to adjust to programs and syllabi assembled by others. Now, at the end of my first year at Xavier, I am trying to assimilate the lessons of these turbulent three years into a vivid picture of my teaching in all its parts. This portfolio is meant to be living document that leaves room for future growth. It is able to assist me right now; but if portions later seem misguided in their conclusions or perspectives, they should be chucked and replaced without tears or shame.

I have taught several different lab courses and I expect to continue doing so. Labs are frequently unpopular with students and teachers alike. I understand. I do not always like them myself. Many feel that the courses give a poor return on the time invested. Students often complain that lab courses are not relevant to their careers. Faculty tend to prefer lectures for a variety of reasons. But labs will remain a central part of my teaching experience. Thus, I am particularly interested in solving this riddle: How can lab courses be made more engaging without lessening their useful content?

This portfolio is the beginning of an ongoing study of laboratory courses. It attempts to do the following: analyze the function of lab courses for majors and non-majors; reflect on the impact of student-teacher relationships on achieving course objectives; create a coherent "mission statement" that will guide me through a school term; preserve continuity through the years while preventing stagnancy; and compare the effectiveness of different approaches and pilot projects over time.

My course portfolio contains the following:

- this cover letter, which serves to introduce and orient the reader.
- a teaching philosophy. This presents my perspective on what a teacher is, what characterizes the relationship between teacher and student, and relates a specific
course (Organic Chem Lab 2230/2240) to my discipline and to the university.

- comments on the syllabus. The students receive a syllabus produced by a team of faculty. The individual instructors are permitted, however, to modify this syllabus within narrow limits. My annotations highlight my particular emphases and also any additional assignments.

- teaching strategies and student learning outcomes. I have some ideas that I have not seen used in chemistry lab courses. This section outlines a few that I have used or will use in the future. In the future, this section will include student work illustrating their progress through the term.

- reflections on student evaluations. This section records notable comments made by students, and my reflections on their import.

- odds-and-ends. I have collected a number of thoughts to be ruminated and kernels of projects. Some represent ambitious changes in the course; others are mere thoughts which have not been incorporated into the portfolio, but promise eventually to find a place. This section is meant for me alone, but other readers are invited to explore this turbulent portion of the portfolio, where the half-baked and the bright are received as equals. No attempt has been made to organize these entries: the only requirement is that the idea be sufficiently descriptive that I will remember what I meant the next time I read it! All sections of the portfolio are "working documents", but they still reflect extensive editing and are somewhat removed from the original creative process. This section, however, preserves ideas that have germinated but have not produced mature fruit.

Bryan Klassen
Teaching philosophy

Why should I teach? What good can come from it?
I have ruminated these questions, processing them first one way, then another, but finding always that they left something behind, something that could not be completely digested. The meal is too large.
Instead, I will describe my teaching philosophy in connection with only a single course, Organic Chemistry Lab 2230/2240. I will discuss the convictions and perspective that I bring into the classroom, proceeding afterward to explain the role I see for this specific class within the department and the institution. What follows is a living, changing document. It is my current expression of what impels me to return to the classroom daily and a statement of what I think I can hope to accomplish in this particular class. In this I have been helped by the comments and writings of many others, particularly Fred Bales.

Personal teaching philosophy

Until I was twelve I had no interest whatever in science. None. Science meant handling dirty rocks and peering into microscopes that would not focus. It meant field trips to mosquito-infested swamps on hot days and lukewarm bag lunches. Things changed with the arrival of Vernon Huebschwerlen, my seventh-grade life sciences teacher. "Huebie" came into class daily with fresh anecdotes about beetles and frogs and sex education and many irrelevant subjects as well. His challenging statement that a mosquito was not really a true bug led the class from our emotional pronouncements ("Well, Mom and Dad call them bugs!") to the revelation that entomologists reserved this ordinary-sounding term for only a specific order (of which there are 26) of insects. With joy we pursued the insects that would compose our required collection, turning over dirty rocks, inspecting our prey under microscopes, and persuading our mothers to take us to the foothills on private field trips where we found precious specimens of Mecoptera and Orthoptera, and, yes--even ate lukewarm lunches. Because we received more points for the first specimen of a new order than for subsequent additions, we learned to collect extra specimens for trading with others. One of the best bargains I ever drove netted me a prized termite (which I had never before seen) for a worthless earwig rousted from beneath the family refrigerator.

After "Huebie", it was Dave Sischo who opened my eyes to the treasures of American history, which I had previously disparaged as boring when compared with the excitement of European wars and Crusades. Notably, another teacher had tried to effect this transformation three years earlier, with wretched results. Then it was Len Barton and calculus. Angie Stacy and inorganic chemistry. Eric Jacobsen and organometallic chemistry. And so on. In literature, people like James Michener have awakened me to the fascinating histories and cultures of such seemingly dull places as Houston, the Platte River, Afghanistan, and Poland. In each case, my interest was awakened by someone who loved the subject. I learned why it was worthy of study and how I could study it. When I see a lowly earwig, it is
possible that I will crush it. What is far more likely is that I will start turning over the stones beside the patio and checking to see what species are hiding there. When memory fails, I have my Zim's guide to refresh it. When I am reunited with old friends, it is these teachers we remember. The others are not always forgotten, but neither is their impact much felt. Sometimes their subject is still resented. In many cases we struggle to remember even the teacher's name.

I will not surprise the reader when I say that the men and women I have named are the embodiments of something much more nebulous, namely my teaching philosophy. I think of them and ask, why did they succeed, while so many others did not? I appreciate Bales' dissection of the varied roles played by instructors and will use his model. Although my choice of terms differs somewhat from his, the characteristics are similar.

I am a coach-as-halftime-motivator. In this role, I try to communicate enthusiasm for my subject and my belief that my students can master it. I address the attitudes in the hearts of students. Frequently, only a few students will be interested in a particular required course. Thus, I introduce features of my subject that connect to things that they already enjoy. I point out things that interest me about a subject, in the hope they will find them interesting, too. Also, I provide reassurance to the students that they can master the subject. A class senses my attitude toward it, and is (I hope) affected accordingly.

I am a trainer. Few enjoy sports practice, but the athlete knows The Game will come, and training will show. The trainer must drill the athlete and critique the performance without always grading it. Chemistry courses, which have a high objective content, are similar. The students need to master certain skills and learn certain facts (often prescribed by the department) to be considered proficient in a subject. I must be firm and clear in directing a class to complete these, sometimes by repetition of unpleasant exercises. In my function as trainer, I should offer constructive criticism that helps the student see how to do better the next time.

I am a coach-as-pregame-planner. While a trainer works on narrow aspects of a game, the coach is responsible for grand strategy and for the final product. I must bear in mind that few of my students will actually attend graduate school in chemistry. But the analytical skills they exercise here at Xavier will find use countless times during their lives. Doctors, for example, will need to write clear and thoughtful reports on their patients. Observations must be made carefully and thoroughly and be used to draw consistent conclusions. Therefore, I want to attend to those aspects of a course that will probably be most useful to them over a lifetime.

In the roles I describe, the relationships between the teacher and the students are hierarchical in varying degrees. The content of an introductory laboratory course tends to make them so, although I am not sure that I like this. The students learn a large amount of information and master unfamiliar skills. The students and their instructor will rarely have comparable levels of comprehension. Perhaps the inequality in student/teacher roles can be reduced by the creative use of collaborative or cooperative teaching strategies (as introduced by Cederblom and Gillespie), and I am eager to explore their use.

In sum, I want to communicate enthusiasm and high expectations. Horace wished for writers that delight and instruct their readers: his words are apt for the
successful teacher as well. I cannot only entertain--TV comedians do the job better. Neither I can I merely communicate information--or I become William Auden's nightmare, "a professor [being] someone who talks in another person's sleep." I must constantly remind myself of the twin obligations to delight and to instruct. In practice, I will probably oscillate between overemphasizing one and then the other. The point is to monitor both progress toward class objectives and also student attitudes, without slighting either.

It may be that I emphasize more than usual the importance of student attitudes. If a course is required, one may say, the class will study the material whether it is enjoyable or not. Besides, heeding students' wishes too closely may debase overall standards. These concerns have merit, and there are other potent objections besides.

But I have been repeatedly amazed by the transformation that time brings when real motivation exists. No matter the poorness of the learning conditions, people show astounding insight and capacity to learn when they are properly motivated. The diagnosis made by a mechanic who hears a single sound, the encyclopedic knowledge of a die-hard baseball enthusiast--these are not trivial achievements, yet they are demonstrated everyday by people who never went to college. Desire, once germinated, often cultivates itself.

On the other hand, I rarely find people who have unlearned a dislike for a subject. And that dislike is manifested by the efficiency with which they have purged the brain of all data connected with the offensive topic. If a student learns early to dislike a subject, chances are that the dislike will persist long after the final exam and may be felt years or decades later. On airplanes, I have met people who find that I am a chemist and ask, "I've always wanted to know why..." These same people began by saying, "I always liked chemistry." I can't recall someone who said, "Oh, I hated chemistry," and then asked, "Why is it that...?"

Let us delight and instruct. Or as a famous evangelist put it bluntly, "Open the mouth wide with laughter, and then dump some truth into it."

The role within the institution

What role does a laboratory course in organic chemistry play within the university? How does this affect the way I view the course and my methods in teaching it?

As Bales points out, "the burden of exploring writing with students cannot be borne by the English Department alone." The same may be said for the task of teaching critical thinking. Both of these are responsibilities of all departments. In a culture saturated with data, students can feel disoriented and confused. All of us should offer what assistance we can in helping them to reconnect fragmented facts and to trace patterns within complex tangles of information.

Within my discipline, these functions are probably best performed by laboratory courses. These courses require students to analyze data, draw conclusions, and document their progress in writing throughout. A good report does need not arrive at the hoped-for result, but it should reach conclusions justified by the data and attempt to explain any shortcomings.
A more narrow role within the university lies in the education of future doctors and pharmacists. While there is no specific reference to this role in the mission statement, Xavier is justly proud of its many students who continue on to these professions. The school should be interested in the role that each course plays in a student’s training. Our chemistry majors who pursue careers in medicine and allied fields will not perform organic reactions ever again; they will, however, constantly require keen observational skills, critical thinking and good writing. Thus, I believe that the complete and coherent presentation of laboratory results is one of the most important components of laboratory work.

The role within the department

Like most courses, laboratories contain components that may be labeled "skills" and "content". The traditional view is that experimental work contains primarily skills, and manual ones at that: for example, one learns to distill a liquid, perform thin-layer chromatography, and recrystallize impure compounds. But the skills of critical thinking and writing are also very important, and without a solid basis of background and theory they are not possible. One may argue, as I do, that the laboratory is perhaps the best place within chemistry where these latter skills can be fostered. Lecture courses in chemistry are usually heavily objective in content, as evidenced by the commonness of "posted answers". Most questions have a best answer--partial credit is obtained by closely approximating that answer. Unless questions are carefully designed, they usually do not require critical thinking so much as the application of various techniques or recall of specific details. In the lab, however, things go wrong: the right compound is not obtained; the melting range is too broad; the apparatus doesn't work properly; and so forth. It is precisely at this point that critical thinking becomes possible and necessary. What may have gone wrong? What are the possibilities? Which of these possibilities can be discounted, and why? What further tests might be used to confirm this explanation? How could the procedure be altered to improve the results?

Within my discipline, original supervised research provides the best environment for exercising critical thinking and good writing. Few students within our department, however, actually reach this level. In terms of the number of students affected, laboratory courses provide the largest opportunity for developing these skills. Laboratories help students to see how real experimental data can be interpreted in view of accepted theories to yield a coherent conclusion.

Unfortunately, students tend toward one of two extreme views. Some believe that lab courses are not writing courses. Whether the experiment is successful or not, they comment sparingly on the results. In laboratories, however, I value students' analyses more than their degree of success. I do not always collect the compounds my students isolate, but I always read their discussion of the data and critique of the problems with the experiment. What I want to see is if their conclusion is consistent with the data and if they realize how strongly this conclusion is supported. It is worse to draw a rosy conclusion from modestly successful data than carefully to account for an unqualified experimental failure.
Other students tend to think that good reports = lengthy reports. Reading lab reports is tedious when this equation becomes axiomatic. The resulting writing drifts, because these students include everything without much attention to order or significance. I reward students who express their views succinctly yet completely and in orderly fashion. But I must also take considerable time to help each student see how to improve the next report. The amount of reading I must do limits what I can do. Although I point out egregious grammatical problems, I focus more on helping them to transform their jagged analyses into smooth summaries.

What has preceded divides my thoughts somewhat artificially. I desire to provide the students a coherent picture of the role of my discipline in the world. I hope that students will be discriminating diners at an academic smorgasbord where the entrees are the paradigms of various instructors. The students examine each prospect and decide which fills the current need. My approach to my discipline should provide coherent connections to other disciplines; otherwise, it will be rejected for lack of relevance. After the meal, one doesn’t want to find dinner rolls in the dessert section. His interests lie elsewhere.
Syllabus
CHEM 2230LB (Organic Chemistry Laboratory I)
Fall Semester 1997

<table>
<thead>
<tr>
<th>Section</th>
<th>Day</th>
<th>Class time</th>
<th>Locat</th>
<th>Instructor</th>
<th>Off #</th>
<th>Phone #</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M</td>
<td>8:00-10:50</td>
<td>36-322</td>
<td>Dr. Giannamore</td>
<td>36-323</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>11:00-1:50</td>
<td>36-302</td>
<td>Dr. Cheng</td>
<td>36-309</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>M</td>
<td>2:00-4:50</td>
<td>36-302</td>
<td>Dr. Robbs</td>
<td>36-101</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>T</td>
<td>7:50-10:40</td>
<td>36-302</td>
<td>Dr. Sevenair</td>
<td>36-301J</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>T</td>
<td>1:15-4:05</td>
<td>36-302</td>
<td>Dr. Foroozesh</td>
<td>36-322C</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>W</td>
<td>8:00-10:50</td>
<td>36-302</td>
<td>Dr. Robbs</td>
<td>36-101</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>W</td>
<td>11:00-1:50</td>
<td>36-302</td>
<td>Dr. Howell</td>
<td>36-301A</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>W</td>
<td>2:00-4:50</td>
<td>36-302</td>
<td>Dr. Sevenair</td>
<td>36-301J</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>R</td>
<td>7:50-10:40</td>
<td>36-302</td>
<td>Dr. Sevenair</td>
<td>36-301J</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>R</td>
<td>1:15-4:05</td>
<td>36-302</td>
<td>Dr. Howell</td>
<td>36-301A</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>F</td>
<td>8:00-10:50</td>
<td>36-302</td>
<td>Dr. Ray</td>
<td>36-301F</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>F</td>
<td>11:00-1:50</td>
<td>36-302</td>
<td>Dr. Howell</td>
<td>36-301A</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>F</td>
<td>2:00-4:50</td>
<td>36-302</td>
<td>Dr. Cheng</td>
<td>36-309</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>M</td>
<td>2:00-4:50</td>
<td>36-322</td>
<td>Dr. Klassen</td>
<td>36-318</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>W</td>
<td>2:00-4:50</td>
<td>36-322</td>
<td>Dr. Foroozesh</td>
<td>36-322C</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>T</td>
<td>7:50-10:40</td>
<td>36-322</td>
<td>Dr. Klassen</td>
<td>36-318</td>
<td></td>
</tr>
</tbody>
</table>

To dial from a campus phone, dial only the underlined portion of the phone number.

Office hours:

*M 11-1; T 2-3; R 11-12, 3-5; F 9-11*

Course Description and Objectives

Students are introduced to microscale and macroscale organic laboratory techniques, selected instrumental analysis, and safety procedures. Students learn to critically assess their data and observations, and to scientifically organize and report their findings. In the second semester, the students will use these techniques in experiments which correlate with the material presented in lecture. The Organic lab sequence is meant to provide the students with hands-on experience in performing organic synthesis, instrumental analysis, and interpretation and presentation of data and observations. Corequisites: CHEM 2210/2210DR. Also, General Chemistry II lecture, drill, and lab are prerequisites for CHEM 2210. That means that you should not be in this class unless you have successfully completed G. Chem. See page 9 of the lab manual for a more complete explanation of corequisites and prerequisites.

Required Materials:

3- Lab. Coat
4- Safety-goggles
The manual, goggles and lab coat are sold in the chemistry stockroom, while the text book is sold in the university book store. **You will not be allowed to perform any experiments, without your goggles and lab coat.**
Course Requirements

While this class does not come under the Xavier "FE" policy, our attendance requirements are stricter. Any student with more than two absences will receive a grade of F, not FE. Any experiments missed must be made up or prorated at the discretion of your instructor. Otherwise, you will receive no points for that experiment. You are expected to be on time for each class. See page 10 of the manual for more details.

There are eleven experiments scheduled for this semester. There will be a quiz, and a laboratory notebook write-up for each experiment. There will also be a midterm test and a final examination. Your grade will be based on these and on your performance evaluation as described below.

Quizzes are given at the beginning of the lab. If you come late and miss the quiz, you will receive a zero. Each quiz is worth 10 points for a total quiz grade = 100 after the lowest grade is dropped.

Laboratory notebook write-ups should follow the instructions provided in the lab manual except when otherwise instructed by you instructor. Your instructor may require a prelab write-up. You will turn in the duplicate pages of your notebook which contain the data and observations for the day's experiment before you leave the lab. Each notebook write-up will have 20 points, for a total of 220 points for all the experiments.

Midterm test will consist of 25 multiple choice questions for a total of 50 points.

Final examination is a 50 question, multiple choice test for a total of 100 points.

Performance grade (10 points total) is based on your instructor's evaluation of intangible items such as safety, technique, punctuality, preparation, and performance of your clean-up duties.

This gives you a 480 possible points for the semester. Your grade will be based on your total points. The scale will not be stricter than the following:

<table>
<thead>
<tr>
<th>Total Points</th>
<th>Letter Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>430-480</td>
<td>A</td>
</tr>
<tr>
<td>382-42.9</td>
<td>B</td>
</tr>
<tr>
<td>334-381</td>
<td>C</td>
</tr>
<tr>
<td>286-333</td>
<td>D</td>
</tr>
<tr>
<td>0-285 or &gt; 2 absences</td>
<td>F</td>
</tr>
</tbody>
</table>

The following statement is found in the Xavier Faculty Handbook:

If a student's test, examination paper, laboratory report, term paper, or other written assignment gives evidence of not being completely his/her own work, he/she may be given an F for the course. A student who communicates with anyone during the course of an examination or test, unless with the permission of the instructor, may be immediately dismissed from the room and given an F. Such communication includes attempt to read from another's paper. If a student is found to have brought study materials into the examination room without the instructor's permission, it may be assumed that he/she intended to use such materials unlawfully, and he/she may be penalized accordingly.

There is additional discussion of academic integrity and various course policies and requirements in the first four chapters of the lab manual. Those items are considered to be part of the syllabus.
<table>
<thead>
<tr>
<th>M</th>
<th>T</th>
<th>W</th>
<th>R</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>8/25</td>
<td>8/26</td>
<td>8/27</td>
<td>8/28</td>
<td>8/29</td>
</tr>
<tr>
<td>Check in</td>
<td>Check in</td>
<td>Check in</td>
<td>Check in</td>
<td>Check in</td>
</tr>
<tr>
<td>9/01</td>
<td>9/02</td>
<td>9/03</td>
<td>9/04</td>
<td>9/05</td>
</tr>
<tr>
<td>No Lab</td>
<td>Melting Point Determination</td>
<td>Melting Point Determination</td>
<td>Melting Point Determination</td>
<td>Melting Point Determination</td>
</tr>
<tr>
<td>9/08</td>
<td>9/09</td>
<td>9/10</td>
<td>9/11</td>
<td>9/12</td>
</tr>
<tr>
<td>Melting Point Determination</td>
<td>Recrystallization</td>
<td>Recrystallization</td>
<td>Recrystallization</td>
<td>Recrystallization</td>
</tr>
<tr>
<td>9/15</td>
<td>9/16</td>
<td>9/17</td>
<td>9/18</td>
<td>9/19</td>
</tr>
<tr>
<td>Recrystallization</td>
<td>Decolorization &amp; Sublimation</td>
<td>Decolorization &amp; Sublimation</td>
<td>Decolorization &amp; Sublimation</td>
<td>Decolorization &amp; Sublimation</td>
</tr>
<tr>
<td>9/22</td>
<td>9/23</td>
<td>9/24</td>
<td>9/25</td>
<td>9/26</td>
</tr>
<tr>
<td>Decolorization &amp; Sublimation</td>
<td>Boiling Point &amp; Index of Refraction</td>
<td>Boiling Point &amp; Index of Refraction</td>
<td>Boiling Point &amp; Index of Refraction</td>
<td>Boiling Point &amp; Index of Refraction</td>
</tr>
<tr>
<td>9/29</td>
<td>9/30</td>
<td>10/01</td>
<td>10/02</td>
<td>10/03</td>
</tr>
<tr>
<td>Boiling Point &amp; Index of Refraction</td>
<td>Midterm Examination</td>
<td>Midterm Examination</td>
<td>Midterm Examination</td>
<td>Midterm Examination</td>
</tr>
<tr>
<td>10/06</td>
<td>10/07</td>
<td>10/08</td>
<td>10/09</td>
<td>10/10</td>
</tr>
<tr>
<td>Midterm Examination</td>
<td>Infrared Spectroscopy</td>
<td>Infrared Spectroscopy</td>
<td>Infrared Spectroscopy</td>
<td>Infrared Spectroscopy</td>
</tr>
<tr>
<td>10/13</td>
<td>10/14</td>
<td>10/15</td>
<td>10/16</td>
<td>10/17</td>
</tr>
<tr>
<td>Infrared Spectroscopy</td>
<td>Distillation</td>
<td>Distillation</td>
<td>Distillation</td>
<td>Distillation</td>
</tr>
<tr>
<td>10/20</td>
<td>10/21</td>
<td>10/22</td>
<td>10/23</td>
<td>10/24</td>
</tr>
<tr>
<td>Distillation</td>
<td>TLC</td>
<td>TLC</td>
<td>TLC</td>
<td>TLC</td>
</tr>
<tr>
<td>10/27</td>
<td>10/28</td>
<td>10/29</td>
<td>10/30</td>
<td>10/31</td>
</tr>
<tr>
<td>TLC</td>
<td>Column Chromatography</td>
<td>Column Chromatography</td>
<td>Column Chromatography</td>
<td>Column Chromatography</td>
</tr>
<tr>
<td>11/03</td>
<td>11/04</td>
<td>11/05</td>
<td>11/06</td>
<td>11/07</td>
</tr>
<tr>
<td>Column Chromatography</td>
<td>Separation of Acidic Substances</td>
<td>Separation of Acidic Substances</td>
<td>Separation of Acidic Substances</td>
<td>Separation of Acidic Substances</td>
</tr>
<tr>
<td>11/10</td>
<td>11/11</td>
<td>11/12</td>
<td>11/13</td>
<td>11/14</td>
</tr>
<tr>
<td>Separation of Acidic Substances</td>
<td>Isolation of Caffeine from Tea</td>
<td>Isolation of Caffeine from Tea</td>
<td>Isolation of Caffeine from Tea</td>
<td>Isolation of Caffeine from Tea</td>
</tr>
<tr>
<td>11/17</td>
<td>11/18</td>
<td>11/19</td>
<td>11/20</td>
<td>11/21</td>
</tr>
<tr>
<td>Isolation of Caffeine from Tea</td>
<td>Gas Chromatography I</td>
<td>Gas Chromatography</td>
<td>Gas Chromatography</td>
<td>Gas Chromatography</td>
</tr>
<tr>
<td>Gas Chromatography</td>
<td>Gas Chromatography II</td>
<td>No Lab</td>
<td>No Lab</td>
<td>No Lab</td>
</tr>
<tr>
<td>12/01</td>
<td>12/02</td>
<td>12/03</td>
<td>12/04</td>
<td>12/05</td>
</tr>
<tr>
<td>Final Examination</td>
<td>Final Examination</td>
<td>Final Examination</td>
<td>Final Examination</td>
<td>Final Examination</td>
</tr>
</tbody>
</table>
Comments on the syllabus

GENERAL COMMENTS

The course strives for several overlapping objectives. Students will be introduced to the physical manipulations associated with a number of laboratory procedures. They will observe reactions first-hand and make measurements. When an experiment is complete, they will select those data and observations that are relevant to the problem, weigh their merits, and formulate a conclusion with the greatest explanatory power. Finally, they will report their results in written form. It is hoped, of course, that the lab and lecture schedules will synchronize and reinforce each other, although departmental coordination of schedules has been imperfect.

A student will master varied experimental techniques. While the instructor cannot always scrutinize each student's proficiency during the lab period, he will frequently collect and retest chemical samples to assess a student's accuracy and precision. A student is also expected to assess the weaknesses and strengths of each method. The limits to the accuracy and precision of a measurement should be recognized. A student should become accustomed to asking, "How reliable is this measurement?"

One will be expected to record detailed observations each week. A student's notebook will be evaluated for thoroughness and for attentiveness to detail. The lab is not simply added on to the lecture: things go wrong in the lab and the results predicted by the text are not always found. When a lab does not work as expected, one's recorded observations may suggest an explanation. Failure is often more instructive than success.

Critical analysis is expected and forms a significant part of the grade for lab reports. One does not check a box reading "Experiment completed." Upon what evidence can success or failure be claimed? One's conclusions must be justified by recorded observations: without supporting evidence, the conclusion will be considered invalid even if it is correct. The point is to connect the observations to the conclusion being drawn. One should seek the explanation that best accounts for the data; alternatively, one may show why the data are inconclusive.

One should also assess the degree of confidence that he or she places in the conclusion. Sometimes, good-looking data yield only uncertain conclusions because the method is unreliable or because special problems occurred at the time of the measurement. Has an encouraging result been drawn on the basis of an insignificant fluctuation? Or is the conclusion solidly based upon independent, converging data?
WEEK-BY-WEEK OBJECTIVES IN THE WRITING OF REPORTS (TENTATIVE)

<table>
<thead>
<tr>
<th>Topic for prelab discussion</th>
<th>Discussion/Handout</th>
<th>Emphasized on report</th>
<th>Component on quiz</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Scientific&quot; purpose/ Qualitative observations</td>
<td>1</td>
<td>2, 3</td>
<td>3</td>
</tr>
<tr>
<td>Quantitative observations and measurements</td>
<td>2</td>
<td>3, 4</td>
<td>4</td>
</tr>
<tr>
<td>Equations &amp; structures/ Calculations (part I)</td>
<td>3</td>
<td>4, 5</td>
<td>5</td>
</tr>
<tr>
<td>Calculations (part II)</td>
<td>4</td>
<td>5, 6</td>
<td>6</td>
</tr>
<tr>
<td>Discussion content</td>
<td>5</td>
<td>6, 7</td>
<td>7</td>
</tr>
<tr>
<td>Error analysis (qualitative)</td>
<td>6</td>
<td>7, 8</td>
<td>8</td>
</tr>
<tr>
<td>Error analysis (quantitative)</td>
<td>7</td>
<td>8, 9</td>
<td>9</td>
</tr>
<tr>
<td>Conclusion (qualitative)</td>
<td>8</td>
<td>9, 10</td>
<td>10</td>
</tr>
<tr>
<td>Stylistic details (part I)</td>
<td>9</td>
<td>10, 11</td>
<td>11</td>
</tr>
<tr>
<td>Stylistic details (part II) and grammar</td>
<td>10</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>FINAL EXAM</td>
<td>11</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Numbers in the table indicate the week in which a particular topic and procedure will be performed.
Teaching strategies

(1) Improving student writing and encouraging critical analysis

STRATEGY
The critical analysis of data and the writing of lab reports are unfamiliar to many students. Although experimental techniques are learned one at a time, the details of analyzing and reporting are given to students all at once, and the students are understandably confused. When they turn to instructors for guidance, they find that each teacher has a different set of preferences. These differences, which may seem trivial to the teachers, do not seem small to the students. I have frequently been distressed by the results: some reports are long-winded and packed with all manner of irrelevant details; others end abruptly without producing a sense of completion; still others master the paragraphs but bungle the calculations.

The problems I encounter wrench me in so many directions that I have often despaired of progress. And when it's time to score reports, how do I compare reports with completely different weaknesses? In facing this problem, I have found solace in the fact that the writing of lab reports is not an art but a craft—and like many crafts, it can be "modularized". A report can be dissected into its components (purpose, calculations, observations, etc.) and presented to the class separately, preferably over an extended period of time.

My strategy can be illustrated by considering the first module. During Week 1, we discuss the writing of a scientific purpose and the collection of meaningful observations. Handouts showing both good and bad examples of each are presented. (The examples could be hypothetical or drawn from reports submitted in earlier years.) In Week 2, the students begin their first experiment. Prior to starting, they must show me a good written statement of the purpose. After the experiment, they turn in their raw data and observations. Although they are expected to turn in a full report the following week (Week 3), the grading emphasizes the purpose and observations so as to encourage the students to pay special attention to these sections. Another feature to note is that chemical samples are submitted by the students and these are analyzed to ensure that accurate observations have been made. After these sections of the report have been evaluated, the students are expected to study my comments. Weeks 4 and 5 are a time to monitor progress: the corresponding sections of the second and third reports are closely evaluated. The weekly quizzes may even contain questions designed to reinforce these concepts. Later weeks may be chosen (perhaps at random) for emphasizing and reinforcing these lessons.

Other modules will overlap the first in staggered fashion. For example, a talk on the presentation of numerical data is given in Week 2. The numerical data would then receive emphasis in the grading of the report turned in on Week 4; progress would be monitored during Weeks 5 and 6; and so forth. A listing of the modules in the order of presentation might be something like this:
WEEK TOPIC INTRODUCED
Week 1 "Scientific purpose"/ Qualitative observations
Week 2 Quantitative observations and measurements
Week 3 Equations and structures/ Calculations: moles and limiting reagents
Week 4 Calculations: pitfalls
Week 5 Discussion (content)
Week 6 Error analysis (qualitative features)
Week 7 Error analysis (quantitative features)
Week 8 Conclusion (qualitative)
Week 9 Stylistic details I
Week 10 Stylistic details II
Week 11 Grammatical and syntactic details

My order is not arbitrary. Although the order may need to be rearranged or compressed (as experience will no doubt show), I believe that a pithy scientific purpose and good observations are the foundation of a good report. The role of observations is obvious—they are necessary to get anything else done. My emphasis on a succinct scientific purpose may need more justification. A real scientific purpose poses the precise question that an experiment should answer; it has nothing to do with learning a technique, which is an educational purpose. For example, an educational purpose might be, "To learn how to use a melting-point apparatus." The scientific purpose, however, should be something like, "To identify an unknown solid by its melting point and to confirm the result by a mixed melting point." Also, terseness is not only desirable: it is essential. A student with a sharp focus is prepared to observe.

Most students have a general sense of what it means to justify a conclusion based on their results. In practice, their writing is often ugly, but they make their point. Stylistic weaknesses and common grammatical problems can be annoying, but they do not render the report incoherent. Thus, presentations on these subjects are scheduled toward the end of the term.

I have only planned for eleven presentations. The last weeks are left open for two reasons. First, the students will have several weeks to "pull it all together". Second, I may need to review certain topics. I can give greater attention to certain sections again without diminishing the attention given to the others.

OUTCOMES

The strategy was not employed precisely as described during the spring semester. Instead, several oral presentations on various parts of the lab report were made. For the most part, these discussions were conducted without using handouts. My discussions early in the term were quite lengthy, but they were not solidly reinforced in later classes. Instead, extensive comments were made on each report.

The effect on student writing appears to be positive, but there are several cautions to be added. Student reports showed qualitative improvement with respect to the practices of making observations and expressing conclusions. On the other hand, discussions tended to ramble and did not show a strong grasp of what makes an observation significant. In the drawing of conclusions, students continued to
tend towards drawing the hoped-for conclusion rather than the one best supported by the data, indicating that analytical skills were being poorly exercised. Regarding the development of critical thinking skills, comparisons could be made with other sections, if their instructors are willing to cooperate. Alternatively, I could apply different teaching methods to my own sections and compare the results.

On the whole, the exercise was a disappointment. Most students did not seem to pay much attention to the comments on their reports, because problems recurred frequently. Thus, much of the time spent writing these comments appears to have been wasted. Only a minority of students sought clarification of my remarks and adjusted their presentations accordingly. In the end, these students showed the greatest improvements in their reports.

This semester was not a real test of the strategy, because only a few of the proposed activities were utilized. Instead, this semester provided a valuable "baseline" showing student output in the absence of a coordinated strategy. Reports turned in this year and next year can be compared to appraise the strategy's success.

(2) Virtual office hours

STRATEGY

Internet and email communications have grown explosively in the last few years. The benefits that they will provide to academia have only begun to be uncovered. One practical use of the internet is the institution of so-called "virtual office hours". By creating and maintaining web pages with email connections, an instructor can: (1) increase the effective number of office hours; (2) disseminate messages to class during non-lab times; (3) provide extra copies of handouts; (4) connect interwoven ideas by using hyperlinked text; and (5) improve the consistency of the information given to a class (which is often garbled when students rely on each other for information).

The five listed improvements are not discrete, but they may be highlighted in different ways. For the moment, I would like to use web pages to help students craft their lab reports. (Quizzes and supplemental experimental details may be added later.) I have often been troubled by the quality of the reports that I have received, but I felt hard-pressed for the time to give this problem its rightful attention.

What I envision is a web page that includes the following: (1) details of the discussions I have given in class on various parts of the reports (see preceding strategy for details); (2) examples of both good and bad ways to approach these parts of lab work, with annotations critiquing them and suggesting ways to improve them; (3) hyperlinks to other web sites that contain related aids; (4) adaptations or approved excerpts of copyrighted material that I have found helpful over the years; and (5) questions posed by students and the answers that I have given them, with links to related earlier Q & A.

OUTCOMES

This strategy was not utilized in any form during the past semester. Having taken the seminar on webpage authoring offered by the CAT, I intend to begin creat-
ing this site this summer and to test it during the fall of 1998. If I am not assigned to any organic labs, as seems likely, I will use it in connection with my biochemistry lab course.
Reflections on student feedback

Student feedback in the spring semester was generally very positive. The numerical data have not been tabulated by the Planning Office, but appear similar to those obtained in the fall. Last semester, student evaluations rated my courses above the norm (compared to the campus and the department) in all but one category (time management). Particularly strong were the responses concerning my ability to communicate, my enthusiasm for teaching, my respect for students, and the students’ willingness to recommend the instructor: in these categories, I was rated at least one-half point above the campus-wide average.

Written comments were found on approximately two-thirds of the evaluations. All comments were collected and are summarized below. Comments that are virtually identical are grouped together and the number of responses is shown on the right. Some are obviously similar in their thrust, but I deemed that the precise wording was distinct from other comments.

would recommend teacher                          2
very effective learning environment             6
teacher was very enthusiastic                   13
teacher had great personality                  4
labs were too long                             3
labs were not too long                          3
class was interesting and fun                   6
student enjoyed being in class                  1
teacher was helpful                             3
instructor treated students as individuals     5
[teacher] gave practical applications for labs  3
best teacher I have had at XU                  1
teacher had extensive knowledge                6
teacher's lectures easy to follow               1
student learned a lot                          3
the prelabs did not relate closely to exams    4
the prelabs related well to quizzes             2
teacher gets off on tangents                   1
teacher was tough grader                       2

Several features are apparent from the responses (including the numerical data). The students had an almost universally positive reaction to me, and in many cases they felt that my personality improved the learning environment. No one reported that the my personality had a negative effect. On the other hand, relatively few commented on the course material itself. The most frequent complaints were that the prelab talks did not provide sufficient preparation for the midterm (which was prepared by all of the instructors working together) and that the labs were too long.
In reviewing these results, I can only draw tentative conclusions, because there are many variables whose impact cannot be assessed at this time. I am encouraged to see that the students enjoy the lab experience and that they appreciate my particular style. At Swarthmore College and at Gettysburg College, student reactions were mixed and a number of students expressed serious annoyance with some of my practices.

On the other hand, it is more difficult to determine if this gain has been bought by debasement of the objective content of the course. The students felt that they learned a lot; interestingly, however, they expected my section to have an overall GPA of 3.45 (based on the grades they anticipated in my class), which was well above the actual value. How seriously the truth might have affected their perceptions is uncertain, but it would likely have had a negative effect on the numbers. My sections performed at or above average on the exams (which were administered to the many sections other than my own), but the reverse was true in the fall. Talks with instructors and advisers make it clear that one of the sections in the fall was composed largely of very weak students, while one of the spring semester sections was packed with ex-Howard Hughes scholars and Dean's List honorees. At this time, my methods do not appear to differ from those of other faculty in their impact on student learning.

The students made little comment on the writing portions of the course, so nothing substantive can be concluded.

In sum, the lessons to be drawn from these evaluations are the following.

• My approach to dealing with students has positive results at Xavier. This contrasts with my experience at other schools, where substantial changes would have been recommended. I do not plan to modify my behavior significantly at this time.

• Student performance on exams has been only average compared to other sections. Finding constructive ways to engage them with the material is an important area for consideration. I will be reviewing the materials presented by Cederblom and Gillespie in the hope of developing collaborative and cooperative learning strategies for objective course materials.

• No student commented on the writing of lab reports. Next semester, students will be asked to comment specifically on my discussions of the writing of reports and their impact on the students' writing.
Odds and ends

- How do I deal with the fact that students vary widely in the skills they bring to the class? Specifically, *since a lab is not a writing course*, how do I decide how to weight the writing skills in the grade?

- My portfolio tends heavily to emphasize the written portion of the course (that is, the critical thinking and compositional aspects). But I have spent much less time addressing the actual scientific content. Does this emphasis "subvert" the intended goals of the course as outlined by the department?

- One goal is "autonomic thought"--not the increase in the number of questions that students can answer, but the difficulty of the questions that they can answer.

- I must teach what I am. If what I am is not "right", I need to change. But I can only teach my convictions, not someone else's. I believe that easy acquiescence to cultural/ethical relativism is vacuous and unproductive. This, however, is not the same thing as saying that one's views are superior. There is a big difference between saying, 'This is the best way that I know" (or "This is the best method that I can use") and saying "I know that your views stink."

- If students do not approve my teaching philosophy, such resistance is based in part on conflicting views about the *future*. I have my ideas about what will serve them best in their future jobs and in life. They have different ideas about these same things. If we agreed completely, there would be no conflict.

- I should design special lab experiments in which the objective is for them to determine what went *wrong*. Perhaps give them a lab report written by a hypothetical student and have them make some guesses as to what may have gone wrong (based on the observations in the report or on their own educated guesses).

- Suggested exercise. PART I. Present to the class a theory (past present, or fictional) that explains certain reported data. PART II. Give them inconsonant data that makes them ask, "How do I explain this new data? Is the experiment in error, or the theory?"

- Help students to identify and list the assumptions they have made during an experiment. Then help them to determine the extent to which these assumptions are obeyed or are valid. (Ex: Beers' Law--ask them what conditions must hold for it to be valid? can they see where the law will break down? With a set of experimental data in hand, can we see if it appears to be obeyed? If it is, is this surprising and lucky, or are we within the limitations of its applicability? Do they recognize--and can they design experiments-in which the data should obey the law?)
• One purpose of the portfolio is to "get all the cards on the table". The portfolio helps me to face the fact that many diverse objectives and approaches may be confronting each other--sometimes they agree, and sometimes they do not.

I have desires and goals; students have desires and goals; colleagues and administrators have objectives and goals. We have chosen methods for achieving these, and these methods may conflict.

Putting my cards on the table is necessary for analysis and self-analysis. By committing myself on paper to objectives, goals and approaches, certain conflicts and/or connections are compelled to surface, where they can be considered "consciously". Others can look at them, too!

• For objective course content, prepare and maintain test histograms showing which topics dive the most trouble. Perhaps I can compare the performances of different classes over the years.

• Any choice is also a rejection. Consider explaining why certain things have not been included in the portfolio or were removed.

• Include tests in the portfolio? How about discussing the rationales behind test design? Over time, this would create a "testing chronology" showing how your ideas about testing are evolving. And ideas about teaching too?

• Teaching is a complex partnership--students are "teachers", and teachers are students, though not of exactly the same subject.

The expert, in acquiring his expertise, has assimilated large bodies of info and developed reasoning shortcuts that enable him to make large, seemingly intuitive jumps in problem-solving.

When the expert becomes a teacher, he attempts to retrace or recover this ground, trying to remember what made the subject hard for him in the first place. He must retrace the ground if he hopes to understand how to get through to his students.

• Davidson and Ambrose say that "developing expertise takes a lot of time and effort... .The hard work needed to achieve the status of expert is spent to a large degree in actively practicing the skills and techniques of the discipline ... Only through time and effort invested in practice do students move along the novice-expert continuum. (D & A, p. 3) What are the implications for my approach to teaching? Well, certainly students must be motivated to do the hard work necessary. D & A comment, "the teacher-student relationship is an important part of [student motivation]."

• Experience teaches me that I am forgetful. As I read my own works of yesterday, I am constantly reminded that "I did this before!", whatever "this" happens to be. I discover that I had a thought earlier, but forgot it; indeed, the only proof that I once had this thought is a jotting in my own hand. Furthermore, my
inability to remember earlier mistakes often haunts me: the sense of deja vu when I say, "Oh, yes. I made the same mistake the last time!" Thus, the portfolio is meant to document my progression as a teacher generally and as a teacher of this course specifically. One component of a portfolio is an ongoing narrative that documents new methods that I try and the results they produce. The methods I currently favor will of course receive greatest emphasis, but evidence of the rejected methods should be included as a reminder for the future.

Another purpose of the portfolio is to serve as a daily reminder. It forces me to renew my focus daily on the objectives of the course and my personal goals in that course. When I am harried day-to-day by problems and a sense of urgency overwhelms me, I must have a polestar to point me back to the important. Remember Edward Bliss' distinctions among the important, the urgent, that which is both important & urgent, and that which is neither.

• When students ask me about the differences among a discussion, a conclusion, and an error analysis, I tell them the discussion is the prosecutor's case, the error analysis is the defense's case, and the conclusion is the verdict.