A Hybrid CD-Internet Delivery System for Pharmaceutical Care Laboratory Instruction

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Table of Contents:

- Objectives and Goals .................................................. 2
- Description of the Teaching Innovation ....................... 4
- Evidence of Student Learning/Evaluative Data ............. 5
- Personal Reflections ................................................... 7
- Abstract .................................................................. 9
- Evaluation Survey For Compounding Laboratories CD .... 10
- Survey Summary (Raw Data) for Compounding Laboratories CD 12
- Individual Student Responses Sorted by Topic .............. 14
Objectives and Goals:

At the University of North Carolina School of Pharmacy, the Pharmaceutical Care Laboratories are a five-semester course sequence that integrates didactic instruction with practical applications (www.pharmacy.unc.edu/carelabs). Among the many skills students learn are patient counseling, drug information retrieval, practical disease management skills, and compounding skills. The course is coordinated between five faculty members, and includes a staff composed of upper Pharm.D. classmen, graduate Pharm.D. residents, and graduate Ph.D. students.

This particular instructor is responsible for the compounding pharmacy skills taught throughout the five-semester sequence. Thus in the fall semester, there are laboratories for the Year 1, Year 2, and Year 3 students; in the spring semester, there are laboratories just for the Year 1 and Year 2 students. During the entire five-semester sequence, students complete twenty compounding laboratory experiences. Scheduling physical space each week for 360 students in the Fall and 240 students in the Spring is it’s own challenge, but the real challenge is to personally instruct that many students in the finer points of pharmacy compounding.

Our students complete pre-professional laboratory courses in chemistry, biology, microbiology, and physics. The laboratory is a new experience where they must learn to integrate previous laboratory experience into the compounding of prescriptions. And there are techniques for them to master that are particular to only pharmacy compounding: operation of Class A balances, levigation, trituration, geometric dilution, etc. Most of the students are not proficient in this new laboratory setting. Therefore, many of the students need more personal instruction than is physically possible in the classroom/laboratory setting. It is also the first time student preparations are critically analyzed using contemporary analytical techniques and the competency is assessed as either satisfactory or unsatisfactory.

It is not possible to meet this need for increased personal instruction through demonstrations before the laboratory or in a classroom setting. If done immediately before the laboratory, students have little time to assimilate the demonstration into their frame of reference. If done in a classroom, students tend to forget what was said or demonstrated in pre-lab lecture. The pre-lab time is on Friday, with labs being conducted the following Monday through Thursday. So for some students, almost a week will have passed between the pre-lab lecture and the actual laboratory experience.

Therefore, this instructor decided to use internet-based technologies to provide the additional instruction needed, and provide the student time to review and assimilate this instruction into their own frame of reference. With the teaching innovations described below, students can review and learn materials at their pace (obviously within a weekly time frame). And more importantly, this instructor feels that the individual instruction needed by the students is readily available when the instructor cannot be.

Thus the internet-technologies are intended to give “personalized” instruction for all of the fine and subtle points of pharmacy compounding. This leads to the demand for development of multimedia aids. Delivery of such materials is not a problem within the School of Pharmacy. The School is fortunate to have access to T1 LAN internet connection lines that allows the rapid delivery of wide baudband multimedia files. Most of the multimedia files are delivered using streaming video through RealNetworks RealPlayer, although the unstreamed AVI files are also used.

The teaching innovation is to deliver wide baudband multimedia files to computers that are not connected to the School of Pharmacy’s T1 LAN line, e.g., the student’s home computer. Typically, these computers would be connected to the internet through a modem and an Internet Service Provider (ISP). Download times for students using a 56K modem for a typical seven minute AVI multimedia file is about an hour. With this limitation, the multimedia mode of delivery over a modem is useless. Streaming video via RealPlayer is employed as part of the online solution for delivering these files, but the student must still be connected to the internet when the streaming is occurring. In addition, streaming video does not give the student a “permanent” file to review in a stand alone manner.
Large multimedia files can be stored on CD-ROM and played in a stand alone manner which would avoid the online problem of long download times or connections to RealPlayer. But I also wanted the students to have the ability to receive the latest updates from the course web site which cannot be done if only a CD-ROM is used. So a delivery mechanism that would play the multimedia files from a CD while still being able to load the smaller files from the web site was designed.

The expected outcomes as students used the technology were:

(1) to decrease the time needed to master compounding skills by giving the students a tool that would be readily available. The tool would demonstrate or graphically illustrate how techniques and procedures should be done so that students would have some idea of what to do. Without this instruction tool, they would have to rely on the availability of the teaching staff during the laboratory time to provide personalized instruction.

(2) students would do better in lab and the grades and analytical results would improve if they had more information when they went into lab.

A couple of possible complicating factors must be considered with objective 2. One factor is that students always "want to get out of lab as fast as possible." But I see them standing around trying to figure out "what to do" or waiting for a staff to get to them to answer their questions. This ties into the statements made earlier about having too much time between pre-lab lecture and the laboratory experience. The other supposition here is that if they know the required techniques and procedures "in advance," they can perform better and that improved performance can be measured in objective assessments such as grades, analytical results, etc.
Description of the Teaching Innovation:

Content

A CD-ROM was created that uses both internet and CD technology to deliver a series of wide baudband multimedia files. The CD was a copy of the course web site (www.unc.edu/courses/phar051) and was intended for use on computers outside of the School of Pharmacy (e.g., those connected to the internet through a modem and ISP). This CD contained all of the large files on the web site (AVI, movie clips, graphics, and images). These multimedia files were the primary means of showing techniques and procedures. There are synchronized audio files on the web site, but those could not be captured on the CD since that technology requires a "live connection" to the RealPlayer server software.

When the CD was used through an ISP, new files on the web site are downloaded and stored in the browser cache of the student's computer. When the student selects a file, the computer displays the most recent file from either the CD, the computer cache, or the web site. If the student wants to use the CD without an ISP connection (stand alone mode), that is also possible. In this mode, the computer displays the most recent (updated) file from either the CD or the computer cache.

Student Audience

First year students (PY1) in our Doctor of Pharmacy curriculum from the Fall, 1998 and Fall, 1999 semesters were compared in the results included in this application. (Note: results of the Spring, 1999 and Spring, 2000 semesters will be included in the presentation at the AACP meeting in San Diego). The PY1 students in the last academic year (1998-1999) did not have the CD and had paper copies of all laboratory materials. The PY1 students in this academic year (1999-2000) had only the CD and did not have paper copies of any laboratory materials. The pre-lab lecture content as well as the laboratory experience was kept as constant between the two years as possible.

Process

Students attended a one hour pre-lab lecture on the Friday before the week of lab. For students in the Fall 1998 semester, the instruction included demonstrations in class and going through the paper copy of the upcoming laboratory experience answering questions and giving clarifications as needed. For students in the Fall 1999 semester, the instruction included demonstrations in class using the multimedia materials, and answering questions and giving clarifications as needed.

Regardless of paper copy or CD, students had received all materials for the semester within the first week of classroom instruction. Students were expected to have read the material for each class or lab prior to the instruction time. Some of the laboratories required that the students record or calculate information before the instruction period. Student compounding lab experiences were scheduled to last between 3-4 hours. Each student had their own lab desk and easy access to all chemicals and equipment needed to complete the lab.

PY1 students are assigned in groups of 6 - 8 to a PY3 teaching assistant. That TA goes with their students through all of the Pharmaceutical Care Laboratory experiences, including the compounding laboratories. These PY3 students have themselves gone through the compounding laboratory experiences as PY1 students, and they serve as the primary contact for students questions, and further instruction on techniques and procedures during the laboratory period. These TAs provide a weekly assessment of student performance both to the student and the faculty. One of the parts of the feedback is to report how much time students took to perform the various components of the lab. This information was used as part of the analysis below. The TAs were not aware that this information was being used in this assessment.

The formulations made by the students during the laboratory period were turned in to the instructor. These formulations were analyzed by HPLC using contemporary procedures, and these analyses were carried out by the graduate teaching assistants under the supervision of the instructor. Acceptable results were based on the USP24/NF19 Supplement 1 <795> Pharmacy Compounding guidelines. If the student formulation is outside of the expected range, they are required to remake the formulation on the Friday afternoon of that lab week under closer supervision from the staff.
Evidence of Student Learning/Evaluative Data:

One piece of subjective information and three pieces of objective information were collected in the assessment of student learning with and without access to the hybrid CD-ROM. They include:

- a survey about the CD and its usefulness
- comparison of the time required to complete each laboratory experience
- comparison of the analytical results of the formulations
- comparison of grades received in each laboratory experience

The Survey

The survey was developed with the assistance of the Center for Teaching and Learning at the University of North Carolina. A copy of the survey instrument is attached. The survey was administered during the laboratory period when the final practicum for the laboratories was conducted. Students had time between the various stations of the practicum to complete the survey in an unhurried and "let me out of here" manner. Students were asked to only put an ID number of the survey to provide confidentiality in the analysis.

Of the 119 students responding in the Fall 1999 compounding laboratory, 89 students used the CD for some of the labs, 30 students did not use the CD at all. 35 students reported using the web version, or a combination of the web version and the CD. Students indicated that the CD provided resources and references in addition to the pre-lab lecture. They did use the multimedia files most of the time and found them to be "somewhat helpful" or "very helpful." It appears that more students than not had some type of technical difficulty with the CD (48 vs. 22). And it appears that students preferred either "printing" or "viewing and printing" to "viewing" alone. 78 students reported they would keep the CD for further use. A complete tabulation of the results is attached.

Time Needed To Complete The Laboratory Experience

Time logs were kept by the sixteen PY3 TAs associated with each years' laboratory. The time was the TAs' estimation of the time it took all of their students to complete different laboratory experiences. The time is expressed in hours.

<table>
<thead>
<tr>
<th>Year</th>
<th>Lab 2</th>
<th>Lab 3</th>
<th>Lab 4</th>
<th>Lab 6</th>
<th>Lab 9</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>3.0 ± 0.4</td>
<td>3.1 ± 0.3</td>
<td>3.0 ± 0.3</td>
<td>5.4 ± 0.3</td>
<td>2.6 ± 0.3</td>
</tr>
<tr>
<td>1999</td>
<td>2.4 ± 0.4</td>
<td>3.1 ± 0.2</td>
<td>3.1 ± 0.2</td>
<td>4.3 ± 0.8</td>
<td>3.3 ± 0.4</td>
</tr>
</tbody>
</table>

Mean ± SD (16 PY3 TAs)

Grades Received For The Laboratory Experience

Each TA was given a grading key from the instructor to grade the lab reports. Grading was done by the TAs. The instructor served as a resource and an arbitrator. Twenty (20) points were assigned for each lab report. The total column is the total number of points for the laboratory experiences listed.

<table>
<thead>
<tr>
<th>YEAR</th>
<th>Lab 2</th>
<th>Lab 3</th>
<th>Lab 4</th>
<th>Lab 6</th>
<th>Lab 7</th>
<th>Lab 9</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>18.2 ± 1.4</td>
<td>18.6 ± 2.7</td>
<td>18.2 ± 2.4</td>
<td>18.2 ± 1.9</td>
<td>19.0 ± 2.6</td>
<td>18.0 ± 2.2</td>
<td>110.2 ± 8.0</td>
</tr>
<tr>
<td>1999</td>
<td>17.6 ± 3.7</td>
<td>18.4 ± 1.9</td>
<td>17.7 ± 2.3</td>
<td>17.4 ± 3.3</td>
<td>16.8 ± 4.7</td>
<td>17.8 ± 2.3</td>
<td>104.8 ± 15.2</td>
</tr>
</tbody>
</table>

Mean ± SD (124 Fall 1998 students and 119 Fall 1999 students)
Analytical Grades

As previously mentioned, HPLC was the primary analytical tool. Data in this table does not show the units of measurement because some units are concentrations and some units are amounts. The analysis in laboratory 8 involved the determination of osmotic pressure in the students’ formulations.

<table>
<thead>
<tr>
<th>YEAR</th>
<th>Lab 2</th>
<th>Lab 3</th>
<th>Lab 3</th>
<th>Lab 6</th>
<th>Lab 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>2.5 ± 0.4</td>
<td>2.2 ± 0.8</td>
<td>75.6 ± 3.2</td>
<td>22.5 ± 1.5</td>
<td>285.6 ± 9.0</td>
</tr>
<tr>
<td>1999</td>
<td>2.5 ± 0.6</td>
<td>2.7 ± 1.2</td>
<td>80.0 ± 2.6</td>
<td>22.0 ± 4.1</td>
<td>276.7 ± 22.1</td>
</tr>
</tbody>
</table>

Mean ± SD (124 Fall 1998 students and 119 Fall 1999 students)

Correlation Between Use Of CD-ROM And Grade

The question of whether using the CD improved grades was addressed by stratifying the grades according to the usage patterns asked on the survey.

<table>
<thead>
<tr>
<th>Semester and CD Usage</th>
<th>Total Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall 1998</td>
<td></td>
</tr>
<tr>
<td>no CD or Web</td>
<td>110.2 ± 8.0</td>
</tr>
<tr>
<td>Fall 1999</td>
<td></td>
</tr>
<tr>
<td>used CD every time</td>
<td>108.3 ± 6.5</td>
</tr>
<tr>
<td>used CD or Web</td>
<td>105.2 ± 14.9</td>
</tr>
<tr>
<td>did not use CD or Web</td>
<td>101.0 ± 17.4</td>
</tr>
<tr>
<td>class average</td>
<td>104.8 ± 15.2</td>
</tr>
</tbody>
</table>
Personal Reflections:

Instructor's Personal Philosophy

Laboratory instruction is a critical teaching component of any Pharmacy curriculum. Instructors are in immediate contact with the students for long periods of time. These long exposures give an instructor enormous opportunities to impact the students both personally and professionally, and to show the relevance of the laboratory experience to practice. But on the other hand, with student loads of 360 students/week in the Fall semester and 240 students/week in the Spring semester, the instructor's personal instruction time is severely limited. UNC has successfully instituted PY3 TAships in the Pharmaceutical Care Laboratories. This program is now in its fourth year. Having 4 TAs per laboratory who have actually completed the laboratory experience themselves has been a tremendous relief in the teaching loads of this instructor.

But the CD was to address the issue of instruction before the students come to the laboratory. It was to prepare the student as much as possible (from the instructor's point) to successfully conduct the laboratory, collect meaningful data, and learn compounding techniques. It was gratifying to see that many students plan to keep the CD as a future reference in light of the increased national emphasis on compounding (FDAMA 1997, USP24/NF19). Students can continue to use the CD for a resource in their workplaces.

What Was Innovative?

This innovation was seen as a method of allowing students to learn independently which is an objective of the Pharmaceutical Care Laboratory model. Not all students work at the same pace and with the aid of the CD and the web, students can refer to the material as often as needed. It has been proven that students retain a larger percentage of material that they see compared to material they only hear. So the CD's multimedia files should increase retention. The hybrid CD brings the student the ability to work at their own pace, increases their ability to absorb the information that is presented, and then apply it in a structured laboratory experience.

An example may serve to illustrate some of the innovations. In the suspensions laboratory, students are to determine the best flocculated suspension based on four criteria: 1) sedimentation rates; 2) sedimentation volumes; 3) ease of dispersion; 4) and presence or absence of a clear boundary during sedimentation. The students first can view a multimedia clip that shows them how to levigate bismuth subnitrate. There is another clip that shows the students how to determine the sedimentation rate of their suspensions. This second clip also illustrates what is meant by a clear boundary during sedimentation. When the PY3 TAs saw these clips they said, "I wish we'd had those when we took the lab. I never did learn how to levigate a powder." I believe the various laboratory experiences will only be strengthened by continued and expanded use of this type of learning methodology.

What Was Successful and Not Successful?

Analysis of the three objective measures (time, grades, analytical) indicates that students in the two years performed at the same level equally well. One interpretation of that data is that the CD made no difference in the objective measures. But I think that another factor actually contributes to the equal student performance.

Our students (probably like all other Pharmacy students) are not really prepared when they come to lab. They have some general idea of the lab and may have done the calculations, but they don't immediately settle into the work. They spend the first 15 – 20 minutes of the lab checking with their fellow students or TAs to "make sure" they know what they need to do. Then during the laboratory experience, they ask the numerous questions which indicate to this instructor they do not understand what the lab is designed to demonstrate.

I think the equal student performance is due to the fact that we have a "critical mass" of TAs in each laboratory. Each lab has 4 TAs, and each TA is responsible for 6 – 8 students. That critical mass of support allows almost immediate response to their questions, a more focused attention to their needs, and a more positive reinforcement structure. If there was one instructor that had to handle all of the students
throughout a 4 day period, those three factors would not be met. So I believe the “positive environment” has as much to do with the students’ success as anything else.

**Modifications Planned**

The survey provided the most insightful information about modifications needed in the innovation. The individual student comments were grouped according to the following topics: (Comments in each group are attached)

- additional material requested to be put on CD
- material already on the CD to clean up or improve
- technical difficulties or issues
- prefer another media
- comments about the operation of the course

Most of the student comments pertained to the first three groupings. Technical difficulties with the CD on home computers certainly was an anticipated problem. The instructor operated on a limited grant budget to produce the CD, and technical enhancements that were needed to prevent some of the problems could not be included. Instructions about using the CD can be improved both in verbal class presentation and help files on the CD.

Some of the students did not have computers at home. However, in the Fall semester 2000 the University of North Carolina will require all students to have personal computers (Carolina Computer Initiative). This means that students entering the School of Pharmacy in the Fall semester 2002 will be computer equipped and literate. Continued improvement of the CD is seen as a means to take advantage of this new “student ability,” as well as encourage and assist other faculty to use this type of technology.

Students only suggested adding more material or improving the material that was present. There were no comments about deleting material. The instructor takes these comments as “positive,” although other more hidden meanings might be implied by the students. Many of the multimedia files need improvement and many more are planned; this will be done.

As to the comments about including Remington’s on the CD, obviously that isn’t a possibility. But the study questions require the students to take the introductory material from the CD and the material from Remington’s and combine them to answer the study questions. There might be some disconnects there. Or perhaps the students just don’t want to look in a second place for information; they may just want everything in one place for convenience. Students need to realize that no one source contains all the information they need. But the instructor will review the study questions and its related material for completeness and appropriateness.

The other major grouping had to do with preferring another media. Students appeared resistant to use only the CD or web version without the crutch of having a paper copy of the material. Using technology media for presenting material is a learning technique to be mastered by the student. Since this was a new medium of learning for the students, it was anticipated that the student grades would not be as high as in previous years when long established teaching methodologies (i.e., lecture) had been used. Although the mean value was lower in the Fall 1999 group, there was not a statistical difference between the two years. The results of this comparison should be considered as a starting point evaluation for students transitioning from traditional teaching methodologies to online learning methods.

It will be beneficial to follow the results yearly while students become accustomed to using computer based learning methods. At this point in their educational process, students may see technology as an added process to learn rather than an assistant to the process. Perhaps some of this “burden” can be lifted by reducing the number of technological difficulties the students experienced. Students who choose to use only a printed copy do not receive the benefit of the multimedia visualization, and this may also limit learning. This instructor expects an increase in the number of students using the CD and web version in the future as the Carolina Computing Initiative permeates through the University. Although not statistically significant, data collected in the Fall 1999 semester suggests a trend toward improved grades with increased use of the technology. As already mentioned, the Pharmaceutical Care Laboratories may have a unique situation in that a critical mass of teaching support is available to students. But the results of this study suggest that the innovation would be most useful in situations where teaching support is not optimal.
A Hybrid CD-Internet Delivery System for Pharmaceutical Care Laboratory Instruction. Robert P. Shrewsbury, University of North Carolina.

**Objectives:** The Laboratory contains twenty compounding experiences. Students can have up to a one week delay between the scheduled pre-lab lecture and actual experience. A hybrid CD-Internet CD-ROM was developed to give students on-demand access to multimedia information about the laboratory outside of the School. The CD-ROM allows students to review pre-lab material in preparation for their laboratory.

**Methods:** The CD-ROM was used in the 1999-2000 academic year. A comparison of these students and the previous year’s students (who did not have the CD-ROM) included individual laboratory grades, results of product analysis, and time to complete the laboratory. A survey was also completed by the 1999-2000 students.

**Results:** Analysis of the Fall semester data showed no statistical difference in time, grades, or analytical accuracy between the two classes. A trend existed between improved total laboratory grade and the usage of the CD-ROM. Students preferred to either print the material, or view and print the material compared to viewing the material alone. An analysis of the Spring semester will also be presented.

**Implications:** This is a new teaching method for UNC students. Their reliance on printed materials indicates they are not acclimated to using newer online delivery methods. The trend toward improved grades with CD usage was suggestive of the technology’s benefit. The full benefit of the CD-ROM delivery system will not be seen immediately but will take time to impact student learning.
1. I referred to the CD containing resource materials for lab preparation in this course
   30 A: for no lab
   18 B: for one lab
   17 C: for a few labs
   18 D: for most labs
   33 E: for all labs

   For those respondents who referred to the CD for no lab or one lab
   5 A: didn’t find the CD material to be very helpful in preparing for the labs
   35 B: used the Web version of the material
   4 C: didn’t have access to a computer at home
   10 D: experienced too much technical difficulty
   1 E: other but no specifics

2. When considered with the pre-lab lecture I found the CD provided additional helpful resources and references:
   3 A: never
   49 B: sometimes
   18 C: always

3. I viewed the video clips
   18 A: never
   39 B: occasionally
   8 C: frequently
   6 D: always

4. When I viewed the video clips, I tended to view each one
   40 A: once
   10 B: twice
   3 C: three times or more

5. In my preparation for the associated lab procedures/techniques/results, the video clips were
   8 A: not very helpful
   36 B: somewhat helpful
   13 C: very helpful

6. I had technical/computer difficulties when I used the CD
   22 A: never
   40 B: occasionally
   8 C: often

7. I usually used the material on the CD by
   11 A: viewing computer
   21 B: printing to paper
   39 C: both

8. In general, how would you prefer to receive information and resources associated with lab preparation?
   18 CD
   45 Web site
   45 Paper manual
   23 In-class lecture
   5 other (in-class handout; all the above, coursepak

9. Do you intend to hang on to the CD for this course?
   78 A: Yes
   21 B: No
Individual Student Responses Sorted by Topic

No Change Needed

- 8 respondents

Additional Material Requested To Put On CD
- Additional background information on each lab.
- More detailed procedures. 2 respondents
- More details about techniques - write what video says
- More explanation in defining terms. Written to supplement CD.
- Examples of calculations and thorough lab explanation
- Exp date information
- Difficulty with exp. date and making solution without outside references
- Some lectures were wasted because they duplicated CD.
- Include calendar of events – all dates in one place.

Material On The CD To Clean Up or Improve
- Better if lab information is more clear—didn’t understand whole calculation lab
- Have all info Dr. Shrewsbury covers in class like which exercises we’re doing.
- Include only pertinent and relevant info so no need to waste time scrolling through. Be concise - 2 respondents
- Let students know lab # doing ahead of time.
- Put labs on CD in order we do them in class.

Study Questions
- Add Remington’s info to CD. Can’t answer study questions from lab info.
- Have all info needed to answer study questions on the CD
- Be more specific on procedures and include answers to study questions in the introduction
- More material pertaining to study questions in introductory material, couldn’t locate in Remington’s, not on pages listed
- Have further information that deals with study questions included in the CD so the use of Merck’s and Remington’s is not as necessary.
- Study questions refer to material not necessarily available on CD (general lab information) or in textbook Remington’s.
- CD study questions hard to find answers. More descriptive study questions would help.

Technical Difficulties or Issues
- Had to go on-line to view CD
- CD wouldn’t read on my home computer – 2 respondents
- All info on CD also on Web – prefer Web
- More clear instructions on 1: How to open files (3 respondents) 2: How to use audio visual aspects of CD 3: exact software needed to run programs
- On CD some pages/procedures were missing when printed OK on Web – 2 respondents
- Computer wouldn’t play video clips
- Make it available on web Microsoft Explorer and IE – Not just Netscape
- Instructions for using CD first time. First time it crashed, after that OK. 5 respondents
- Couldn’t get CD to open at home – 2 respondents
- Put example of Rx label preparation on CD – 2 respondents
- Didn’t use CD. My computer too slow with internet hookup. Not realistic to think everyone will use it. – 2 respondents
- If Pharmacy school admitted only students with computers, then giving a CD would make sense and be effective.
- Better means to access/load CD
- Demonstration of how to use the CD. Dialogue boxes confusing. – 2 respondents
Prefer Another Media
- CD helpful for video presentations otherwise paper manual more helpful and everyone wouldn't have to print it out
- Coursepak so no printing out stuff.
- Don't require to be on-line to use CD – Web is easier
- It is currently supplement to Web Site and class. Due to cost maybe CD should only be given to those without internet access. – 2 respondents

Comments About The Operation Of The Course
- Pre-lab data on CD not as helpful as Remington's
- Consistency among lab instructions on paper, verbal, and to TA