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ABSTRACT

This paper discusses some of the issues involved and lessons learned in including a formal computer laboratory component in a freshman mathematics course for business administration students at Monmouth University (New Jersey), focusing on both the technical and the pedagogical aspects of the component of the course. The concept is modeled after traditional physics and chemistry laboratory exercises. Students are expected to attend a scheduled laboratory session supervised by the instructor. They are encouraged to work in teams of two to three students and are required to submit a formal laboratory report for the team. The laboratory exercises involve solving problems that resemble "real world" situations with data that is beyond paper-and pencil solution techniques. The exercises require a written conclusion or a recommendation for action for the simulated problem. Students are expected to do a reasonable amount of work each week; this concept is reinforced with a 30-minute quiz one week and a formal laboratory assignment the next. While no formal pre- and post-analysis or control group comparisons were conducted, student surveys indicated that more than 90% of students would recommend the "technology-infused" course to others. The Course/Instructor Evaluation questionnaire and responses are appended. (Author/AEF)

Lessons Learned
Formal Computer Laboratory Exercises

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Abstract:

This paper discusses some of the issues involved and lessons learned in including a formal computer laboratory component in a freshman mathematics course for Business Administration Students. It will focus on both the technical and the pedagogical aspects of that component of the course.

During the Spring 1996 term, the author began the task of including "formal" laboratory exercises as a component in the required first term mathematics course for the Business Administration Students. The concept is modeled after traditional physics and chemistry laboratory exercises. Students are expected to attend a scheduled laboratory session supervised and moderated by the instructor. They are encouraged to work in teams of 2 to 3 students and are required to submit a formal laboratory report for the team. The laboratory exercises typically involve solving problems that resembled "real world" situations with data that normally is beyond reasonable paper and pencil solution techniques. The exercises require a written conclusion or a recommendation for action for the simulated problem.

The course has evolved into one based upon the concept that students are expected to do a reasonable amount of work each week. That concept is reinforced by alternating a short 30-minute quiz one week with a formal laboratory assignment the next – there are six quizzes and seven laboratory sessions during the term.

Each laboratory session is centered around a 40 to 50 minute time frame. For the past fifteen years, the course has met twice a week for 75-minute sessions. The laboratory sessions are scheduled during one of the regularly scheduled class sessions. Because of the 35 student class size and the 20 student laboratory size, the 75 minutes meeting times are divided into two laboratory sessions. However, beginning with the Fall 1998 term, the weekly meeting schedule will revert back to the traditional three 50-minute sessions, the class sized will be lowered, and the computer laboratory facility will be enlarged so that an entire class can be accommodated in one 50 minute laboratory meeting.

While no formal pre and post analysis or control group comparisons have been conducted, the author will report on surveys that were conducted. The general conclusion, so far, has been that the overwhelming majority (90+%) of students would recommend the "technology infused" course to others.

Instructional Setting:

Monmouth University is a private, comprehensive, teaching university enrolling approximately 4500 students of which 3200 are full-time undergraduate students. The University is located in the central shore area of New Jersey – about 55 miles south of New York City.

The Mathematics Department of the University has twelve full-time faculty members. The Mathematics Majors program at the University enrolls about 35 full-time equivalent students; a significant number of those students are dual majors – mathematics and education. As with many institutions of today, a substantial part of the teaching responsibility of the Mathematics Department at Monmouth University is directed toward instruction for non-majors with many in the non-science disciplines. The largest single population serviced by the Mathematics Department consists of those students majoring in programs within the Business School. Those students are required to complete three (3) credits in "traditional" finite mathematics, three (3) credits in applied calculus, and three (3) credits in statistics. The first course, Math 111, will be the focus of this paper. Eight sections of Math 111 are offered during the fall semester and five sections during the spring semester. A total of about 500 students enroll in the course on an annual basis.

The University has a computer network, called HawkNet, with a fiber optic backbone that connects all academic buildings including the library and the nine residence halls. Students residing in the residence halls may subscribe to a network connection on a no-charge basis. There are 15 "public" computer laboratories in size ranging from six to thirty computers, and an "Information Commons Area" in the library. One of the computer laboratories is located in one of the new residence halls. Each of the other residence halls contain at least two public accessible computers in the lobby. All of these facilities are accessible to students and support access to the campus network and "web" server. In addition, the University supports a modem pool for dial-in access and a T1 link to an Internet Service Provider.

As of this writing, all but a few of the 185 faculty at the University have a PC on their desk. Except for the Computer Science Faculty who have SUN Workstations and the Art Graphics Faculty who have Apple Macs, most of the faculty systems are Pentium class units. All are connected to HawkNet and most are running Windows 95 with the standard productivity tools (either Office 95 or Office 97) along with Netscape.

Faculty members in the Mathematics Department have at least a Pentium P75 system. The Department has standardized on Maple V as the mathematics symbolic algebra language. In addition to the standard productively tools, all faculty workstations have a copy of Maple V installed locally on their systems.

The Mathematics Department computer laboratory contains 16 workstations networked through a 10 Meg, 3Com Super Stack switching hub. The workstations in the laboratory are 133 MHz Pentium computers with 32 Meg of main memory. Most of the laboratory software resides on the local hard drive. The laboratory workstations are connected to the Mathematics Department server through a 100 Meg port on the switching hub.

The mathematics server is running Windows NT 4.0 with the latest service packs and fixes. It is administered locally by the Mathematics Department and acts as both a file server for individual faculty files that are publicly available in the laboratory and as a "web" server for Mathematics Department information and faculty course notes.

Each faculty member is provided with two main directories on the server. One directory is for notes and files that are accessible from the computers in the Mathematics Laboratory. Normally, those files are templates or data files to be used as source material for student exercises in Maple, Excel, or SPSS. These files are only available in the Mathematics Laboratory. The other main directory is for the distribution of course materials over the Web. These materials include course notes, study guides, and homework assignments. The Web materials are part of the University Web structure and, as such, are accessible from any station that has Internet Web access. The URL of the Mathematics Department Home Page is: "mathserv.monmouth.edu"

Course Description and Rationale:

Math 111 is the first in a three-course sequence that is designed explicitly to provide the basis for quantitative business decision-making techniques. The general theme of the three-course sequence follows the concepts being developed by the Villanova Project which, in part, is being funded by the National Science Foundation. That project is developing course materials that support decision making in business applications. The focus of the effort is to provide resource materials in the "reformed tradition;" that is, to show the connections between the mathematical topics and the student's world – present and future.

The Math 111 course provides the foundation in model building that will be used throughout the sequence. This foundation includes: clarifying a problem, making estimates, defining variables in a problem, fitting a model to the problem, finding mathematical solutions by solving model, and validating a mathematical solution against plausible answers to the original problem.

Given that our world is technology oriented, the courses in the sequence will make the most of that reality. It is estimated that a Business graduate entering the career environment will have a 90% chance or better of having computer on his/her desk. Consequently, the use of technology is an important component of the course sequence. Students are expected to be able to solve simplistic problems by hand to master the concepts, however, it doesn't stop there. Through the use of an integrated series of laboratory exercises, students experience solving realistic problems using data that would be too laborious to manipulate without the aid of technology.

The graphing and symbolic manipulation capabilities there are available through many of the technologies of today minimize many of the traditional topics. For example, how can we justify spending considerable time and effort on factoring algebraic expressions beyond the quadratics, solving complex equations, curve sketching, or laboriously calculating simple statistical measures. Even though the use of technology in mathematical instruction may reduce the need for some skills, it does increase the need for other skills. One of the important skill objectives that is included in the course is recognizing that a solution is not just a bunch of numbers on a piece of paper. The laboratory component stresses the importance of relating the numbers to the real-world problem, an interpretation, or a conclusion.

The formal catalog description for the course is:

> **Catalog Description:** Linear equations and models, systems of linear equations and applications, matrices and techniques for solving systems of equations, linear programming and applications, quadratic functions and models, and exponential and logarithmic models. A computer laboratory component is incorporated. Designed for students majoring in Business Administration; other student majors by permission of the Mathematics Department.

Laboratory Component and Objectives:

The laboratory component of the course consists of seven "formal" laboratory sessions. They are formal in the sense that students are expected to attend and participate. As mentioned above, they are modeled after the traditional chemistry and physics laboratories.

The first exercise is intended to introduce students to some basic techniques for using the technology to assist in problem solving and some of the basic syntax of the Maple V application. The remaining six laboratory exercises present students with simulated problems that resemble real world applications.

The goal of the laboratory exercises is not to have students become proficient in using the Maple technology – it is unlikely that they will have access to such technology in the business world. It is, however, to have students recognize that such technology exists and that it can be used in a relatively easy manner to solve problems that normally could not be solved by pencil and paper. When the need for technology assistance occurs in the work place , they would be able to go searching for assistance with the knowledge that they are capable of using some technology even though they "never had a course in it." They would not be intimidated by technology – that is, they would have a comfort level toward using technology in problem solving.

In addition to the "comfort level" idea, the following list describes other objectives of the laboratory component, which are, in fact, elements in the "reformed movement:"

1. Foster and encourage collaborative problem solving through the "team" approach to comple- ting individual assignments as well as inter-team discussions during the laboratory time.

2. Relate mathematics to solving real-world problems – in particular, the problems have been selected so that students can directly relate to their applications and can translate the problem to the realm of even bigger and more complex applications.

3. Require conclusions, reports, and/or recommendations – solutions to real-world problems are not just numbers. Students are required to communicate the solution in terms of written reports.

4. Demonstrate that maybe more is not better – with the inclusion of the formal laboratory exercises, less content is being covered. However, students should be able to relate to more mathematics.

Laboratory Implementation Details:

At the current time, the official class capacity for Math 111 is 35 with an average class size of 30. Since the current laboratory has seating for 20 students with 16 workstations, classes are divided into two sections. The scheduled 75 minute class meeting is divided into two 40 minute sessions — the first half and the second half. During the first class meeting before the first laboratory, a signup sheet is sent around requesting students to sign up for the first session or the second session. For the second lab, students are told to attend the same session. After that, no mention is made of sessions; students seem to even themselves out and there has been very little contention over seats.

Each laboratory exercise consists of a sample Maple worksheet and an assignment template. Normally, the sample worksheets contain a solution to a very simplistic problem. The purpose of the sample is to demonstrate a possible sequence of steps that could be used to solve the problem as well as to illustrate the syntax of the Maple commands that can be used to solve the problem. In some cases, the sample worksheet demonstrate several different approaches to solve the problem.

The sample worksheet and the assignment template are available through a network share drive. As mentioned above, these files are only available in the Mathematics Laboratory. The Mathematics Department has recently acquired the Adobe Suite of software. We are beginning to make the sample worksheets and templates available through the PDF read-only format on the web server. At this point, not all the worksheets have be made available. The rationale is to require students to obtain copies of the material before the lab and come prepared. At this point, that might be a little too much to expect.

A brief overview of the laboratory exercise is presented during the end of the class period that precedes the laboratory. It's unclear how much time needs to be spent preparing the students for the laboratory.

Often the most difficult part that students have in solving problems is getting started. The purpose of the assignment template is to provide a starting point – they are not starting with a blank worksheet and spending time searching for a plan to get started. Even though there is value in devising a solution plan, it is the author's belief that it is more valuable to put the time in at the end – that is, translate the mathematics back to the real problem and describe the solution. We have found, that in the allocated laboratory time, it is unrealistic to require creative thinking at both beginning and the end of the assignment. The template provides suggestions on the steps to following – that is, the order of the activities.

Students are required to sign an attendance sheet for each of the laboratories. There is an implication that if they do not attend a laboratory session and they do not have an excused absence, they cannot get credit for the laboratory. Point of fact is that we haven't needed to go so far as to enforce the attendance; the unsaid implication has kept attendance at a high level. Students who miss the formal sessions have talked to the instructor and have worked out a method to insure they are doing their own work.

Approximately 75% of the teams complete the laboratory assignment during the scheduled lab session. Those that do not, have until the next scheduled laboratory to complete the assignment.

With the increased laboratory capacity and extended time allocation, the author is planning to require a preliminary report in the event that the assignment is not completed during the allocated time period. A further description of that idea is contained in the Future Section.

Testing and Evaluation:

Each of the laboratory assignments is graded on a point scale of 1 through 5 with 5 being the highest grade. Most of the scores have been between 3 and 5. One point (20% of the grade) is allocated to conclusion – the write up for the report and one point to the overall neatness of the report. The rest of the points are for general content and syntax. In general, a team has to work fairly hard at not getting a passing grade. Very seldom has a report been turned in that demonstrated a "really don't care" attitude. In general, we are fairly accommodating in providing assistance on syntax errors and procedure errors and have been rigid in requiring students to provide their own conclusions and analysis. The laboratory grades represent 20% of the course grade.

All members on a team receive the same grade. Since the teams are self organizing, the "coasters" (the students that don't contribute but expect to have their name on the report) seem to catch on after a while. It's a self-correcting problem, since other students avoid having them on their team.

Students are not tested directly on any Maple syntax. Occasionally, syntax from a previous laboratory exercise is required. In that case, students ask for assistance or use the help feature of Maple. We suggest that students use the Maple help on syntax by going directly to the example section. By entering three question marks followed by the command, Maple will go directly to the example section; for example "???plot" will display a set of examples on the use of the plot command.

Even though there is no direct testing of the laboratory exercises, an occasional quiz question will require that students to explain in their own words the processes that were followed in the laboratory exercise. These have been tough questions for the students to answer.

Summary of Individual Laboratory Exercises and Objectives:

Laboratory 1 – Introduction. In this introductory laboratory exercise, students learn to enter Maple commands and text into a worksheet, execute a worksheet, use the Maple commands *plot* and *solve*, and use the assignment command to represent long expressions. The exercise has two parts: plot three lines to discover the concept of simultaneous solutions and to approximate a line of best fit by adjusting the slope and intercept parameters until the fit looks "good."

Laboratory 2 – Supply and Demand. This exercise involves data points collected by a consultant relating to pricing and demand of tuition charges – linear demand curve; and information from a university financial office on the willingness (ability) to provide services related to pricing – linear supply function. Students are expected to translate the verbal description of the problem into mathematical models for the demand and supply curves, use the technology to estimate the point of market equilibrium, and to prepare a report representing a recommended tuition level. The report must contain at least a graph of the demand and supply curves.

Laboratory 3. – Budget Manipulation using Matrix Algebra. Matrix operations are used to manipulate data representing budget information. Rows in the matrix represent budget categories while columns represent departments. Students discover how to use scalar multiplication to accomplish "across the board" increases or decreases, and how to use matrix multiplication to adjust the budget through category changes and to eliminate the allocation of a given department.

Laboratory 4. – Quadratic equation containing data points. This exercise demonstrates solving a system of linear equations to find the quadratic equation containing three non-collinear points. The exercise is presented in the context of a business that attempts to maximize job satisfaction. Jobs within the company are divided into two broad types – Type A and Type B. Type A are the narrow, well-defined positions while Type B are the more demanding and challenging positions. An analysis collects three data points relating satisfaction to age for both of the job types. The exercise requires that students use the data points to estimate a quadratic satisfaction model for the two types of jobs. From these mathematical models, students are requested to submit a recommendation to the CEO suggesting appropriate age levels when employees should be considered for movement between job categories with the objective to maximize job satisfaction.

Laboratory 5 – Graphical solution to Linear Programming Problem. This is a Two Product Farm Scheduling Problem that attempts to maximize total income. The problem involves resources – available land, capital, and storage capacity. Students are requested to use the Graphical Method to solve the corresponding Linear Programming Problem. Students are expected to prepare at report to the farmer with a planting scheme recommendation. As it turns out, they will need to justify to the farmer why not all the available acreage is used. They need to explain how the available resources impact on the planting scheme.

Laboratory 6. – Standard Linear Programming Problem (many variables). This exercise simulates an Admissions Yield and Recruitment Constraints Problem. A University has a desire to enroll an appropriate mixture of the four categories of students, but in such a way that the admission decision process is nondiscriminatory; that is, only academic admission criteria is used in the decision process and not the fact that a specific category is over subscribed. The data for the problem consists of estimated yields of new student enrollments in four categories of students from five different geographic regions. The constraints for the problem consists of statements representing desired enrollments in each of the four categories of students and statements regarding geographic diversity.

Laboratory 7. – Fitting Exponential Growth Curve to data. This last laboratory exercise involves using an exponential function to model the recorded HIV infections for the 10 year period from 1981 through 1990. To estimate the model, students are given an exponential function with two variables (the base is given as 1.5). They are expected to adjust the values of the variables, as in Exercise 1 for a linear model, until they have a good fit. After they have constructed a model that estimates the data, students are asked to make future projections. The exercise ends with asking students to comment on their projections for 2000 and 2010 related to the total world population.

Problems:

In an open collaborative environment – such as our computer laboratory experiences – one of the biggest issues is the encouragement and support of team efforts while at the same time discouraging just coping another team's or person's report. Our position at the present time is to err on the collaborative part. That is, encourage team and inter-team collaboration but not accept duplicate reports – everyone fails the project report when duplicate reports (or sections) are submitted. Rephrasing and/or rewriting of ideas and sections are accepted.

Maple V is a syntactical and non-forgiving language. Students experience difficulty remembering the proper syntax for a given command. Initially a lot of time is spent assisting students with syntax errors. Their ability to appreciate the importance of proper syntax grows with experience. This is one of the areas where having a lab assistant in the room is very helpful. The assistant resolves most of the syntax problems, while the instructor works with the team in the thought process that goes into solving the problem.

Even after students have been able to understand and articulate the problem, there is a tendency to mimic the sample worksheet regardless of whether or not a particular step is related to their problem or not. Some have very rudimentary skills in "knowledge transfer."

Students have difficulty relating to the fact that mathematics is more than numbers on a piece of paper. They find it difficult to draw conclusions from the data, to put the mathematics in the form of a recommendation for a course of action; or to just describe what they did in the experiment. Initially, we get incomplete thoughts or poorly constructed sentences. However, by the end of the course, students recognize that something has to be said and most make attempts at writing something; albeit a single sentence.

When a problem statement is long, students have difficulty getting to the essence of the problem. We have attempted to present problems to which students can relate and have a frame of reference.

We have found it difficult to get students to come to the laboratory sessions with some semblance of preparation. Just providing written material that is either handed out in class or made available through the web is not adequate. Students don't feel obligated to prepare for the experience. We resorted to spending time in class preparing students for the experience. We'll spend 5 to 10 minutes discussing the goals and objectives of the forthcoming laboratory. In some cases, we'll discuss the steps and the command syntax..

The Maple V software is only available to students in the Mathematics Laboratory. Student versions of the product are available through the University Bookstore, but few, if any, purchase a copy for their own computer. This is understandable; but it does create a problem when students would like to use the software to solve problems not directly related to the formal laboratories. Where we are going on this issue is not known at this time.

The current laboratory has been configured as a teaching laboratory ___ with a front of the room where the instructor would lecture. The workstations have been arranged to facilitate viewing the instructor and not for encouraging teamwork or permitting circulation around the room.

Successes:

Each class has its own personality and dynamics. Even the silent classes – where it is nearly impossible to get the students to speak, ask questions, or in anyway provide feedback – experience a transformation in the laboratory component of the course. They do talk, they do interact and participate, and they do smile.

When one acknowledges the fact that almost no one in the course is there because of their choice, it is somewhat telling that most students recommend the technology infused format (computer laboratory) over the traditional course.

The student confidence level in using technology to assist in problem solving increased through the experience.

Future:

In order to accommodate the laboratory component in the revised schedule format of three 50 minute class meetings each week, the class size has been reduced from 35 to 30 students and the computer laboratory will be increased from 16 workstations to 30 workstations. These changes will permit the entire class to meet in the laboratory for the scheduled 50 minutes.

Each student registered for the Math 111 course will be assessed a computer laboratory fee of $40. Those funds will be returned to the Mathematics Department to support the laboratory expenses which include computer maintenance and upgrades, software licenses and acquisitions, and laboratory assistants. The laboratory will be open from 9 am to 10pm – Monday through Friday. During open hours, it will be staffed by a laboratory assistant, who will be able to assist students with technology and software syntax related issues. In addition, each scheduled laboratory session will have one lab assistant in the room along with the instructor.

The dramatic increase in the number of students that will be participating in the laboratory exercises next Fall has raised some concern over plagiarism of the laboratory exercises. Several ideas to minimize the issue are under discussion. The one that seems most promising at this point is the concept that students will be required to turn in the assignment at the end of the session or will present the instructor with a work-in-progress document that will be signed by the instructor. That signed work-in-progress document will permit the student to continue to work on the assignment. To receive credit for the assignment, the student must attach the authorized work-in-progress document with the final report.

An on-line Maple Tutorial directed to the needs of students in Math 111 and the subsequent courses will be developed. The current Maple tutorial prepared by the Department contains too much material that is beyond the need and reach of students in the sequence.

Student Surveys:

Appendix A contains a copy of the survey completed by the 55 students who were in attendance when the survey was administered.

Conclusion and Recommendations:

Clearly, the formal laboratory component does diminish the total amount of content covered in the course. However, our experience so far indicates that students feel a little more comfortable with mathematics, they generally interact and "come alive" in the laboratory, and they recommend the laboratory experience to others.

Faculty that engage students in the collaborative problem solving, laboratory approach must recognize that it is not possible to identify performance with any given student Some of our faculty have expressed concern over that loss of identification.

One of the significant concerns expressed by students in prior year's exercises was the wait time for assistance. In previous terms, the instructor was the only support person in the room. This problem was alleviated this past spring with the addition of a trained laboratory assistant. At this point, it appears that an appropriate support formula is one professional (instructor or lab assistant) for each 10 to 15 students.

We have found that it is unrealistic to expect students to prepare ahead of time and come to the laboratory prepared. Consequently, we spend about 5 to 10 minutes at the end of the class period just prior to the laboratory session explaining the laboratory objective.

Don't expect students to be programmers. Maple is a highly syntactical, non-forgiving language. In the laboratory environment, we quickly resolve syntax problems, but we require students to work out their own process goals – what they want to do and the order in which to do it.

We have found the need to continuously reinforce the requirement that individual team reports be unique. Unfortunately, the technology in the laboratory makes it easy to duplicate reports.

The Laboratory environment should facilitate moving around. Both students and lab assistants need to be able to easily navigate the room. One possible room configuration is to have a set of stations around the perimeter of the room with a free standing island in the middle. Our laboratory is 730 sq. ft. It will be reconfigured to accommodate 30 stations using that scheme.

It is unlikely that a laboratory experience for more that 20 or 25 students will be successful without a networked environment where the requisite files and templates can be placed. Along with that, it is imperative that the faculty member responsible for the creation and updating of the files have "easy" and "complete" access to the directories containing the files. There will be times when last minute changes and additions will have to be made.

There has to be general acceptance that the goal of the laboratory component is to get students comfortable with using technology to solve problems and not to cover more material in a more "efficient" manner.

Appendix A

Course/Instructor Evaluation

Professor:_____________ Course:_________________ Section:_____ Term: _______

1. Of the on-line class notes that were made available, I obtained:
   1=none, 2=25%, 3=50%, 4=75%, 5=all
   Response: 1-0; 2-6; 3-8; 4-10; 5-31 — 1 2 3 4 5

2. In general, the value of the on-line class notes was:
   1=no value, 2=minimal, 3=average, 4=helpful, 5=extremely helpful
   Response: 1-0; 2-4; 3-9; 4-23; 5-19 — 1 2 3 4 5

3. Of the laboratory meetings that were scheduled, I attended:
   1=none, 2= 25%, 3= 50%, 4= 75%, 5=all
   Response: 1-0; 2-0; 3-1;4-11; 5-43 — 1 2 3 4 5

4. In general, the value of the laboratory experience was:
   1=no value, 2=minimal, 3=average, 4=helpful, 5=extremely helpful
   Response: 1-2; 2-4; 3-14; 4-22; 5-12 — 1 2 3 4 5

5. In general, the value of the collaborative problem solving experiences in the laboratory was:
   1=no value, 2-minimal, 3=average, 4=helpful, 5=extremely helpful
   Response: 1-0; 2-6; 3-11; 4-28; 5-10 — 1 2 3 4 5

6. Regarding the use of computer technology, at the beginning of the course I was:
   1=apprehensive, 2=somewhat fearful, 3=neutral, 4=comfortable, 5=very adept
   Response: 1-4; 2-9; 3-20; 4-19; 5-3 — 1 2 3 4 5

7. Regarding the use of computer technology, at the end of the course I now feel:
   1=apprehensive, 2-somewhat fearful, 3=neutral, 4=comfortable, 5=very adept
   Response: 1-0; 2-1; 3-6; 4-35; 5-13 — 1 2 3 4 5

8. For me, a frustrating aspect of the laboratory requirement was:________________________

____

____

9. From my experience, I (circle one) would/would not recommend this technology-infused course to others.
   Response: would - 49; would not - 5

10. Taking all factors into consideration, the general rating for the course is:
    1=poor 5=excellent
    Response: 1-1; 2-1; 3-5; 4-31; 5-19 — 1 2 3 4 5

General comments on how to improve the course are appreciated. In particular, your general thoughts on the (a) electronic mail communication, (b) on-line class notes, and (c) laboratory exercises are most welcome. Use the space on the back for these comments.

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