

# Using Group Projects on Community Issues to Develop Quantitative Skills

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and Loyola Marymount University ([www.lmu.edu](http://www.lmu.edu))

# **Quantitative Literacy With Collaborative Projects**

by

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## **Acknowledgements**

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- T.Z., S.L., J.D.

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This course manual is available on the Internet: <http://myweb.lmu.edu/tzachari/semcer.html>

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## PREFACE

Loyola Marymount University (LMU), a comprehensive university with a liberal arts focus located in Los Angeles, CA, has an enrollment of 5500 undergraduates. LMU balances a challenging liberal arts and sciences curriculum with outstanding professional programs at the graduate and undergraduate levels. Of particular interest to this project is the mathematics core requirement for all LMU undergraduates. Those students whose major does not require a mathematics course fulfill their mathematics core requirement with:

MATH 102: QUANTITATIVE SKILLS FOR THE MODERN WORLD (3 Semester Hours) Quantitative and analytic skills used to understand personal and social issues faced in everyday life. Topics include problem solving, computer spreadsheets, probability and statistics, and the mathematics of finance. An accompanying computer lab uses a spreadsheet program to explore these topics.

In 2004 the LMU Project Team received a grant from SENCER (Science Education for New Civic Engagements and Responsibilities)<sup>1</sup> to develop a “SENCERIZED” version of this quantitative literacy course. Our specific goals were to: (1) develop an alternate version of our current math core class (MATH 102 Quantitative Skills for the Modern World) that would be accessible to students with only a high school math background and in which students learn and apply mathematics to address problems in the greater Los Angeles area (and hence became ‘civically engaged’); (2) have each of the three mathematics faculty on the team teach at least one section of the course during academic year 2005-6; (3) recruit other faculty to teach this SENCERIZED version of the course.

In keeping with SENCER’s vision of teaching

*“To” basic science and mathematics*

*“through” complex, capacious, and unsolved public issues,*

our original thought was to base the course on mathematical modeling of civic and environmental problems in Los Angeles. However, when we examined the available mathematical modeling textbooks, we found they were aimed either too high or low, especially considering the wide variety of math backgrounds of our potential students. We also realized that there would be many advantages to keeping the mathematical content of the SENCERIZED version more in line with the original course content. These include the ability to mix students from the standard and the SENCER version of the course together in the accompanying computer spreadsheet labs. Another advantage to keeping the mathematical content very similar is that we are able to utilize the same course number for both versions. So our SENCERIZED MATH 102 employs a “group projects approach” and adopts a very local interpretation of “unsolved public issues.” The project topics were drawn from local campus or community issues, and many topics, such as the cost of college textbooks, use of the student health center, campus parking availability and safety, have a very clear and direct impact on students’ lives. For the rest of this manual we will distinguish between the original math core course and the SENCERIZED version by using the terms “standard” or “projects-based.”

Both versions are 3-semester-hour courses. Standard course topics include number sense, computer spreadsheets, probability and statistics, mathematics of finance, and voting theory. In 2005-06 Drs. Zachariah, Larson and Dewar incorporated a civic engagement component in five sections of MATH

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<sup>1</sup> <http://www.sencer.net>

102 by assigning group projects involving local community issues in which students could use the mathematics of MATH 102 as tools. All three instructors presented a model demonstration project based on the topic of student loan debt. To provide time for presenting the model project and to allow time for some in-class group project work two standard topics (theory of voting and probability) were removed from the course.

This manual contains the curricular and assessment materials that were developed and utilized for the student projects and the model project. In it we describe our experiences using them, and make suggestions for adopters. We also include some additional materials we developed that relate to or extend the standard MATH 102 course content. These consist of: new examples for the topics of number sense and making large numbers meaningful; an exercise based on a jury trial where the outcome hinges on correctly comparing linear and volumetric measurements; an expanded discussion of sampling methods; how to find a 90% confidence interval; and the Central Limit theorem. Finally, we wrote one new computer spreadsheet lab to ensure that students would be able to represent data graphically for their final presentations.

We consider this course revision effort a work in progress. Here we report some initial assessment results. During 2005-6 we surveyed a portion of the students in both the projects-based version of MATH 102 (n=29) and the standard version of MATH 102 (n=62) about (1) their views of the usefulness of math and (2) their awareness of community issues. They give strikingly similar responses about the usefulness of mathematics, which demonstrates that the standard version of MATH 102 was already doing a good job of reaching one of its goals. However, students in the projects-based course had significantly greater awareness of community issues after the course. In addition, 79% of the students in the projects-based courses agreed that their projects enabled them to connect their classroom learning (elementary statistics, mathematics of finance, computer spreadsheets) to campus or community issues and 59% said it helped them practice and learn mathematical or analytical skills. Chapter 6 contains additional details of the various assessments we conducted.

We offer this manual as a guide to anyone who wishes to adopt this course or apply a projects-based approach to another course. Please contact any one of us if you have any suggestions for improvements or if you believe that we can be of assistance to you in adopting these materials or the projects-approach for use at your institution.

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## Introduction

We developed a new version of our general education math core course MATH 102 Quantitative Skills for the Modern World. This course is required by the core curriculum for all students except those majoring in science, mathematics, engineering, business, psychology, economics and elementary education because those majors require other mathematics courses. So a typical student might be majoring in English, Modern Languages, Speech Communications, Art History, or Film and Television. The course had to be accessible to students with only a minimal high school math background. Yet students might enroll having studied calculus in high school.

We wanted the course to:

- be a new, challenging, and yet feasible experience for all students regardless of their previous math background,
- demonstrate the power of mathematics as a tool for analyzing complex issues,
- encourage students to think and act critically in regard to environmental and/or civic issues,
- provide students and faculty a venue for collaborative research.

Five sections of the revised version were taught during the 2005-6 academic year by the three developers to a total of 110 students using the materials presented in this manual. During this same time period, fifteen sections were taught with the standard approach.

For our course we had the following three student learning outcomes that can be categorized as:

**Awareness/attitude, Performance, Engagement:**

- A. Students will be aware of the usefulness of math in addressing real world problems, and will have greater confidence toward using mathematics
- P. Students will be able to describe, analyze, and make recommendations about community or environmental problems arising in the LA area using appropriate mathematical tools
- E. Students will be engaged in a community issue during the course and more likely to be engaged in civic issues in the future.

These were layered upon the existing goals for the standard course, which we list here:

- Prepare students for other core science classes (topics that do this are percentages, scientific notation, significant digits, basic statistics)
- Produce students with quantitative and analytical skills useful in day-to-day living (topics that do this are understanding quantitative statements, basic probability, statistics, math of finance, and to a lesser extent theory of voting).

Our approach was to incorporate semester-long group projects involving local community issues that students could investigate using the mathematics of MATH 102 as tools. All three instructors presented a model demonstration project based on student loan debt. To provide time for presenting the model project and to allow time for some in-class group project work one standard topic (theory of voting) was removed from the course and another (probability) was diminished. We retained the same textbook<sup>2</sup>, but, as indicated in the syllabi and calendar comparisons shown in Chapter 1, we covered slightly different and fewer sections. However, all students participated in the same computer spreadsheet laboratory that accompanies all sections of MATH 102; in fact, students from the standard and the projects-based versions of the course were mixed together in the same computer lab sections.

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<sup>2</sup> Bennett, J. and W. Briggs. *Using and Understanding Mathematics: A Quantitative Reasoning Approach* (3rd ed.) Boston: Pearson Education, Inc., 2005.

# Chapter 1

## Syllabi and Calendars

### Introductory Notes for Instructors

Both the standard and projects-based versions of LMU's quantitative literacy course (MATH 102) are 3 unit courses that meet for 150 minutes per week with an accompanying required 75-minute computer lab that meets once a week. Generally, enrollment in sections of the standard course is capped at about 30 students, but we have capped sections of the projects-based course at 24. Topics covered in the standard course include: number sense (percents, significant digits, putting numbers in perspective), financial mathematics (compound interest, loans, credit cards, annuities, taxes), basic probability and statistics, and the theory of voting. The projects-based course includes the same topics with the exception of probability and the theory of voting, which were dropped to allow sufficient time for the projects.

The required computer lab period has been a part of the course since its inception. In the lab, students learn to use the Microsoft Excel spreadsheet application to create computer tools that are useful in daily life. Each week the lab begins with a 10 – 15 minute mini-lecture, then students (typically) work with a partner to create and modify spreadsheet projects that will perform a variety of information organization and analytical tasks. The first few lab projects require students to enter data, format cells and use basic formulas. Later lab projects require additionally that students use relative addressing appropriately, create somewhat more involved formulas and apply Excel's chart feature. At the end of the semester students take an Excel exam using the computer. Over the years, some lab projects have been replaced by new projects. When modifying the course to include projects, we created and added a new lab project centered around using Excel's chart feature in order to ensure students enrolled in the projects-based course would have appropriate tools for use in organizing data and presenting their results (see pages 77-80). This new computer spreadsheet lab has been adopted for use by all MATH 102 students – those in the standard course and those in the projects-based course.

### Intended Audience

MATH 102, Quantitative Skills for the Modern World, is the required core course in mathematics designed for all students with the exception of majors in science, mathematics, engineering, business, psychology, economics and elementary education who take other mathematics courses related to their majors. So a typical student might be majoring in English, Modern Languages, Speech Communications or Film and Television.

### Textbook

The textbook that we have used with both the standard and projects-based course is *Using and Understanding Mathematics: A Quantitative Reasoning Approach* (3rd ed.) by J. Bennett and W. Briggs. Neither the standard nor the projects-based version of this course is dependent on this particular text. Any of the competing quantitative literacy textbooks on the market could be selected as the foundational text for a projects-based course.

### Syllabi and Calendars

For comparison purposes, the following four pages give template syllabi and sample calendars used in the standard course and used in the projects-based course. These reflect only small differences in the topics covered in the course, although the ordering of topics varies between the two courses. The grading schemes are also very similar. The standard course includes a final exam for 25% of the grade, and that final exam includes a multiple-choice portion that is matched to a pre-test for core curriculum assessment purposes. In the projects-based course this 25% grading component consists of a project

grade worth 20% and the post-test worth 5%. Both the standard and projects-based course include 3 in-class exams during the semester and 4 or 5 quizzes so that students are tested on virtually all class material at some time. The calendar for the projects-based course (on page 13) gives an indication of the amount of class-time devoted to the projects.

## Syllabus for MATH 102 (Standard Course)

Instructor:

Office:

Office Extension:

E-mail Address:

Math Department Secretary Extension:

Office Hours:

Course Goals To prepare students for other core science classes, to provide students with quantitative and analytical skills that will be useful in day-to-day living and some level of confidence in their ability to use those skills.

Required Textbook: *Using and Understanding Mathematics-A Quantitative Reasoning Approach* (third edition), by Bennett & Briggs, Pearson Education (Boston), 2005.

Required Calculator: TI-30XA

Grading System: 4 or 5 Quizzes - 15% of the grade  
3 In-Class Exams - 45% of the grade  
Labs - 10% of the grade  
Lab Final - 5% of the grade  
Final Exam - 25% of the grade

The grade will be calculated as follows:

$$\text{Score} = (0.15)\text{Quiz Grade} + (0.15)\text{Exam 1 Grade} + (0.15)\text{Exam 2 Grade} + (0.15)\text{Exam 3 Grade} \\ + (0.10)\text{Lab Grade} + (0.05)\text{Lab Final Grade} + (0.25)\text{Final Exam Grade}$$

A score in the 90's will receive at least an A-, a score in the 80's will receive at least a B-, a score in the 70's will receive at least a C, and a score in the 60's will receive at least a D.

Attendance: Class attendance is expected and the instructor will discuss specific attendance policies.

Homework: Homework assignments will be given and collected regularly. The use of homework as a factor in grade determination is at the discretion of the instructor.

Missed Exams: The weight of a missed exam that is excused will be shifted to the final exam.

Labs: The purpose of the lab periods is to allow you to learn about the use of spreadsheet programs in analyzing real problems. For most of the lab projects, you will have the opportunity to work with another student, while using a spreadsheet program. By doing so, you can learn from other students and gain from the experience of communicating your knowledge to others.

All of the lab periods this semester will be held in a computer lab (University Hall Room 2717).

Attendance and punctuality at each lab is required and the grade for each lab project will be based in part on participation in the project.

Academic Honesty: Academic dishonesty will be treated as an extremely serious matter, with serious consequences that range from receiving no credit for assignments/tests to expulsion. It is never permissible to turn in any work that has been copied from another student or copied from a source without properly acknowledging the source. It is your responsibility to make sure that your work meets the standard of academic honesty set forth in the Honor Code. See the section on "LMU Honor Code and Process" in the *Undergraduate Bulletin 2005-2006* pages 61 – 64.

### Calendar from Fall 2005 for MATH 102 (Standard Course)

	M	W	F	Lab	Week #	Class Day #
<b>Aug/Sept.</b>	<b>29</b> Course Introduction, 3A - Uses and Abuses of %	<b>31</b> 3A -Uses and Abuses of %	<b>2</b> Pre-test	Excel Overview	<b>1</b>	<b>1 to 3</b>
<b>Sept.</b>	<b>5</b> Labor Day	<b>7</b> 3B-Putting Numbers in Perspective, 3C- Dealing With Uncertainty	<b>9</b> 3C- Dealing With Uncertainty, <b>quiz 1</b>	<b>No Lab</b>	<b>2</b>	<b>4 to 5</b>
	<b>12</b> 3E – How Numbers Deceive: Polygraphs ...	<b>14</b> 3E – How Numbers Deceive: Polygraphs ..	<b>16</b> 7A – Fundamental of Probability	Project: Mustang Configuring	<b>3</b>	<b>6 to 8</b>
	<b>19</b> 7A – Fundamental of Probability, 7B – Combining Probabilities	<b>21</b> 7B – Combining Probabilities	<b>23</b> 5A-Fundamentals of Stats, <b>quiz 2</b>	Project: Mustang Financing	<b>4</b>	<b>9 to 11</b>
	<b>26</b> 5B Should You Believe a Statistical Study?	<b>28</b> Review for Exam I	<b>30</b> Exam I	Project: Course Tracking	<b>5</b>	<b>12 to 14</b>
<b>Oct.</b>	<b>3</b> Return Exam, 5C-Statistical Tables and Graphs	<b>5</b> 6A-Characterizing a Data Distribution	<b>7</b> 6B-Measures of Variation.	Project: Graphs	<b>6</b>	<b>15 to 17</b>
	<b>10</b> 6C-The Normal Distribution	<b>12</b> 6C-The Normal Distribution	<b>14</b> 6D-Statistical Inference, <b>quiz 3</b>	Project: Budget 1	<b>7</b>	<b>18 to 20</b>
	<b>17</b> 6D-Statistical Inference	<b>19</b> 4A-The Power of Compounding	<b>21</b> 4A-The Power of Compounding	Project: Budget 2	<b>8</b>	<b>21 to 23</b>
	<b>24</b> Fall Break	<b>26</b> Review for Exam II	<b>28</b> Exam II	<b>No Lab</b>	<b>9</b>	<b>24 to 25</b>
<b>Nov.</b>	<b>31</b> 4B-Savings Plans and Investments	<b>2</b> 4B-Savings Plans and Investments	<b>4</b> 4B-Savings Plans and Investments	Project: Savings and Loans	<b>10</b>	<b>26 to 28</b>
	<b>7</b> 4C-Loan Payments, Credit Cards and Mortgages	<b>9</b> 4C-Loan Payments, Credit Cards and Mortgages	<b>11</b> 4D-Income Taxes, <b>quiz 4</b>	Project: Credit Cards	<b>11</b>	<b>29 to 31</b>
	<b>14</b> D-Income Taxes	<b>16</b> 1040EZ	<b>18</b> 12A-Voting: Does Majority Always Rule?	Project: Checkbook	<b>12</b>	<b>32 to 34</b>
	<b>21</b> 12A-Voting: Does Majority Always Rule? 12B-Theory of Voting	<b>23</b> 12B-Theory of Voting <b>quiz 5</b>	<b>25</b> Thanksgiving Break	<b>No Lab</b>	<b>13</b>	<b>35 to 36</b>
	<b>28</b> 2A-The Problem Solving Power of Units	<b>30</b> Review for Exam III	<b>2</b> Exam III	Excel Review	<b>14</b>	<b>37 to 39</b>
<b>Dec.</b>	<b>5</b> 2A-The Problem Solving Power of Units, 2B-Standardized Units	<b>7</b> 2B-Standardized Units	<b>9</b> Review for Final Exam	Excel Final Exam	<b>15</b>	<b>40 to 42</b>

Dates are shown on the left of the cell.

## Syllabus for MATH 102 (Projects-based Course)

Instructor:

Office:

Office Extension:

E-mail Address:

Math Department Secretary Extension:

Office Hours:

Course Goals To prepare students for other core science classes, to provide students with quantitative and analytical skills that will be useful in day-to-day living and some level of confidence in their ability to use those skills.

Required Textbook: *Using and Understanding Mathematics-A Quantitative Reasoning Approach* (third edition), by Bennett & Briggs, Pearson Education (Boston), 2005

Required Calculator: TI-30XA

Grading System:

- 4 or 5 Quizzes & homework - 15% of the grade
- Three in-class exams - 45% of the grade
- Labs - 10% of the grade
- Lab final - 5% of the grade
- Post test - 5% of the grade
- Group projects - 20% of the grade

Final Grade: The final grade will be calculated as follows:

Final score = (0.15) quiz grade + (0.15) exam-1 grade + (0.15) exam-2 grade + (0.15) exam-3 grade + (0.05) lab final grade + (0.05) posttest grade + (0.20) project grade. A score in the 90's will receive at least an A-, a score in the 80's will receive at least a B-, a score in the 70's will receive at least a C, and a score in the 60's will receive at least a D.

Attendance: Class attendance is required.

Homework: Homework assignments will be given and collected regularly. The use of homework as a factor in grade determination is at the discretion of the instructor.

Missed Exams: There is no makeup exam. If there is a valid reason for missing an exam, the instructor must be notified in writing.

Labs: The purpose of the lab periods is to allow you to learn about the use of spreadsheet programs in analyzing real problems. For most of the lab projects, you will have the opportunity to work with another student, while using a spreadsheet program. By doing so, you can learn from other students and gain from the experience of communicating your knowledge to others.

All of the lab periods this semester will be held in a computer lab (University Hall Room 2717).

Attendance and punctuality at each lab is required and the grade for each lab project will be based in part on participation in the project.

Academic Honesty: Academic dishonesty will be treated as an extremely serious matter, with serious consequences that range from receiving no credit for assignments/tests to expulsion. It is never permissible to turn in any work that has been copied from another student or copied from a source without properly acknowledging the source. It is your responsibility to make sure that your work meets the standard of academic honesty set forth in the Honor Code. See the section on "LMU Honor Code and Process" in the *Undergraduate Bulletin 2005-2006* pages 61 – 64.

## Calendar from Fall 2005 for MATH 102 (Projects-based Course)

	M	W	F	Lab	Week #	Class Day #
Aug.	<b>29</b> Intro, 2A-Problem Solving Power of Units	<b>31</b> 2B-Standardized Units	<b>2</b> Pre-test	Excel Overview	<b>1</b>	<b>1 to 3</b>
Sept.	<b>5</b> Labor Day	<b>7</b> 3A - Uses and Abuses of %	<b>9</b> 3A - Uses and Abuses of %, <b>quiz 1</b>	No Lab	<b>2</b>	<b>4 to 5</b>
	<b>12</b> 3B-Putting Numbers in Perspective, 3C- Dealing With Uncertainty	<b>14</b> 4A - The Power of Compounding	<b>16</b> 4A - The Power of Compounding	Project: Mustang Configuring	<b>3</b>	<b>6 to 8</b>
	<b>19</b> 4B-Savings Plans and Investments	<b>21</b> 4B-Savings Plans and Investments	<b>23</b> 4B-Savings Plans and Investments, <b>quiz 2</b> , <b>project groups and projects assigned</b>	Project: Mustang Financing	<b>4</b>	<b>9 to 11</b>
	<b>26</b> Stage 1 Model Project	<b>28</b> Review for Exam I	<b>30</b> Exam I	Project: Course Tracking	<b>5</b>	<b>12 to 14</b>
Oct.	<b>3</b> 4C-Loan Payments, Credit Cards and Mortgages	<b>5</b> 4C-Loan Payments, Credit Cards and Mortgages	<b>7</b> 5A-Fundamentals of Stats.	Project: Graphs	<b>6</b>	<b>15 to 17</b>
	<b>10</b> Sampling	<b>12</b> 5B-Should You Believe a Statistical Study?	<b>14</b> Stage 2 Model, <b>quiz 3</b> , <b>Stage 1 deadline</b>	Project: Budget 1	<b>7</b>	<b>18 to 20</b>
	<b>17</b> 5C-Statistical Tables and Graphs	<b>19</b> 5D-Graphs in Media (or Horizons Article <sup>3</sup> ) use examples from model project	<b>21</b> 6A-Characterizing a Data Distribution	Project: Budget 2	<b>8</b>	<b>21 to 23</b>
	<b>24</b> Fall Break	<b>26</b> Review for Exam II	<b>28</b> Exam II	No Lab	<b>9</b>	<b>24 to 25</b>
Nov.	<b>31</b> 6B-Measures of Variation	<b>2</b> Stage 3 model, <b>Stage 2 deadline</b>	<b>4</b> 6C-The Normal Distribution	Project: Savings and Loans	<b>10</b>	<b>26 to 28</b>
	<b>7</b> 6C-The Normal Distribution	<b>9</b> Central Limit Theorem	<b>11</b> Central Limit Theorem, 6D, Statistical Inference, <b>quiz 4</b>	Project: Credit Cards	<b>11</b>	<b>29 to 31</b>
	<b>14</b> 6D-Statistical Inference (our version)	<b>16</b> 6D-Statistical Inference (our version)	<b>18</b> Stage 4 Model, <b>Stage 3 deadline</b>	Project: Checkbook	<b>12</b>	<b>32 to 34</b>
	<b>21</b> Projects	<b>23</b> 4D - Income Taxes	<b>25</b> Thanksgiving Break	No Lab	<b>13</b>	<b>35 to 36</b>
	<b>28</b> 4D-Income Taxes	<b>30</b> Review for Exam III	<b>2</b> Exam III	Excel Review	<b>14</b>	<b>37 to 39</b>
Dec.	<b>5</b> 1040EZ	<b>7</b> Review for Post-test, <b>Stage 4 deadline</b>	<b>9</b> Post-test	Excel Final Exam	<b>15</b>	<b>40 to 42</b>

Dates are shown on the left of the cell.

<sup>3</sup> The Horizons article referred to is "Graphic Violence" by Dale Hathaway (*Math Horizons* April 2005, p. 14 – 16). In this article, several of the most common misleading features of charts and graphics are described and real examples found in the media are given.

## Chapter 2

### Projects: Topics, Framework, and Model

#### Introductory Notes for Instructors

The projects-based quantitative literacy course we developed has the same basic goals as the standard core course, but with an increased emphasis on preparing students to play active roles in addressing the problems and challenges of the larger society and world in which they live, using mathematics as tool. We tried to achieve this goal through the introduction of semester-long group projects involving local community issues.

In this chapter we describe projects developed during 2005-6 and provide various templates and resources for structuring the projects and clarifying expectations. After stating a purpose for each project and providing background reading, our framework for structuring the projects divides each project into four stages:

1. Background Investigation
2. Planning and Preparation
3. Action, Analysis, Conclusion
4. Response/Dissemination.

The generic framework enables the instructor (or a group of students) to develop new projects by stating a purpose, locating background reading and providing a description for each of the four stages. In addition, we include all the materials necessary to illustrate the stages of a project for the students, using a “model project” based on student loan debt. We also provide detailed descriptions of what is due at the end of each stage and how the mathematical content of the course connects to and can be utilized in a project.

This chapter contains:

- A list of the ten project topics developed during 2005-6, indicating the three that were student generated and the one that we present as a model (page 15)
- A generic project framework that can be used by faculty or students to design new projects (page 16)
- A framework for each of the nine projects that includes a statement of the purpose, background reading and a description of the 4 stages (pages 17-25)
- A detailed description of what is due at the end of each stage of a project (page 26)
- A list of the mathematical topics from the course with questions and suggestions to help students connect and apply the topics to their projects (page 29)
- A framework for the model project that includes a statement of the purpose, background reading and a description of the 4 stages (page 35)
- Transparency slides for introducing the model project and (page 36)
- The end product for each of the first three stages of the model project (pages 36-47)

Typically, a group of three or four students worked on each project. In certain cases a group of only two students were allowed to work on a project. A discussion of how groups were formed, mentored, and evaluated appears in Chapter 3. At the end of the project the students were required to turn in a written report, give an oral/PowerPoint presentation and devise a plan to disseminate their results. Chapter 4 contains information on assessing the projects.

## **List of Project Topics Developed during 2005-6**

### **Ballona Insect Survey**

**Purpose:** To investigate and catalog the insect species that populate different types of plants (native vs. nonnative) or substrates within the Ballona Wetlands. Ballona Wetlands is the last major coastal wetland in Los Angeles County and located adjacent to our campus. For this project, we were working closely with Friends of Ballona Wetlands (<http://www.ballonafriends.org>), which is a non-profit organization whose mission is to preserve, protect and restore the wetlands.

### **Living Expense: Living On-campus vs. Off-campus**

**Purpose:** To make a comparative study between the expenses incurred by a student who lives on-campus and a student who lives off-campus (assuming that s/he lives in a rented place). Which is “better” (in terms of cost, quality of life, convenience, etc.)?

### **Math Homework Help Session**

**Purpose:** To conduct an independent evaluation of the Precalculus and Calculus Homework Help Sessions offered by the LMU Mathematics Department and staffed by undergraduate teaching assistants.

### **Social Security: Will it Go Broke?**

**Purpose:** To make an independent assessment of Social Security by analyzing receipts and payments under the current system and under President Bush’s proposed changes.

### **Student Health Center Project**

**Purpose:** To act as consultants to the LMU Student Health Center to investigate who uses the LMU Health Center (and who does not) and for what reasons they do or don’t.

### **Textbook Cost Project**

**Purpose:** To investigate issues related to the pricing of college textbooks and to investigate whether trends found in a study of public colleges and universities in California and Oregon hold at LMU.

### **Model Project**

#### **Project – Student Loan Debt**

**Purpose:** To calculate a prototypical student’s loan balance at the end of her/his undergraduate studies and to estimate the impact of this loan balance on this student’s life once s/he starts working.

### **Student Designed Projects**

#### **Project – Campus Parking (Spring 2006)**

**Purpose:** To determine if there is “enough” parking on campus and if the parking lots are safe.

#### **Project – College Students’ Work-hours (Spring 2006)**

**Purpose:** To determine how much LMU students work and its impact on their studies.

#### **Project – Future Financial Planning (Spring 2006)**

**Purpose:** To develop a financial plan from college graduation to retirement.

## ***Generic (Design Your Own) Project Framework***

**Purpose:** What is the purpose/focus of the project? How does the project connect to your own community (on/off campus)? Be sure to consider what sort of mathematical skills it is likely to require.

### **Introductory Reading:**

List some appropriate background reading.

### **Project Stages**

- Stage 1. **Background Investigation:** In addition to background reading what other information should be gathered?
- Stage 2. **Planning and Preparation:** Plan and prepare to gather data, information, or evidence appropriate to answering your question by applying knowledge gained from this course. This might involve a survey, focus groups, interviews or developing a case study.
- Stage 3. **Action, Analysis, Conclusion:** Collect and analyze information and evidence by applying knowledge gained from this course. This might involve the following: tabulate the data, represent it using graphs, compute numerical summaries, find confidence intervals. For case studies, include calculations and any underlying assumptions. Draw conclusions.
- Stage 4. **Response/Dissemination:** Write a report, prepare an oral report and a PowerPoint presentation, and undertake an active response to your findings. This might include recommendations to the class, a letter to the campus newspaper, or a presentation at an undergraduate research conference.

### **Timeline:**

Please discuss your project idea with your instructor.

Week 3 – Submit a one-page (maximum) written proposal for your project idea stating:

- What is the purpose/focus of the project?
- How does the project connect to your own community (on/off campus)?
- What sort of mathematical skills is it likely to require?
- Suggested background reading

Week 4 – Student groups and project topics are finalized

Week 7 – Stage 1 deadline for completion

Week 10 – Stage 2 deadline for completion

Week 12 – Stage 3 deadline for completion

Week 15– Stage 4 deadline for completion

## ***Ballona Insect Survey Project Framework***

**Purpose:** To investigate and catalog the insect species that populate different types of plants (native vs. nonnative) or substrates within the Ballona wetlands.

### **Introductory Reading:**

“Ballona Wetlands Preserved” Heal the Bay Internet news article, Friday, November 14, 2003  
[http://www.healthebay.org/news/2003/11\\_14\\_ballona/default.asp](http://www.healthebay.org/news/2003/11_14_ballona/default.asp)

Friends of Ballona Wetlands website:  
<http://www.ballonafriends.org/>

### **Project Stages**

Stage 1. **Background Investigation.** Obtain a list of insects of interest in the area. Research descriptions and information on each type of insect. Obtain pictures of each insect of interest. Meet the Programs Director of the Friends of the Ballona Wetlands and the external biological consultant. Learn from these experts about appropriate types of sampling methods (traps, bait, etc.), sampling frequency, identification procedures etc.

Stage 2. **Planning and Preparation.** Plan location of traps and schedule of checking traps. Obtain traps and other necessary equipment. Seek comparison data from other sites. Create data collection forms.

Stage 3. **Action, Analysis, Conclusion.** Collect data (check traps and record). Represent the data in appropriate tabular form, graphical form, and find numerical summaries. Share data and consult with the expert on insects.

Stage 4. **Response/Dissemination.** Write conclusion; submit the entire work; write a report for the Friends of Ballona Wetlands; prepare a PowerPoint presentation.

### **Timeline:**

Week 4 – Student groups and project topics are finalized

Week 7 – Stage 1 deadline for completion

Week 10 – Stage 2 deadline for completion

Week 12 – Stage 3 deadline for completion

Week 15– Stage 4 deadline for completion

## ***Future Financial Planning Project Framework***

**Purpose:** To develop and analyze a case study for the financial future of a recent college graduate.

### **Introductory Reading:**

Schworm, Peter. "College Graduates Leap onto the Fast Track", *The Boston Globe*, May 11, 2006, Third edition, (Globe South), 1.

Haiyang Chen and Ronald P. Volp. (1998) "An Analysis of Personal Financial Literacy Among College Students." *Financial Services Review*. 7(2), 107-128.

### **Project Stages**

- Stage 1. **Background Investigation:** In addition to background reading and internet search of sites such as The Learning Center Consolidated Credit Counseling Services <http://www.consolidatedcredit.org/> or <http://financialplan.about.com/od/college/a/SmartMoves.htm>, interview your parents or other adults on- or off-campus about what financial planning advice they might offer. Google college graduates and money for other possible sites.
- Stage 2. **Planning and Preparation:** Develop and document a 5 to 10-year case study "story" for an individual who has just graduated from LMU. Include major, career position, salary earned, living expenses, savings plans, debts, taxes, etc. Also include some long-term goals for major purchases, life changing events and/or retirement.
- Stage 3. **Action, Analysis, Conclusion:** Apply knowledge gained from this course to perform calculations, as appropriate, and clearly state any assumptions made for the calculations. For example, calculate the value of retirement savings at age 65, the taxes the individual will pay, and so on. Draw conclusions about what salary or lifestyle is necessary or possible to achieve the long-term goals.
- Stage 4. **Response/Dissemination:** Write a report, prepare an oral report and a PowerPoint presentation, and undertake an active response to your findings. This might include recommendations to the class, a letter to the campus newspaper, or a presentation at an undergraduate research conference.

### **Timeline:**

Week 4 – Student groups and project topics are finalized

Week 7 – Stage 1 deadline for completion

Week 10 – Stage 2 deadline for completion

Week 12 – Stage 3 deadline for completion

Week 15– Stage 4 deadline for completion

## *Living On-campus vs. Off-campus Project Framework*

**Purpose:** To make a comparative study between the expenses incurred by a student who lives on-campus and a student who lives off-campus (assuming that s/he lives in a rented place). Which is “better” (in terms of cost, quality of life, convenience, etc.)?

### **Introductory Reading:**

LMU Student Housing Internet site: <http://www.lmu.edu/Page1391.aspx>

“Ditching the Dorm; Even in this Market, Some Parents Find it Smart to Buy Homes for Their College-Age Kids” – L.A. Times article – August 21, 2005.  
(Go to LMU’s Von der Ahe library page, click on find articles, click on alphabetical list, click on LEXISNEXIS Academic Universe, and search for this article.)

### **Project Stages**

- Stage 1. **Background Investigation:** Read news articles and the information provided by the LMU housing office both in print form and over the Internet (<http://www.lmu.edu/Page1391.aspx>). Investigate what the different expenses are incurred by living on-campus and off-campus.
- Stage 2. **Planning and Preparation:** Design a survey instrument in order to measure the total cost of living on-campus and that of living off-campus (room, board, transportation, phone, cable/Internet, other utilities and expenses).
- Stage 3. **Action, Analysis, Conclusion:** Collect data from 50 on-campus students and 50 off-campus students about their living expenses. Tabulate the data, represent them using graphs if appropriate, compute numerical summaries, find confidence intervals, and draw conclusions.
- Stage 4. **Response/Dissemination:** Write a report, prepare an oral report and a PowerPoint presentation, and disseminate your findings to other college students. This might include recommendations to the class, a letter to the campus newspaper, or a presentation at an undergraduate research conference.

### **Additional Reading:**

1. *The Gap Between College Costs and Student Resources*, Education Statistics Quarterly, Vol. 5 (2) ([http://nces.ed.gov/programs/quarterly/vol\\_5/5\\_2/q2\\_4.asp](http://nces.ed.gov/programs/quarterly/vol_5/5_2/q2_4.asp))
2. “How Much Should I Budget for College Living Expenses?” The PNC Bank Student Plan, <http://partners.financenter.com/pncbank/calculate/us-eng/college11.fcs>

### **Timeline:**

- Week 4 – Student groups and project topics are finalized
- Week 7 – Stage 1 deadline for completion
- Week 10 – Stage 2 deadline for completion
- Week 12 – Stage 3 deadline for completion
- Week 15 – Stage 4 deadline for completion

## ***LMU Parking Project Framework***

**Purpose:** To determine (a) if there is a problem finding parking on-campus and (b) if LMU campus parking lots are safe.

### **Introductory Reading:**

Button, Kenneth J. and Hensher, David A. (2001) *Handbook of Transport Systems and Traffic Control*. Pergamon: New York, Chapter 24.

Hicks, Katie. "Parking Woes at LMU." *Loyolan* 5 Oct. 2005 (84), 8.

Quinn, Carolyn. "Stolen Car Found in Long Beach." *Loyolan* 11 Nov. 2005 (84), 13.

### **Project Stages**

Stage 1. **Background Investigation:** Obtain parking regulations from Public Safety. Search the *Loyolan* student newspaper archives for additional articles related to parking. Consider comparing parking costs, availability, and safety at LMU to that on other university campuses in Los Angeles.

Stage 2. **Planning and Preparation:** Design a survey around these questions and other questions that arise during your background investigation.

Stage 3. **Action, Analysis, Conclusion:** Collect and analyze information and evidence by applying knowledge gained from this course. This might involve the following: tabulate the data, represent it using graphs, compute numerical summaries, find confidence intervals. Draw conclusions.

Stage 4. **Response/Dissemination:** Write a report, prepare an oral report and a PowerPoint presentation, and undertake an active response to your findings. This might include recommendations to the class, a letter to the campus newspaper, or a presentation at an undergraduate research conference.

### **Timeline:**

Week 4 – Student groups and project topics are finalized

Week 7 – Stage 1 deadline for completion

Week 10 – Stage 2 deadline for completion

Week 12 – Stage 3 deadline for completion

Week 15– Stage 4 deadline for completion

## ***Math Homework Help Session Project Framework***

**Purpose:** To conduct an independent evaluation for the LMU Mathematics Department of the Calculus and Precalculus Homework Help Sessions staffed by undergraduate teaching assistants.

### **Introductory Reading:**

Effective Math Tutoring Tips from Boise State University:

[http://www.educ.uidaho.edu/bestpractices/peer\\_train\\_math.html#Five%20Tips%20for%20Math%20Tutors](http://www.educ.uidaho.edu/bestpractices/peer_train_math.html#Five%20Tips%20for%20Math%20Tutors)

Baril, Helen. "Study Skills with Emphasis on Math and Science." *Handbook of the College Reading and Learning Association*. College Reading and Learning Association. Auburn, CA, 146-150.

### **Project Stages**

Stage 1. **Background Investigation.** Contact the Mathematics Department Chairperson to find out which faculty member is the supervisor of the Homework Help Session TA's. Interview that person regarding the focus of this project. Seek data via the internet (or print sources) for tutor training, "client profiles," usage figures, or tutor remuneration (if any) of other "free" collegiate level math tutoring programs. If possible, note whether the tutoring is sponsored by a Learning Center, a Mathematics Department, or a Math Club as a service, and for what course levels tutoring is provided.

Stage 2. **Planning and Preparation.** Design a survey around these questions and information gained during your background investigation. Other possible methods to gather data besides a survey include interviews or focus groups with the tutors and clients.

Stage 3. **Action, Analysis, Conclusion.** Collect and represent the data in appropriate tabular form, graphical form, find numerical summaries, compute confidence intervals, as appropriate. Summarize results and draw conclusions.

Stage 4. **Response/Dissemination.** Write a report, prepare an oral report and a PowerPoint presentation. Submit a written report to the Mathematics Department including suggestions for improvements or further investigations.

### **Timeline:**

Week 4 – Student groups and project topics are finalized

Week 7 – Stage 1 deadline for completion

Week 10 – Stage 2 deadline for completion

Week 12 – Stage 3 deadline for completion

Week 15– Stage 4 deadline for completion

## *Social Security - Will it Go Broke? Project Framework*

**Purpose:** To make an independent assessment of Social Security by analyzing receipts and payments under the current system and under President Bush's proposed changes.

### **Introductory Reading:**

“Social Security Will Never Go Broke” – Internet article by Rock the Vote.  
[www.rockthevote.com/socialsecurity/whatisss](http://www.rockthevote.com/socialsecurity/whatisss).

Strengthening Social Security – The White House Internet site  
[www.whitehouse.gov/infocus/social-security/](http://www.whitehouse.gov/infocus/social-security/)

### **Project Stages**

- Stage 1. **Background Investigation:** Read news articles especially the Heritage Foundation Reports *How Today's Social Security Works* (<http://www.heritage.org/Research/SocialSecurity/bg1827.cfm>). Understand how the current Social Security system works and familiarize yourself with the terms such as retirement benefits, FICA, and trust funds used in connection with the Social Security issues. Find out what changes have been proposed by the President.
- Stage 2. **Planning and Preparation:** Conduct research to find the annual average number of workers in the US (who pay Social Security taxes), the annual average contribution of a worker and her/his employer toward Social Security, estimate the current total annual receipts, total annual payments and the current surplus or deficit of the Social Security Administration. State all assumptions you make and cite all sources used.
- Stage 3. **Action, Analysis, Conclusion:** Make estimates (a) for 10 years from now (b) 20 years from now and (c) 30 years from now of each item in stage 2 under the current social security system. Remake these same estimates for a system with the President's proposed changes. Your estimates could be given as a range of values. Clearly state and support all assumptions used and cite all sources used.
- Stage 4. **Response/Dissemination:** Write a report, prepare an oral report and a PowerPoint presentation that clearly states the assumptions you made, shows your calculations, and summarizes your findings. Write an article to disseminate your findings to other college students. (Suggestion: write an article to the Loyolan.)

### **Timeline:**

- Week 4 – Student groups and project topics are finalized
- Week 7 – Stage 1 deadline for completion
- Week 10 – Stage 2 deadline for completion
- Week 12 – Stage 3 deadline for completion
- Week 15– Stage 4 deadline for completion

## ***Student Health Center Project Framework***

**Purpose:** To act as consultants to the LMU Student Health Center to investigate who uses the LMU Health Center (and who does not) and for what reasons they do or don't.

### **Introductory Reading:**

LMU Student Health Center Internet site: <http://www.lmu.edu/Page1390.aspx>

“Away From Home” - Tribune-Review (Greensburg, PA) Article - August 29, 2005.

(Go to LMU's Von der Ahe library page, click on find articles, click on alphabetical list, click on LEXISNEXIS Academic Universe, and search for this article.)

“Dorm Health 101; Immunizations Can Reduce Risks Many Freshmen Face in College Dormitories” - San Diego Union-Tribune Article - August 16, 2005.

(Go to LMU's Von der Ahe library page, click on find articles, click on alphabetical list, click on LEXISNEXIS Academic Universe, and search for this article.)

### **Project Stages**

Stage 1. **Background Investigation.** Interview Katharine Arce, Director Student Health Services, regarding the focus of this project. Seek data via the internet for “client profiles” of other student health center users, and for health care in general (for example, gender, ethnicity, year in school, resident/non-resident status, etc.).

Stage 2. **Planning and Preparation.** Design a survey around these questions and/or gather information on reasons for use/non-use by interviews or focus groups. See [http://www.acha.org/projects\\_programs/ncha\\_sampledata\\_public.cfm](http://www.acha.org/projects_programs/ncha_sampledata_public.cfm)

Stage 3. **Action, Analysis, Conclusion.** Collect and represent the data in appropriate tabular form, graphical form. Find numerical summaries, compute confidence intervals, as appropriate. Summarize results and draw conclusions.

Stage 4. **Response/Dissemination.** Write a report, prepare an oral report and a PowerPoint presentation. Submit a written report to the Student Health Services including recommendations and suggestions for further investigations.

### **Timeline:**

Week 4 – Student groups and project topics are finalized

Week 7 – Stage 1 deadline for completion

Week 10 – Stage 2 deadline for completion

Week 12 – Stage 3 deadline for completion

Week 15– Stage 4 deadline for completion

## *Students' Work-hours Project Framework*

**Purpose:** To determine how many hours LMU students work and how it affects their academic success. In addition, this project can investigate what LMU faculty perceptions are regarding these two questions and how accurate faculty perceptions are.

### **Introductory Reading:**

Haupt, Suzanne. (2003/4?). College Students Successfully Balancing School and Work. [On-Line] <http://homepages.wmich.edu/%7Eclumpkin/ConsEd/SuzanneH-TimeMgmt-Balancing.htm>

Marklein, Mary Beth. (2002). College Students Feel the Crunch of Longer Work Hours <http://www.usatoday.com/news/education/2002-04-17-college-jobs.htm>

Pascarella, Ernest, et al. (1998) "Does Work Inhibit Cognitive Development During College?" *Educational Evaluation and Policy Analysis*. 20(2), 75-93.

### **Project Stages**

Stage 1. **Background Investigation.** Contact Student Employment Services regarding what information they can provide on the questions. Additional aspects of this investigation can be found in the recent study of college student employment conducted by the American Council on Education (ACE) Center for Policy Analysis (See the ACE website: [www.acenet.edu](http://www.acenet.edu) for a copy of the 2006 study titled *Working Their Way Through College: Student Employment and Its Impact on the College Experience*). To compare LMU students with those nationwide, seek data via the internet and print sources for national averages on hours students work, and related questions such as, the recommended number of hours to work, types of work, reasons for working.

Stage 2. **Planning and Preparation.** Design a survey around these questions and the information developed during your background investigation. Other possible methods of gathering data besides a survey include interviews or focus groups.

Stage 3. **Action, Analysis, Conclusion.** Collect and analyze information and evidence by applying knowledge gained from this course. This might involve the following: tabulate the data, represent it using graphs, compute numerical summaries, find confidence intervals. Draw conclusions and comment on the validity of your results.

Stage 4. **Response/Dissemination.** Summarize results and conclusions. Write a report, prepare an oral report and a PowerPoint presentation, and undertake an active response to your findings. One possibility is to write an article or letter for the campus newspaper or disseminate your results at an undergraduate research conference.

### **Timeline:**

Week 4 – Student groups and project topics are finalized

Week 7 – Stage 1 deadline for completion

Week 10 – Stage 2 deadline for completion

Week 12 – Stage 3 deadline for completion

Week 15– Stage 4 deadline for completion

## ***Textbook Cost Project Framework***

**Purpose:** To investigate issues related to the pricing of college textbooks and to investigate whether trends found in a study of public colleges and universities in California and Oregon hold at LMU.

### **Introductory Reading:**

“Debate Over Textbook Costs Isn’t Just Academic” L.A .Times Article - August 21, 2005.

<http://www.latimes.com/business/la-fi-perfin21aug21,1,3405534.story?ctrack=1&cset=true>

or go to LMU’s Von der Ahe library page, click on find articles, click on alphabetical list, click on LEXISNEXIS Academic Universe, and search for this article.

“Textbook Costs: Up to \$900 a Year” U.S.A Today article – August 16, 2005

(Go to LMU’s Von der Ahe library page, click on find articles, click on alphabetical list, click on LEXISNEXIS Academic Universe, and search for this article.)

### **Project Stages**

Stage 1. **Background Investigation.** Read news articles and the CALPIRG study *Ripoff 101: How the Current Practices of the Textbook Industry Drive Up the Cost of College Textbooks.*

(<http://www.calpirg.org/>) Evaluate the methodology of this study.

Stage 2. **Planning and Preparation.** Choose three areas of the CALPIRG study and one additional question to investigate at LMU. Design survey and data collection method.

Stage 3. **Action, Analysis, Conclusion.** Collect data. Represent the data in tabular form, graphical form, and find numerical summaries. Find appropriate confidence intervals.

Stage 4. **Response/Dissemination.** Write conclusion; submit the entire work; write an article for the campus newspaper based on your conclusions; prepare an oral report and a PowerPoint presentation. Consider making a presentation at an undergraduate research conference.

### **Timeline:**

Week 4 – Student groups and project topics are finalized

Week 7 – Stage 1 deadline for completion

Week 10 – Stage 2 deadline for completion

Week 12 – Stage 3 deadline for completion

Week 15– Stage 4 deadline for completion

## **Projects: What is Due at the End of Each Stage?**

### **Stage 1: Due in Week 7 of the Semester**

#### **What is Due at the End of Stage 1?**

1. Cover sheet with project title, members' names, date, stage number.
2. An annotated bibliography of each of the resources.
3. A paragraph summary of what your group learned from the background investigation.
4. A glossary of terms pertinent to your project.
5. A photocopy of the notes you have taken during this stage.

### **Stage 2: Due in Week 10 of the Semester**

#### **What is Due at the End of Stage 2?**

1. An outline of your plan of action for the investigation.
2. (a) For projects with surveys: a copy of the survey instrument together with a description of your proposed sampling method.  
(b) For case studies: a copy of your case study referenced with footnotes, other supporting documents, and data collection forms.
3. A copy of any (new) notes or calculations.

### **Stage 3: Due in Week 12 of the Semester**

#### **What is Due at the End of Stage 3?**

1. A copy of all of the data collected, calculations performed, and resulting graphics. If a survey was involved these would typically include mean, median, mode, standard deviation, proportion, confidence interval for the mean, confidence interval for the proportion and a box-plot. If a case study was involved, then give sources for the data and clearly state any assumptions made for the calculations.
2. A paragraph summarizing what your group learned from the action, analysis and conclusion stage.
3. A brief statement of your conclusion.
4. If this was a Design Your Own Project, also submit a formal project framework including the purpose, suggested background reading, and a description of each of the 4 stages. Use the project frameworks given out at the beginning of the semester as a guide for this.

### **Stage 4: Due in Week 14 of the Semester**

#### **What is Due at the End of Stage 4?**

1. The written report for your project

The following lists essential components of and provides a uniform structure for your written report.

Title: The title must capture the central theme of the paper. It should be short. Usually it is centered, bold, and is in a larger font than the rest of the paper.

Names: List the names of your group members below the title.

Table of Contents: Help the reader easily navigate through your report with a table of contents/tabs/page numbers. NOTE: If this was a Design Your Own Project, include a final version of the Project Framework (purpose, background reading, and description of the 4 stages) immediately after the table of contents.

Introduction: Catch the reader's attention and then clearly state the topic or problem and explain your goals.

Main Body: Organize the main body logically so that it is easy to follow. Divide it into several sections using section headings as needed. Be sure that your data is presented and summarized in appropriate ways. Include summary statistics such as mean, median, standard deviation, and 5-number summaries, as appropriate. Also, include histograms, bar charts, pie charts etc. as appropriate. Address the question of validity of your sample or rationale for your case study approach. Do not include large amounts of raw data in this section; put these in an appendix. Do show the details of important calculations, but put these in an appendix. Remember, your paper will be evaluated (in part) on having adequate and correct mathematical content.

Conclusion: Summarize the conclusions of the project. Include any limitations of your work and suggestions of related topics for future work that could extend this project.

Bibliography: Provide documentation of all sources including full documentation on web sources (not just a URL).

Data and Calculations Appendices: Place all raw data and calculations in separate appendices.

Action Response Appendix: Include in a separate appendix the response action (letter, article, memo and summary report, etc.) you have taken as a result of your project (see item #3 below).

Proof read, proof read, proof read!!

2. The Oral Report (20 minutes for each report on \_\_\_\_\_)

Aside from the bibliography and appendices, your oral presentation should have the same features as your written report. However, your oral report is to be just 20 minutes long (15 minutes for the actual presentation and 5 minutes for question and answers and transition), and so you will not be able to cover all of the material in your written report. All team members need to be a part of the presentation. The following lists a few tips for giving a mathematical talk.

Organize and prepare your talk ahead of time. Experienced speakers know that a lot of preparation is required to give a concise and interesting talk. There is a wonderful quote, attributed to Abraham Lincoln: "If you want me to give a ten minute speech, give me two weeks... If you want a two hour speech, I'm ready now!"

Practice giving the talk in a classroom setting if possible.

- Be considerate of your audience. It is surprisingly easy to lose the audience, so be sure you give them adequate help in understanding the problem you worked on and the work you carried out. Be sure to define new terms.

- The audience usually doesn't start concentrating until there is a visual cue, such as a PowerPoint slide, or transparency, and may miss that which is only spoken. A good general strategy is to *show* and then *tell*; that way the audience has two chances to get the point.
- At the very beginning, outline your presentation. State the topic or problem you plan to discuss. Make sure the audience knows where you are headed before you launch into the details.
- Let the audience know when you are about to finish the talk; conclude, don't just stop talking. Summarize what you have found, discuss the questions left unanswered by the work presented, and indicate what would be the "next step" in furthering your investigation.
- Describe briefly your Action Response.
- Anticipate questions, and prepare answers in advance.
- Make eye contact with the audience when giving the talk.
- Time your talk when you practice and, if necessary, revise the talk for length.
- For greatest impact, use relatively few transparencies or PowerPoint slides, with carefully chosen images. Covering more than 1 slide per minute in a talk is too fast a pace.
- Another useful rule of thumb is to put at most 6 talking points on a single slide. Also use a large font type, at least 18 point, preferably larger than that.

### 3. Your Action Response/Dissemination to a (Wider) Audience

Decide on an action response to the findings and conclusion of your report. Then disseminate your results or recommendations to an appropriate customer, audience or community by means of an article, letter, etc. For example, for the Health Center Project or Ballona Insect projects, prepare a memo and summary report for the Health Center and the Friends of the Ballona Wetlands, respectively. A letter to the editor of the campus newspaper is another option or a letter to an appropriate administrative official or unit on campus. Your work can also be submitted for presentation at an undergraduate research conference.<sup>4</sup>

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<sup>4</sup> See, for example, <http://www.math.pepperdine.edu/~kkillpat/PCUMC/PCUMC.htm>

## What Mathematics Should We Do For Our Project?

### Introductory Notes for Instructors

The following material can be used in a number of ways. It was written in response to students' comments about their difficulty with the open-ended nature of the projects. It is intended to help them see how the mathematical content of the course connects to and can be utilized in a project. The list is somewhat long because it includes essentially all the mathematical topics discussed in the course. As students work on early stages of the project, they will (of course) not yet have seen all of the topics from the course. We suggest that when you introduce each stage of the model project in class, you indicate some of the topics in the list below that might be especially pertinent for that stage of any of the projects. Students can also use the list to track their progress through the course, and it should be especially useful to students who are designing their own project. It could be turned into a checklist or be the basis for a final reflection by the students on what mathematical topics have underpinned their investigations.

## What Mathematics Should We Do For Our Project?

The mathematics your group needs to carry out for your project is open-ended. It is up to your group to consider what mathematical calculations would best shed light on the problem on which your group is working. As you work through each stage of your project, consider the following in deciding what mathematics to do. Note: The list of topics below follows (roughly) the order in which topics appear in the course – not (necessarily) the order in which you should apply the topics. You may not have reason to use some of these topics, and you may have reason to use other topics in several different ways and at more than one stage of the project.

NOTE: The Textbook Sections listed below refer to Bennett and Briggs *Mathematics: A Quantitative Reasoning Approach, 3rd ed.*, and the Handout page numbers refer to pages in this manual.

- I. Working with Units and Converting Units (Textbook Sections 2A, 2B)  
Would the results found in sources or calculated by your group be put in better perspective in different units? If so, identify more appropriate units, and calculate the unit conversions. (For example, it would be better to report the average speed of Greenland's Jakobshavn Isbrae glacier in miles per year than in miles per hour.)
- II. Uses and Abuses of Percentages (Textbook Section 3A)
  - A. Counts vs. percentages: Will reporting percents, rather than just a count (number of things) be more enlightening? (For example, when comparing auto thefts that occurred on various sized college campuses, it would be more informative to report percentages of cars that were stolen from each of the campuses in a certain year than just the number of car thefts that occurred on each campus.)
  - B. Percentages to describe change: Is there a quantity that has changed over time? Calculate the percent change of this quantity.
  - C. Percentages for comparisons: Are there two quantities that you would like to compare? Calculate the percent that one quantity is *more than* the other quantity, or calculate the percent that one quantity is *of* the other.
  - D. Misuses of percentages: Have you found any misuses of percentages in any of your sources? If so, show where/how the misuse occurs. Calculate the correct percentage.

### III. Putting Numbers in Perspective, Significant Digits (Textbook Sections 3B, 3C)

- A. Perspective through comparisons: Are there any very large or very small numbers involved that could be better “made sense of” through comparisons? If so, calculate at least one meaningful comparison. (For example, if LMU’s bookstore found next fall, that there would be a \$235,000 increase in the cost of ordering undergraduate textbooks, it would help us to understand the impact of this increase by calculating that this represents an average increase of  $\$235,000/5500 \approx 43$  dollars per LMU undergraduate student.)
- B. Absolute, relative error: Can you calculate the absolute or relative error to any measured quantities involved?
- C. Combining and reporting measured numbers: Are you reporting results of measurements with an appropriate (and not misleading) number of significant digits? When adding, subtracting, multiplying or dividing measured numbers have you reported the results with the appropriate number of significant digits?

### IV. Power of Compounding (Textbook Section 4A)

- A. Simple interest: Are there financial accounts involved that earn simple interest? Are there quantities (of any kind) involved that will grow over time at a rate proportional to the *original* quantity? If so, use the simple interest formula to predict account balances or quantities at various (later) times.
- B. Compound growth: Are there financial accounts involved that earn compound interest? Are there quantities (of any kind) involved that will grow over time at a rate proportional to the quantity in the *previous time* period? If so, use the compound interest formula to predict account balances or quantities at various (later) times.
- C. Annual percentage yield: Can you calculate the actual percentage by which a balance (quantity) will increase in one year?

### V. Savings Plans and Investments (Textbook Section 4B)

- A. Savings plan formula: Are there any savings plans (annuities, retirement savings plans) involved for which it would be helpful to predict account balances at (various) future times? Or do you want to know what regular savings will yield a desired amount at a future date? If so, use the savings plan formula. You may want to use the formula to predict account balances under various assumptions about interest rates, quantities deposited etc.
- B. Total and annual return: Is there an investment or quantity that has grown from some original quantity to a later quantity? It may be of interest to calculate the relative change in the investment and the annual percentage yield that would give the same overall change in the investment (quantity). That is, calculate the total return and annual return for the investment (quantity).
- C. Liquidity, risk, and return: Are there investments involved? If so, evaluate the investments for their liquidity, risk, and return.

### VI. Loans and Credit Cards (Textbook Section 4C)

- A. Loan payment formula: Are there (installment) loans involved? If so, find the required monthly payment using the terms of the loan. Could the terms of the loan vary – such as the interest rate or the life (length) of the loan? If so, recalculate the required monthly payment using the various terms.
- B. Amortization tables: Would it be helpful to be able to track the loan balance and interest paid over the life of a loan? If so, create an amortization table showing the payment date, payment amount, payment amount of interest, payment amount of principal, and account balance for each month of the loan.
- C. Predicting credit card bills: Do credit cards play a role in your project? Can you calculate the amount due at various times for a certain credit card (assuming a certain previous balance, interest rate, and method of charging interest)? Given a certain credit card balance and desired time-frame to pay off the entire balance, use the loan payment formula to calculate the amount that must be paid each month in order to pay-off the credit card balance.
- D. Loan payment, prepayment strategies: If there are (installment) loans involved, calculate the effect on the loan payment, total interest paid over the life of the loan and the length of the loan by (voluntarily) paying an extra amount each month.

VII. Fundamentals of Statistical Studies (Textbook Section 5A)

Will you be carrying out a statistical study? If so, develop the basic steps for your statistical study: (i) Develop the precise goal and population for your study; (ii) determine how you will choose a representative sample for your study; (iii) determine what raw data will you collect and what sample statistics you will calculate; (iv) determine what inferences you can make about the population parameters from the sample statistics; and (v) look back and evaluate your study and its results.

VIII. Sampling (Textbook Section 5A and Handout from pages 70-72)

Will you be choosing a sample as part of your statistical study? If so, carefully consider possible methods of choosing a (representative) sample and the feasibility of each method. Will you use simple random sampling, systematic sampling, convenience sampling, quota sampling, stratified random sampling etc?

IX. Should You Believe a Statistical Study? (Textbook Section 5B)

Have you evaluated the results of statistical studies you reference by considering the eight guidelines in our text for evaluating a statistical study? Have you evaluated your methods you use in your own survey project against the eight guidelines in our text for evaluating a statistical study?

X. Statistical Tables and Graphs (Textbook Sections 5C, 5D)

Which of the following types of statistical tables and graphs will best summarize the data you have collected - frequency tables, bar graphs, pie charts, histograms, line charts? After deciding on appropriate data categories (or bins), use a spreadsheet program to construct statistical tables and graphs from your results.

XI. Characterizing a Data Distribution (Textbook Section 6A)

- A. Measures of center: Can you summarize your data by calculating a mean, median, and/or mode value? Are there outliers in your data? If so, what effect do the outliers have on the mean, median, mode values?
- B. Shapes of distributions: What features does the distribution of your data have? Is there more than 1 peak to the data distribution? Is the distribution symmetric or skewed? Does it show large or small variation?

XII. Measures of Variation (Textbook Section 6B)

Did you use a median value to describe the center of your data? If so, compute the quartiles and the five number summary as a measure of the variation in your data. Did you use a mean value to describe the center of your data? If so, compute the standard deviation as a measure of the variation in your data. Give interpretations of what your measures of variation tell about the data.

XIII. Normal Distribution (Textbook Section 6C)

Are there any normal distributions of data involved? If so, is it appropriate to calculate standard scores and percentiles corresponding to certain data values?

XIV. Central Limit Theorem (Handout from page 73)

What does the Central Limit Theorem say about the distribution of sample proportions or sample means taken from many different samples? What does this say about sample proportions or sample means you have calculated?

XV. Statistical Inference (Textbook Section 6D and Handout from pages 73-76)

- A. Statistical significance: Does any of your background research indicate that certain measurements are “statistically significant?” If so, give some interpretation of what it means to say they are statistically significant.
- B. Margin of error, confidence intervals: Have you calculated a mean or percentage (proportion) of data values collected from a sample of a larger population? If so, determine the appropriate confidence level(s), then calculate the associated margin of error and confidence intervals, and finally give an interpretation of the meaning of each confidence interval.

XVI. Income Taxes (Textbook Section 4D)

Are there tax implications involved with the financial aspects of your project? If so, calculate the taxes an individual owes under the (various) financial actions projected.

## **Model Project: Student Loan Debt**

### **Introductory Notes for Instructors**

In order to illustrate what is expected from the student project groups we created a model project to present to students. Our model project aims to look at the effect of student loan debt after a student has graduated. The topic of student loan debt was chosen in part because it fits in well with the other financial topics in the course and because we have become increasingly aware that many of our students graduate with student loan debt and many of these students do not really understand their situation relative student loan debt.

The calendar for the projects-based course (page 13) shows the class time allocated for each stage of the model project and the due dates for each stage. “What is Due at the End of Each Stage” (page 26) shows the required elements of each project stage. At the outset of each stage, the instructor typically will briefly go over what is due for that stage, describe the kind of work required for survey-based and case-study based projects, spend time going over elements of the model project, and make available to students finished elements of the model project to demonstrate what the product for that stage might look like. Finally, any specific recommendations the instructor may have for each of the project groups are given.

At the outset to Stage 1, we begin by using the “Summary of Background Investigation” transparency (page 36) to introduce and motivate the topic, and then hand out the model project framework (page 35). The framework is reviewed and the class discusses what further background investigation is needed. To get students thinking a little about eventually presenting their work, we ask the students for input on what would have made the presentation of the material on the Summary of Background Investigation transparency more interesting. (Students will generally mention the need for graphics or that using PowerPoint would be better than an overhead transparency. One instructor introduced typos into the transparency intending for the students to find and comment on them.) Finally, the requirement for a glossary and annotated bibliography is pointed out, and the model project’s glossary (page 38) and annotated bibliography (page 39) are reviewed.

At the outset of Stage 2, we begin by introducing the stage as a time for planning and preparation and what that typically entails. For the model project, we discuss the need for incorporating various aspects (such as a second loan, subsidized or non-subsidized loan) into the case-study and planning what kinds of calculations will be done. This is reflected in the “Outline of Plan of Action” on page 40, which is made available to students. We discuss the need for realism and documentation of assumptions in a case study. This is modeled for students by going over why various aspects of the model case study were included and pointing out the footnotes documenting the various assumptions. Finally students are reminded that in this stage they are to create any necessary data forms and sample data collection forms for the model project are made available. For the benefit of students working on survey-based projects, we discuss the need for careful planning of survey instruments, sampling techniques, and data recording.

Just before students are to begin work on Stage 3, we introduce the idea that this is the stage in which all surveys and calculations are to be completed. We give class time to students to carry out some of the calculations needed for the model project such as calculations of the monthly loan payments, credit card payments, tax approximations etc. (This also serves as a review of topics previously covered relating to finances.) Students are advised that complete calculations and explanations need to be given and the “Income and Expense Summary” form (page 43) and the “Excerpt from Explanation of Calculations” (page 45) is reviewed. Finally, the conclusions that can be drawn from the model project are discussed.

For the benefit of students working on survey-based projects, we review the types of calculations that are typically associated with surveys. The “What Mathematics Should We Do for Our Project” (page 29) can be very helpful here.

When students are ready to begin Stage 4, we review the requirements and advice given in “What is Due at the End of Each Stage,” but do not present a final report for the model project. We emphasize that work done for earlier stages can be used as a framework for the final report, that an active response to their findings such as a letter to the editor should be taken, and that every group member is required to have a speaking role in the final presentation.

## ***Student Loan Debt (Model Project) Project Framework***

**Purpose:** To calculate a prototypical student's loan balance at the end of her/his undergraduate studies and to estimate the impact of this loan balance on this student's life once s/he starts working.

### **Introductory Reading:**

“Degree in Debt” The Washington Times Article - June 26, 2005.

Go to LMU's Von der Ahe library page, click on find articles, click on alphabetical list, click on LEXISNEXIS Academic Universe, and search for this article.

“Trends in Student Borrowing,” Education Statistics Quarterly, Vol. 1 (2)

[http://nces.ed.gov/programs/quarterly/vol\\_1/1\\_3/4-esq13-c.asp](http://nces.ed.gov/programs/quarterly/vol_1/1_3/4-esq13-c.asp)

### **Project Stages**

Stage 1. **Background Investigation:** Read the Introductory Reading articles and the Nellie Mae brochure *A Student's Guide to Borrowing and using Credit* (<http://www.nelliemae.com/managingmoney/Meet.pdf>). Familiarize yourself with the common terms, processes, and student responsibilities related to student loans.

Stage 2. **Planning and Preparation.** Find current statistics on the average student loan amount at LMU, at the state, or at the national level. Create Phil Brown's case study and compare numbers in the case study with the corresponding average numbers at LMU, at the state, or at the national level.

Stage 3. **Action, Analysis, Conclusion.** Calculate Phil's monthly payments and carry out all tasks described in the case study.

Stage 4. **Response/Dissemination.** Write conclusion; submit the entire work; write an article for the campus newspaper on the implications you uncovered based on your work; prepare a PowerPoint presentation.

**Reflection:** Reflect in general terms on how your personal situation is similar or different to that of the situation delineated in the case study

### **Timeline:**

Week 4 – Student groups and project topics are finalized

Week 7 – Stage 1 deadline for completion

Week 10 – Stage 2 deadline for completion

Week 12 – Stage 3 deadline for completion

Week 15– Stage 4 deadline for completion

## **Model Project Transparency: Student Loan Debt**

### **Stage 1: Summary of Background Investigation**

Background statistics on student loan debt:

- In '99-'00, 68% of those graduating from college had borrowed money to pay for college.
- In '99-'00, those graduating from a private school owed an average of \$16,000 on their education.
- The federal government lends over \$50 billion each year to college students.

With costs of college tuition increasing (at rates faster than inflation), these numbers must be rising.

Studies show that the average earnings of a person with a bachelor's degree is about \$2.1 million in lifetime earnings, compared to \$1.2 million for those with only a high-school degree. Collect a master's degree, and you'll be up to \$2.5 million. So, your student loan debt is "good".

Financial experts agree that there is good debt and there is bad debt.

Good debt – debt for which there is high return value.

e.g. college education, home ownership

Bad debt – debt for which there is little or no return value.

e.g. most credit card debt

One of the most important consequences for not paying off your student loan debt is that it will ruin your credit, which in turn can:

- Make it difficult to impossible to buy a home
- Make it difficult to obtain a good job

Also, filing for bankruptcy will not get you out of student loan debt.

Important first steps for anyone with student loan debt are to know:

- how much you owe
- the terms of your loan, its repayment schedules, and repayment options
- that if you make higher monthly payments, you can pay the loan off more quickly
- who the lender is and how to reach them
- if you move, you need to inform the lender
- what to do if you can't make a monthly payment for some reason

(The lender will generally be willing to work with you.... Monthly payments of up to 10% of your income are usually considered “manageable”.)

## Model Project: Student Loan Debt

### Stage 1: Glossary of Terms

**Accrued Interest:** Interest accumulating on the unpaid principal balance of a loan.

**Annual Percentage Rate (APR):** The cost of your loan or credit represented as a yearly rate.

**Capitalization of Interest:** The addition of unpaid interest to the principal balance of a loan. This can increase the total outstanding principal amount.

**Combination:** Combining several loans into one account so that the borrower only pays one monthly bill. The loans' original terms still apply, such as payment and interest.

**Consolidation:** A lender pays off the borrower's current student loans and issues a new, single loan. The monthly payment is usually lowered due to a longer repayment term.

**Default:** Failure to meet a financial obligation, such as a loan. Staying out of default will help protect a borrower's credit record.

**Deferment:** A borrower is allowed to postpone payments on the loan principal. During deferment, the federal government will pay the interest on a subsidized Stafford Loan. On others, the interest will accrue and be capitalized, and the borrower is responsible for paying it.

**Delinquency:** Failure to make loan payments when due. Delinquency can lead to default.

**Forbearance:** A special agreement between lender and borrower to delay or reduce monthly loan payments because of financial hardship.

**Free Application for Federal Student Aid (FAFSA):** The official application students must use to apply for federal aid.

**Grace Period:** On a student loan, the six- or nine-month period between graduation or leaving school and the start of repayment when no loan payments are due.

**Income-Sensitive Repayment:** A borrower's monthly payments are adjusted annually, based on income level. Under this plan, the borrower selects payments between four and 25 percent of his/her gross monthly income.

**Monthly Payment:** On a student loan, this is the fixed amount you must pay each month during repayment.

**Origination Fee:** A fee charged to the borrower (usually three percent) by the federal government that is deducted from the principal of a loan prior to disbursement.

**Pell Grant:** Grant program funded by the federal government and awarded by schools to undergraduate students based on financial need.

**Perkins Loan:** Loan funded by the federal government and awarded by the school. These types of loans tend to have a very favorable interest rate.

**PLUS Loan:** A PLUS Loan is not need-based. On the student's behalf, parents or legal guardians can borrow through the PLUS program.

**Prepayment:** An amount of money that is paid by the borrower before it is due. There is not a penalty for prepayment of federal student loans.

**Principal:** The original amount borrowed and the amount upon which interest will be charged.

**Promissory Note:** A written and legal promise to pay back a loan at a specified time to a specified party.

**Repayment Schedule:** A repayment plan that alerts the borrower of the length of the repayment period, monthly repayment amount, number of payments required, and the due date of each payment.

**Stafford Loan:** A loan that is either subsidized (need-based) or unsubsidized (non-need based) and guaranteed by the federal government for students.

## Model Project: Student Loan Debt

### Stage 1: Annotated Bibliography

Leonard, Robin and Deanne Loonin (2001). *Take Control of Your Student Loan Debt*. Berkeley: Nolo Books. Description: Different types of student loans and the government's role in the various types of student loans are described. Making a budget that includes student loans, and repayment options are explained. Strategies for various situations where one cannot afford the student loan payments are given and the consequences of not paying student loans are described. Advice for "finding help beyond the book" is also included such as advice on how to do your own legal research, hire a lawyer, and contact a credit counseling agency. Various worksheets to help with budgets, deferment requests etc are found in the appendix. Very practical and comprehensive source.

Loyola Marymount University (2005). *Financial Aid web page*. Available at <http://www.lmu.edu/Page1003.aspx> Description: This site offers some information on financial aid, the cost of study at LMU, how financial need is determined, who is eligible for financial aid, types of aid available, how to apply for financial aid, and student responsibilities concerning financial aid. A "frequently asked questions" page is included. Aimed at LMU and potential LMU students.

Nellie Mae (2003). *A Student's Guide to Borrowing and Using Credit*. Available at <http://www.nelliemae.com/managingmoney/Meet.pdf>

Description: Gives basic information on principles of borrowing, debt, budgets, and credit cards. Includes some basic examples with actual dollar amounts, but does not show the calculations needed to obtain these dollar amounts. Includes some useful advice for controlling debt. Not very detailed.

O'Connell, Brian (2004). *Free Yourself From Student Loan Debt*, Chicago: Dearborn Trade Publishing.

Description: Begins with some basic statistics on student loan debt in the U.S. The book explains rights and responsibilities associated with student loans, strategies for paying off student loans, debt management. It gives detailed meanings of the terms loan default, loan deferments, forbearance, bankruptcy, cancellation and the consequences of these situations. Student loan ombudsman contact information and number of internet resources for further help and information are described and listed. Some general money management tips are given.

U.S. Department of Education (2005) *The Student Guide: Financial Aid from the U.S. Department of Education*. Available at <http://studentaid.ed.gov/students/publications/student%Fguide/index.html>

Description: Describes federal student financial aid programs and how to apply for them. Contains information on how to choose a school, direct and FFEL program loans, grants, campus-based programs, borrower responsibilities and rights, loan deferment summary, discharge/cancellation summary and important terms. There is an English and Spanish version.

U.S. Department of Education (2004). *2003-2004 National Postsecondary Student Aid Study (NPSAS:04): Undergraduate Data Analysis System*. Available at <http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2005164>

Description: This is an online system that contains the data from a survey with a sample of about 80,000 undergraduates who were enrolled at any time between July 1, 2003, and June 30, 2004, in about 1,400 postsecondary institutions. It represents all undergraduate students that were eligible to participate in the federal financial aid programs in Title IV of the Higher Education Act. The survey focused on how they and their families pay for postsecondary education and includes general demographics, types of aid and amounts received, and cost of attending college. The system allows one to look-up a HUGE number of statistics such as the mean loan principal received by students for each of the different kind of federal loans. Very easy to obtain a great deal of statistics from this site.

## **Model Project: Student Loan Debt**

### **Stage 2: Outline of Plan of Action**

- I. Stage 1: Research background information including:
  - A. Student loan terminology
  - B. Types of student loans available, terms of the common types of student loans
    1. Perkins loans
    2. Stafford loans
    3. PLUS loans
    4. Federal consolidation loans
  - C. Typical amounts borrowed
  - D. Reasonable salary expectations for a communications major
  - E. Cost of living data for the LA area
  - F. Financial experts “recommended” limits on spending for various categories of spending, including student loans, housing, food
  
- II. Stage 2:
  - A. Create a realistic Phil Brown case study, being sure to include:
    1. Communications major
    2. Graduating with some credit card debt
    3. Period of working at a first job, and beginning to pay off loan
    4. Period of time where he quits his job and returns to school
    5. Need for a second student loan
    6. Considerations regarding consolidation of the loans
      - a) when is it good/bad to consolidate?
      - b) differences in terms of the consolidated loan and non-consolidated loans
      - c) extended repayment
  - B. Create appropriate forms (data sheets) for calculations using a spreadsheet program
    1. Income and expenses summary (budget)
    2. Amortization table
  
- III. Stage 3:
  - A. Calculations for phase 1 of Phil’s loan payments (after graduating from LMU and beginning to repay his student loan)
    1. Monthly loan payment required under the standard repayment plan
    2. Loan amortization table
    3. Income and expenses summary (budget) for Phil
  - B. Calculations for phase 2 of Phil’s loan payments (after returning to school and obtaining a second loan)
    1. Amount of capitalization that has occurred with Phil’s first loan
    2. Monthly loan payment required under the standard repayment plan for both loans
    3. Loan amortization tables for both loans
    4. Income and expenses summary (budget) for Phil
  - C. Calculations for phase 3 of Phil’s loan payments (when considering consolidation)
    1. Monthly payments required on consolidated loan
    2. Loan amortization table for consolidated loan
    3. Total amount of interest paid on consolidated loan compared to unconsolidated loans
    4. Income and expenses summary (budget) for Phil
    5. Consequences of need for forbearance or deferment
  
- IV. Stage 4:
  - A. Write conclusion, report, article
  - B. Prepare oral presentation

## Model Project: Student Loan Debt

### Stage 2: Phil Brown's Case Study

**Phase 1.** Phil Brown received a subsidized Federal Perkins loan in the amount of \$4,000<sup>5</sup> in each of his four years at LMU to help pay his tuition. The terms of this loan<sup>6</sup> are summarized as:

5% annual interest rate (fixed rate)

10 year term

monthly payments

grace period: 9 months after no longer being at least a half-time student at LMU.

Phil graduated on May 8, 2005 with a major in Communication Studies, a student loan, and credit card debt (at 18% annual interest) totaling \$6,000<sup>7</sup>. Interest on Phil's student loan will begin to accrue February 1, 2006 and his first payment will be due on March 1, 2006. In August 2005, Phil begins a full-time job as a Public Relations Specialist at an annual salary of \$29,800<sup>8</sup> and by this time his credit card debt has increased to \$8,500.

**Phase 2.** Phil makes all required payments on time through August 1, 2009. Phil has recently applied and been accepted to the ABC Journalism School beginning September 1, 2009. He quits his job, finds a part-time job and enrolls in the journalism school. At this time, Phil applies for and is granted a student deferment on his Perkins loan for a period of two years during which he remains a full time student. Phil had managed to save some money, and obtained some help from his parents in paying his first year's tuition to journalism school, but just prior to his second year in journalism school, Phil finds he must obtain an additional loan to help pay for his journalism school tuition. This loan for journalism school tuition is an unsubsidized Stafford loan, for \$7,000. The terms of this loan<sup>9</sup> are summarized as:

5.3% annual interest rate, adjustable annually on July 1<sup>st</sup>, with a maximum rate of 8.25%

10 year term

monthly payments

grace period: 6 months after no longer being at least a half-time journalism student.

Phil graduates from journalism school in May 2011 and now has two student loans to repay. As of November 1, 2011, he must begin to repay both student loans. Phil lands a job as a Public Relations Assistant Manager, earning \$38,000<sup>10</sup> annually.

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<sup>5</sup> In Stage 1 we found from O'Connell (2004, p. 2) that \$16,000 was the US average student loan debt at graduation from a private school.

<sup>6</sup> Loyola Marymount University Financial Aid web page (Accessed October 12, 2005). <http://www.lmu.edu/Page1003.aspx> and its link to the Federal Perkins government loan information and the Federal Perkins Master Promissory Note form.

<sup>7</sup> According to PRNewswire (Oct.12, 2005) the average credit card debt among college students is \$2,400, and 14% owe more than \$5000. We assumed that by graduation a senior at LMU would owe more than the average, and so we put Phil in the top decile.

<sup>8</sup> Salary obtained by consulting the Bureau of Labor Statistics website <http://www.bls.gov/> and the *Occupational Outlook Handbook* <http://www.bls.gov/oco/> found there and then just choosing a salary that was slightly below the first quartile – thinking that being a first job, his salary would be at the low end, but being in LA, his salary would not be at the very low end. When accessed in Fall 2005, the data for 2002 listed median earnings as \$41,710 with the middle 50% earning between \$31,300 and \$56,180. More recent data is given at the end of the bibliography.

<sup>9</sup> Loyola Marymount University Financial Aid web page (Accessed October 12, 2005). <http://www.lmu.edu/Page1003.aspx> and its link to the Federal Stafford government loan information.

<sup>10</sup> Salary obtained by consulting the Bureau of Labor Statistics website <http://www.bls.gov/> and the *Occupational Outlook Handbook* <http://www.bls.gov/oco/> using reasoning similar to that in Footnote 4.

**Phase 3.** After making all required payments for two years, Phil considers consolidating his student loans by applying for a Federal Consolidation Loan<sup>11</sup>. He needs to know if he meets the requirements for a consolidation loan, what are the benefits of consolidation, and what are the drawbacks to consolidation. Will he save any money in the short and long term by consolidation?

**Bibliography:**

Leonard, Robin and Deanne Loonin (2001). *Take Control of Your Student Loan Debt*. Berkeley: Nolo Books.

Loyola Marymount University (2005). *Financial Aid web page*. Available at <http://www.lmu.edu/Page1003.aspx>

O’Connell, Brian (2004). *Free Yourself From Student Loan Debt*, Chicago: Dearborn Trade Publishing.

*PRNewswire* (October 12, 2005). “Students With Too Many Credit Cards: New Survey Reveals More Than Half of College Students Charge Their Credit Cards To The Limit Some or Most of The Time; Day-To-Day Living Expenses Run Up Credit Card Bills For Students”

NEW YORK, Oct. 12 /PRNewswire/ -- The following is a revised version of the release that was originally issued on August 17, 2005:

According to a new survey funded by OppenheimerFunds, Inc., a leading asset management company and conducted by Smith College, the majority of college students are in credit card debt largely from the use of credit cards to purchase personal items including toiletries, clothing and accessories. The survey found that 65% of college students carry credit card debt and over 50% charge their cards to the limit some or most of the time. More than half of respondents (58%) said that they never pay balances in full or pay in full less than half of the time. Nearly 20% of students do not know what the APR is on the credit card they use most. The average credit card debt among the respondents is \$2,400 and 14% owe more than \$5,000.

<http://www.bls.gov/oco/ocos086.htm#earnings> U.S. Department of Labor, Bureau of Labor Statistics. *Occupational Outlook Handbook*. (Accessed 2/28/06).

The following is a few of the statistics found at this site on 2/28/06:

Median annual earnings for salaried public relations specialists were \$43,830 in May 2004. The middle 50 percent earned between \$32,970 and \$59,360; the lowest 10 percent earned less than \$25,750, and the top 10 percent earned more than \$81,120. Median annual earnings in the industries employing the largest numbers of public relations specialists in May 2004 were:

Advertising and related services	\$50,450
Management of companies and enterprises	47,330
Business, professional, labor, political, and similar organizations	45,400
Local government	44,550
Colleges, universities, and professional schools	39,610

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<sup>11</sup> A link to information on loan consolidation is available on LMU’s Financial Aid website <http://www.lmu.edu/Page3257.aspx>

**Model Project: Student Loan Debt**  
**Stage 2: Income and Expenses Summary Form<sup>12</sup>**

1. Marital Status:

- Single
- Married
- Widow(er)
- Separated/Divorced

2. Number of Dependents: \_\_\_\_\_

Relationship: \_\_\_\_\_ Age: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

3. Monthly Income from ALL Sources:

Gross Monthly Salary/Wages \$  
 Spouse's Monthly Salary/Wages \$  
 Child Support \$  
 Alimony/Support \$  
 Unemployment \$  
 Public Assistance \$  
 Social Security/Veteran \$  
 Stocks, Bonds, & Investments \$  
 Other: \_\_\_\_\_ \$  
 Total Monthly Income: \$

4. Checking Account Balance: \$

5. Savings Account Balance: \$

6. Monthly Expenses:

Rent/Mortgage: \$ \_\_\_\_\_  
 Food: \$ \_\_\_\_\_  
 Utilities: \$ \_\_\_\_\_  
 Child Care: \$ \_\_\_\_\_  
 Car Payments: \$ \_\_\_\_\_  
 Other Vehicle(s) \$ \_\_\_\_\_  
 Public Transportation: \$ \_\_\_\_\_  
 Student Loan Payment(s) \$ \_\_\_\_\_  
 Type: \$ \_\_\_\_\_  
 \$ \_\_\_\_\_  
 \$ \_\_\_\_\_  
 Insurance: \$ \_\_\_\_\_  
 Telephone: \$ \_\_\_\_\_  
 Cellular Phone/Pager \$ \_\_\_\_\_  
 Credit Card(s) \$ \_\_\_\_\_  
 Other Charge Accounts: \$ \_\_\_\_\_  
 Medical: \$ \_\_\_\_\_  
 Cable/Satellite TV: \$ \_\_\_\_\_  
 Entertainment: \$ \_\_\_\_\_  
 Clothing: \$ \_\_\_\_\_  
 Dry Cleaning: \$ \_\_\_\_\_  
 Cleaning Yard Service: \$ \_\_\_\_\_  
 Other: \$ \_\_\_\_\_  
 \$ \_\_\_\_\_  
 \$ \_\_\_\_\_  
 Total Monthly Expenses: \$ \_\_\_\_\_

IF YOU NEED ADDITIONAL SPACE, PLEASE ATTACH A SEPARATE SHEET

Be sure to submit the applicable supporting documents along with this form completed on both sides.  
 IF THIS FORM IS NOT INCLUDED WITH YOUR APPLICATION, YOUR REQUEST MAY BE DENIED.

\_\_\_\_\_  
 Borrower's Signature

\_\_\_\_\_  
 Date

<sup>12</sup> Obtained from the LMU University Loan Programs, Controllers Office



## Model Project: Student Loan Debt

### Stage 3: Excerpt from Explanation of Calculations

**Phase 1:** The following lists the assumptions and observations we made in creating the amortization table for the subsidized Perkins loan together with brief explanations.

1. **Phil's first payment on the subsidized loan will be due March 1, 2006 and the loan balance at that time will be \$16,000.** Since Phil graduates at the beginning of May 2005, and the grace period is 9 months, the grace period will end on February 1, 2006 and his first payment would then be due March 1, 2006. Because Phil has a subsidized loan, no interest will have accrued during the grace period.
2. **Phil's loan balance at the end of phase 1 (August 1, 2009) is \$11,281.35.** So, at this time he is granted the deferment, his balance is \$11,281.35 (as shown in the loan amortization table).

The following lists the assumptions and observations we made in creating Phil's "budget" together with brief explanations.

1. **Phil's monthly rent is \$745.** Financial advisors say that a person's monthly expenditure on housing, ideally should not exceed 30% of their monthly income. For Phil, 30% of his income is \$745. However, in order to find housing with this monthly payment, Phil must share an apartment with two of his friends.
2. **Phil's monthly car payments are \$250.** Phil has purchased a used car, spending \$150 per month on car payments and \$100 per month in gasoline. To estimate the amount he spends in gasoline per month, we assumed that Phil drives 12,000 miles per year or 1,000 miles per month. Assuming his car gets an average of 30 mpg, and the cost of gasoline is \$3.00 per gallon, his car would consume  
$$1,000 \text{ miles/month} \div 30 \text{ miles/gallon} \approx 33 \text{ gallons/month,}$$
and that would cost  
$$33 \text{ gallons/month} \times 3.00 \text{ dollars/gallon} \approx 100 \text{ dollars/month.}$$
3. **Phil's credit card balance is at \$7,500 on March 1, 2006 and at that time, Phil intends to pay that balance off within 5 years and during those five years, he will limit further charges to his credit card to \$100 per month.** We assumed that when Phil begins his new job in August, he will be able to pay off \$1000 of his credit card debt by March 1, 2006 since he will not have loan payments to make during that time period. In order to pay off a \$7,500 balance on a credit card charging 18% and \$100 in new charges each month, Phil will begin to make credit card payments of:

$$\text{PMT} = \frac{7500 \left( \frac{.18}{12} \right)}{1 - \left( 1 + \frac{.18}{12} \right)^{-60}} + 100 = \$290.45.$$

4. **Phil will pay about \$407 in federal and state income taxes each month.** Phil's gross annual income is \$29,800, and with the \$3,300 personal exemption and deductions of \$770 in student loan interest, his taxable income will be approximately \$25,730. He is in the 15% federal tax bracket and so will pay approximately  $.15 \times 25730 = \$3,860$  in federal income taxes. In state taxes, he will pay approximately 4% of his taxable income, or approximately \$1,029. This gives an annual total of \$4,889 in federal and state income taxes, or \$407 per month.

**Phase 2:** The following lists the assumptions and observations we made in creating the amortization table for the unsubsidized Stafford loan together with brief explanations.

1. **Phil takes out his unsubsidized Stafford loan on September 1, 2010 and interest will compound until the end of the grace period on November 1, 2011.** So interest will have compounded for 14 months at the end of the grace period, and so the loan balance at the end of the grace period will be:

$$7000(1 + .053/12)^{14} = \$7,445.48$$

2. **Phil's first payment on the unsubsidized loan will be due December 1, 2011.** Since Phil graduates at the beginning of May 2011, and the grace period is 6 months, the grace period ends on November 1, 2011 and his first payment would then be due December 1, 2011.
3. **The interest rate will rise each year by .5%, until reaching the maximum rate of 8.25%, then remain at 8.25% for the duration of the loan.** We made this assumption because some economic forecasts predict rising interest rates in the near future, and because it will be more interesting to see if Phil can make his loan payments with a rising interest rate.
4. **The loan payment will be re-calculated annually on July 1<sup>st</sup>.** That is, assuming that the loan is to be paid off in full in ten years, and that interest rates have changed, the loan payment required will be recalculated based on the remaining balance, the remaining number of payments, and the new interest rate. This assumption was made because it is a common practice in the loan industry and will ensure the loan is repaid in full in ten years. For example, on July 1, 2012, the interest rate would rise to 5.80%, Phil will have 113 payments left to make (having already made 7 of the 120 payments), and his loan balance will be \$7,097.85, causing his new monthly loan payment to be calculated as:

$$\text{PMT} = \frac{7097.85(.058/12)}{1 - (1 + .058/12)^{-113}} = \dots$$

**Model Project: Student Loan Debt**  
**Stage 3: Income and Expenses Summary**

March 1, 2006 (phase 1)

1. Marital Status:

- Single
- Married
- Widow(er)
- Separated/Divorced

2. Number of Dependents: 0

Relationship: \_\_\_\_\_ Age: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

3. Monthly Income from ALL Sources:

Gross Monthly Salary/Wages \$ 2483.33  
 Spouse's Monthly Salary/Wages \$ \_\_\_\_\_  
 Child Support \$ \_\_\_\_\_  
 Alimony/Support \$ \_\_\_\_\_  
 Unemployment \$ \_\_\_\_\_  
 Public Assistance \$ \_\_\_\_\_  
 Social Security/Veteran \$ \_\_\_\_\_  
 Stocks, Bonds, & Investments \$ \_\_\_\_\_  
 Other: \_\_\_\_\_ \$ \_\_\_\_\_  
 Total Monthly Income: \$ 2483.33

4. Checking Account Balance: \$ \_\_\_\_\_

5. Savings Account Balance: \$ \_\_\_\_\_

6. Monthly Expenses:

Rent/Mortgage:	<u>\$745.00</u>
Food:	<u>\$200.00</u>
Utilities:	<u>\$45.00</u>
Child Care:	_____
Car Payments, Upkeep:	<u>\$250.00</u>
Other Vehicle(s)	_____
Public Transportation:	_____
Student Loan Payment(s)	<u>\$169.70</u>
Type: <u>Perkins</u>	_____
_____	_____
Insurance: Auto	<u>\$100.00</u>
Telephone:	<u>\$45.00</u>
Cellular Phone/Pager	_____
Credit Card(s)	<u>\$290.45</u>
Other Charge Accounts:	_____
Medical:	<u>\$78.00</u>
Cable/Satellite TV:	_____
Entertainment:	_____
Clothing:	<u>\$100.00</u>
Dry Cleaning:	_____
Cleaning Yard Service:	_____
Other:	_____
Taxes	<u>\$407.00</u>
_____	_____
_____	_____

Total Monthly Expenses: \$2,430.15

IF YOU NEED ADDITIONAL SPACE, PLEASE ATTACH A SEPARATE SHEET OF PAPER.

Be sure to submit the applicable supporting documents along with this form completed on both sides.  
 IF THIS FORM IS NOT INCLUDED WITH YOUR APPLICATION, YOUR REQUEST MAY BE DENIED.

Borrower's Signature

Date

## **Model Project: Student Loan Debt**

### **Stage 4**

Since Stage 4 involves a full written report and an oral presentation, we did not provide a model for Stage 4. Instead, we review the requirements and advice given for Stage 4 in “What is Due at the End of Each Stage,” (pages 26-28). We also remind them of the best practices for oral presentations that they suggested on the day of our Stage 1 demonstration.

## Chapter 3

### Group Projects: Background, Implementation and Rationale

#### Introductory Notes for Instructors

Collaborative learning is more than a classroom technique; it is a philosophical approach to teaching that places the instructor in the role of facilitator or, when long-term projects are underway, consultant. Below we use both the terms collaborative and cooperative learning. Theoretically, there are some distinctions drawn between these two terms (Rogers, et al, 2001, p. 4-6). Cooperative learning groups tend to be more organized, often with specific roles (such as leader, recorder, reporter, etc.) assigned to group members. Also, the assigned tasks are structured and the instructor provides closer oversight, including hints, questions, etc. In general, collaborative learning approaches are less structured and instructors assume students possess the social, communication and interpersonal skills known to facilitate group work. Another distinction is that students are more often assigned to groups in cooperative learning, whereas in collaborative learning, they are more likely to self-select their groups. We have used both terms below in describing our approach, because at times it appears more like one or other of these active learning techniques. For example, during Fall 2005 the two instructors assigned students to groups, but in Spring 2006 the third instructor had the groups self-select. Before they self-selected their groups, we were careful to provide more structured cooperative group tasks first involving textbook problems, to help students get acquainted and give them an opportunity to practice working together. Although we provided a fairly structured framework for the projects, all the students felt that their investigations were quite open-ended.

In the last decade a substantial literature has developed regarding cooperative learning in collegiate mathematics. This includes techniques for facilitating group work in mathematics (Black, et al, 1997; Resek, 1992; Weissglass, 1993), assessing group work (Gold, et al, 1999; Hagelgans, et al, 1995), as well as evidence of the value of working in groups (Dubinsky, et al, 1997). The collective wisdom of nearly 150 participants in the Mathematical Association of America's Project CLUME (Collaborative Learning in Undergraduate Mathematics) is represented in Rogers, et al (2001). Far less has been published regarding the use of long-term projects in mathematics for groups of students, especially in quantitative literacy courses. While Schwartz (1992) recommends the assignment of long-term group projects in a liberal arts mathematics class, he gives little in the way of details.

Fortunately, much of the advice to students and faculty regarding factors for success when working cooperatively in the classroom may be applied to working collaboratively on long-term projects. Below we describe various aspects of cooperative learning discussed in the literature and provide some details of our own implementation of group projects in our projects-based course.

#### Implementation of Collaborative Work on Group Projects

To help students begin the process of working collaboratively on a project, it is necessary to provide activities that will foster a cooperative environment and encourage students to get acquainted (Rogers, et al, 2001, p. 16-18). This can begin on the first day of class, by replacing the traditional roll call with an invitation to students to introduce themselves to the entire class, give their major and tell something they did during the summer or over break. This works best when the instructor goes first and models the introduction for them, including telling something of her own activities. If the class is small enough (say 20 or fewer), inexpensive name cards in the shape of triangular cylinders can be made with triple folded notebook paper and markers to facilitate learning everyone's names. The use of think/pair/share or small group problem solving on short in-class problems from the very first day gets students talking with classmates. Allowing some time for in-class group work each day sets the tone for collaborative

work. By encouraging students to pair or group with different classmates each day, they get a chance to meet many of their classmates (Hagelgans et al, 1995, p. 27-29). This familiarity proved advantageous in Spring 2006 when students were invited to self-select their groups.

In Fall 2005 when we assigned students to groups we first had them fill out the “Project Preference Sheet” (page 56). Our thinking was that we would assign students to groups primarily according to their interest in a particular project topic, and secondarily according to the strengths they would bring to the group. We have since learned that a factor that may be important for the success of a group is that at least some of the students have had prior experience working in groups, even if that experience was a negative one, since they are likely to have learned some aspects of successful collaboration (Colbeck, et al, 2000). We did allow more than one group within a single section of the course to select the same topic. We encountered no issues with competition or sharing of resources. The project topics were rich enough that different groups tended to focus on different aspects of the topic.

The development of productive groups begins with convincing students of the value of cooperative learning and clarifying the behaviors that lead to success. More and more employers and institutions of higher education are indicating that the ability to work as part of a team on a complex problem is a desired student learning outcome (Dubinsky, et al, 1997, p. 203-204). We point this out to students with the observation that working on a project will let them answer an interview question like: *Have you ever worked as part of a team on a complex problem? Can you describe the project and your contribution?* In addition, the project gives them the opportunity to use technology and practice their presentation skills, which they can then cite on their resumes. Some students in Spring 2006 said the group project work enabled them to meet other students and facilitated their successful transition as freshmen or transfer students to the university.

The behaviors that have been associated with successful groups are getting to know and trust one another, being able to communicate clearly and accurately, accepting and supporting each other, and resolving conflicts constructively. One effective way of orienting students to the requirements of successful collaboration on group projects is to take a few minutes of class time to list positive and negative aspects of group work on the board. After generating the lists, ask students to suggest ways they or the instructor can encourage effective behaviors and mitigate potential problems. Although we did not do this, the method comes highly recommended (Dubinsky, et al, 1997, p. 201-202).

A frequent complaint about group work is that students’ busy schedules work against finding a meeting time out side of class for the whole group. Some recommend taking schedules into account before forming groups (Hagelgans et al, 1995, p. 26). Our approach was to provide some class-time periodically for the group to work on their project and this helped to some extent. This is reflected in the projects-based course calendar found on page 13.

As expected, we encountered some problems relating to students working in groups. A small number of students did not adequately participate in their groups, a small number of others tried to be too controlling of their groups, etc. Our solutions (meeting with a troubled group, allowing a group to kick a member out, providing a separate project for that person) may not have been perfect, but they are in keeping with suggested approaches from the literature (Hagelgans, et al, 1995, p. 70-76). A component of the project grade (20 out of 150 points, see rubric page 58) was set aside for each student’s contribution to the cooperative work. We discuss the details of our assessment of the project and the student’s contribution to the project in Chapter 4.

We encourage anyone who wants more information about how to use cooperative groups to consult the annotated bibliography at the end of this chapter.

### **Making the Case for Group Projects**

So far in this chapter, with one exception, we have given citations from the mathematics education literature on various theoretical and practical aspects of using collaborative/cooperative learning in the mathematics. The one exception (Colbeck, et al, 2000) reported on a study of engineering students working on design projects. In this section we turn to a well-known and provocative article *Seven principles for good practice in undergraduate education* written by Chickering and Gamson for the entire spectrum of higher education – faculty members, campus administrators, state agencies and government policy makers, and later amplified into a book<sup>13</sup>. After reflecting back on our year's experience using group projects in a quantitative literacy course, we find that our group-projects approach matches up rather well to the seven principles.

Here we present (in italics) the Seven Principles for Good Practice in Undergraduate Education each with a brief summary as compiled in a study supported by the American Association of Higher Education, the Education Commission of States, and The Johnson Foundation. After each principle we describe how our approach using semester long group projects conforms to that principle.

#### **1. GOOD PRACTICE ENCOURAGES STUDENT -- FACULTY CONTACT**

*Frequent student-faculty contact in and out of classes is the most important factor in student motivation and involvement. Faculty concern helps students get through rough times and keep on working. Knowing a few faculty members well enhances students' intellectual commitment and encourages them to think about their own values and future plans.*

When students divide into project groups, it is easier for the instructor to learn and remember their names because of the association with their project topic. As students select and work on their projects, the instructor's role naturally shifts from authority-figure to that of consultant and resource. When students consult the instructor outside of class with questions about the project, the conversation often wanders to other topics including their previous experiences or educational and career goals.

#### **2. GOOD PRACTICE ENCOURAGES COOPERATION AMONG STUDENTS**

*Learning is enhanced when it is more like a team effort than a solo race. Good learning, like good work, is collaborative and social, not competitive and isolated. Working with others often increases involvement in learning. Sharing one's own ideas and responding to others' reactions improves thinking and deepens understanding.*

The culture of the class as a community of learners begins to develop from the first day of class when students introduce themselves and work cooperatively on problems. Nametags assist everyone in learning others' names and changing partners for group work facilitates meeting students initially seated across the room. Once groups are formed students share ideas about how to develop and investigate the project question.

Students are graded against performance criteria spelled out in a rubric, not in comparison to the work of others, thereby reducing competition. During the final project presentations, students are very

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<sup>13</sup> Chickering, A.W., and Gamson, Z.F. (1991). Applying the Seven Principles for Good Practice in Undergraduate Education. *New Directions for Teaching and Learning*, Number 47, Fall 1991. San Francisco: Jossey-Bass Inc.

supportive of other groups. Critical comments on the peer evaluation sheets are typically offered in the spirit of improvement and positive encouragement.

Assigning points to group participation and checking periodically how the group is doing signals that cooperation is expected and valued. Every group member must have a speaking part in the final presentation.

### **3. GOOD PRACTICE ENCOURAGES ACTIVE LEARNING**

***Learning is not a spectator sport. Students do not learn much just sitting in classes listening to teachers, memorizing pre-packaged assignments and spitting out answers. They must talk about what they are learning, write about it, relate it to past experiences, and apply it to their daily lives. They must make what they learn part of themselves.***

The group projects begin with a question arising from the students' daily life on campus or local community. They must discuss and decide as a group what their approach to the question will be. They carry out their ideas. They write (and, if necessary, revise) progress reports at the end of each stage. They must identify the mathematical ideas and skills that they called upon in their project as part of their final report. They reflect on and report how to improve upon their approach. They present their final product to the entire class and fashion a "public" response that might take the form of a letter to the editor or a report to the agency that "commissioned" the project (for example, the student health center on campus).

### **4. GOOD PRACTICE GIVES PROMPT FEEDBACK**

***Knowing what you know and don't know focuses learning. Students need appropriate feedback on performance to benefit from courses. In getting started, students need help in assessing existing knowledge and competence. In classes, students need frequent opportunities to perform and receive suggestions for improvement. At various points during college, and at the end, students need chances to reflect on what they have learned, what they still need to know, and how to assess themselves.***

The division of the project into stages with evaluation rubrics guiding assessment of each stage provides numerous opportunities for feedback. Because revision is possible, even requested, at each stage, opportunities abound for improvement. Several times students are asked for a self-assessment of their group participation. The mathematical topics list encourages students to reflect on the mathematical topics considered in the course and requires them to select those to apply to the project. By communicating a summary of the peer evaluation forms including the written comments we provide students with an alternative assessment of their project from their peers.

### **5. GOOD PRACTICE EMPHASIZES TIME ON TASK**

***Time plus energy equals learning. There is no substitute for time on task. Learning to use one's time well is critical for students and professional alike. Students need help in learning effective time management. Allocating realistic amounts of time means effective learning for students and effective teaching for faculty. How an institution defines time expectations for students, faculty and administrators, and other professional staff can establish the basis for high performance for all.***

Subdividing the project into stages helps students with time management. It also signals the importance

of committing sufficient time and energy throughout the term. Points for on-time completion of each stage are built into the evaluation rubric for that stage. We make clear our expectations that students practice in preparation for the final presentation. The periodic assessments of group participation indicate any problems and give us a reason to discuss work habits and participation with students who are not contributing and to give positive reinforcement to those who are.

## **6. GOOD PRACTICE COMMUNICATES HIGH EXPECTATIONS**

*Expect more and you will get it. High expectations are important for everyone-- for the poorly prepared, for those unwilling to exert themselves, and for the bright and well motivated. Expecting students to perform well becomes a self-fulfilling prophecy when teachers and institutions hold high expectations of themselves and make extra efforts.*

The semester length of the project, the fact that it addresses an open problem or question, and the 20% portion of the grade assigned to it communicate its significance. The description of what is expected at each stage and the corresponding rubric, which include a “needs improvement” category, serve to convey high expectations. The model project demonstrates the type of documentation, quality of writing, and thoroughness of the investigation that we expect. When presenting various stages of the model project we invite student critiques of how it can be improved (for example, better graphical displays) and thereby hold up a higher standard.

## **7. GOOD PRACTICE RESPECTS DIVERSE TALENTS AND WAYS OF LEARNING**

*There are many roads to learning. People bring different talents and styles of learning to college. Brilliant students in the seminar room may be all thumbs in the lab or art studio. Students rich in hands-on experience may not do so well in theory. Students need the opportunity to show their talents and learn in ways that work for them. Then they can be pushed to learning in new ways that do not come so easily.*

The project preference form suggests a variety of different talents and strengths ranging from analytical to artistic that would be useful for a project group to have. The project stages involve background research, planning, analysis, synthesis, and presentation skills; they accommodate a multiplicity of learning styles. Since the primary audience for the course consists of students spanning the liberal, performing and studio arts, the project provides a means for these students to showcase their talents. In particular, replacing the final exam with the project presentation provides a type of performance assessment not typically available to student in a traditional quantitative literacy course.

### **The SENCER Course and LMU’s Core Curriculum**

In addition, our SENCER course, developed prior to the publication of “Improving the Core: Summary and Reflections,” a Spring 2006 report by our university’s Core Curriculum Committee, appears to have addressed a number of concerns expressed therein. In particular, we see the course as addressing the following concerns.

Students should:

- see connections between their academic study and life in the “real world”
- deliberate over and act on real-world problems
- use technology as a tool for learning and doing work

Courses should:

- take advantage of the location of LMU in Los Angeles and how that might influence and shape learning experiences and outcomes
- help students become independent thinkers who can approach complex and unstructured problems
- demand reading and writing

Faculty should:

- discuss content and pedagogy with others teaching in the core.

### Cooperative Learning Bibliography

Artzt, Alice and Claire Newman. *How to Use Cooperative Learning in the Mathematics Class*. (2<sup>nd</sup> ed.) Reston, VA: National Council of Teachers of Mathematics, 1997.

Research suggests that learning is a social process and that cooperative learning activities are essential if students are to be able to construct their own knowledge. This booklet, written for K-12 teachers, presents many classroom-tested ideas and techniques.

Black, Beverly, Pat Shure and Doug Shaw. *The Michigan Calculus Instructor Training Materials*. New York: John Wiley & Sons, Inc., 1997.

Colbeck, Carol, Susan Campbell, and Stefani Bjorklund. "Grouping in the Dark: What College Students Learn from Group Projects." *The Journal of Higher Education*, 2000, 71(1), 60-83.

Dubinsky, Ed, David Mathews, and Barbara E. Reynolds, editors. *Readings in Cooperative Learning for Undergraduate Mathematics*. Washington D.C.: Mathematical Association of America, 1997.

The editors have selected 17 papers from the literature on cooperative learning in undergraduate mathematics classes to present in this book.

Gold, Bonnie, Sandra Keith and William Marion, editors. *Assessment Practices in Undergraduate Mathematics*. Washington D.C.: Mathematical Association of America, 1999.

This book offers assessment techniques ranging from brief 10-minute classroom exercises and examples of alternative testing, group work and assignments to examples of how departments can measure placement of students into courses, the effectiveness of the major, and the quantitative literacy of their graduating students.

Hagelgans, Nancy, Reynolds, Barbara, Schwindendorf, Keith, Vidakovic, Draga, Dubinsky, Ed, Shain, Mazen, and G. Joseph Wimbish, Jr. (eds.). *A Practical Guide to Cooperative Learning in Collegiate Mathematics*. Washington D.C.: Mathematical Association of America, 1995.

This book presents detailed discussion of every aspect of cooperative learning as it applies to college level mathematics. It incorporates the experience of over 40 colleagues who responded to a survey on cooperative learning.

King, A. "Guided Peer Questioning: A Cooperative Learning Approach to Critical Thinking," *Cooperative Learning and College Teaching*, Winter, 1995, 5(2), 15-19.

Resek, Diane. "Techniques for Cooperative Group Work," *Focus on Calculus: A Newsletter for the Calculus Consortium Based at Harvard University*. New York: Wiley and Sons, Fall 1992, (2) 5-6.

Rogers, E., Reynolds, B., Davidson, N., and Thomas, A. (eds.) *Cooperative Learning In Undergraduate Mathematics: Issues that Matter and Strategies that Work*. Washington D.C.: Mathematical Association of America, 2001.

The experience of nearly 150 participants in the Mathematical Association of America's Project CLUME (Collaborative Learning in Undergraduate Mathematics) is drawn upon in this text. The 17 contributors to this text have extensive experience using cooperative learning and many are involved in research projects investigating its effectiveness.

Schwartz, R. H. "Revitalizing Liberal Arts Mathematics" *Mathematics and Computer Education*, 1992, 26(4), 272-277.

Weissglass, Julian. "Small Group Learning," *American Mathematical Monthly*, 1993, 100(7) 662-668.

## Project Preference Form

Name: \_\_\_\_\_

Math 102 Project Preference Form – Due: \_\_\_\_\_

This semester, there are six project topics available (or you can propose your own):

Textbook Costs  
Math Homework Help Session  
Social Security: Will It Go Broke?

Living Expenses: On vs. Off-Campus  
Student Health Center  
Ballona Wetlands Insect Survey

or

Your Own Design

On the lines below, list the project topics in order of your preference:

- |          |          |
|----------|----------|
| 1. _____ | 4. _____ |
| 2. _____ | 5. _____ |
| 3. _____ | 6. _____ |

List pertinent areas in which you have strengths. (e.g. word processing, PowerPoint, science background, math background, writing ability, oral communication, organizational skills)

List any student(s) in this class that you especially want to work with.

List any student(s) in this class that you especially wish *not* to work with.

## **Chapter 4**

### **Assessment Tools**

#### **Introductory Notes for Instructors**

In this Chapter we provide the various tools we developed for assessing the projects and describe how we use them. It contains the overall project grading rubric, an evaluation sheet for each of the four stages, two versions of a form to gather student response on group work, and an oral presentation evaluation sheet suitable for use by students or the instructor.

When the projects were first introduced, students were provided with a copy of the “Project Grading Rubric” (page 58) that would be used in evaluating final projects so that they would be fully aware of the requirements and desired attributes of the projects. The instructor’s final evaluation of the projects was carried out at the completion of the projects using the “Project Grading Rubric.”

At the end of each stage, students submitted their work on that project stage. Students were generally given full credit for stages 1-4 in the Project Grading Rubric (on page 58) provided their group satisfactorily met all requirements for those stages. However, instructors did review, comment, and provide suggestions for improvement on the work at the end of each stage. Students were encouraged to revise their work on a stage before turning in their final project and were reminded that the final evaluation of the project would consider the quality of work, as well as completeness. To aid in providing feedback at the end of each stage, we used the “Stage Evaluation” forms found on pages 59-62.

As one means of monitoring the contribution of students to their group project, we periodically (usually at the end of each stage) asked students to take 5 minutes to complete one of the “Student Response on Group Work” forms (pages 63-64). We found that this exercise served to give the instructor feedback on group dynamics and encouraged students to reflect on their own contribution. In completing these forms, students were generally honest and willing to give credit to others when credit was due. Several students commented at one stage or another that they felt they themselves had not contributed as much as they should have during that stage and resolved to work to make that up in the next stage. We mentioned earlier that a few students were allowed to work in pairs on projects. We note that it is more problematic to gather an honest evaluation from a single peer.

At the end of the semester, student groups gave presentations of their projects. Every member of the group was required to give part of the presentation and instructors used the “Oral Presentation Evaluation Sheet” (page 65) when evaluating the presentations. One instructor also had students fill out the “Oral Presentation Evaluation Sheet” and averaged the numerical ratings and had the students’ comments typed up for distribution to group members as another source of feedback.

## Project Grading Rubric

Project Title:

Student's Name:

Group Members:

Criteria	Max Points	Awarded Points
On time completion: All tasks for each stage <i>satisfactorily</i> completed on time earns 5 points for each stage. See rubrics for each individual stage for more details.		
Stage 1	5	
Stage 2	5	
Stage 3	5	
Stage 4	5	
Group work contribution:		
Teacher observed student contribution	10	
Peer assessment of student contribution	10	
Mechanics of the project:		
Sufficient background data, organization, representation, etc.*	10	
Use of appropriate mathematical or statistical tools*	10	
Drawing logical conclusions based on data*	10	
Written report:		
Organization/ neatness (logical, understandable and easy to follow)*	10	
Communicates mathematical ideas clearly*	10	
Correct spelling, grammar, acceptable rules of citations and writing composition (viz. ENGL 110)*	10	
Oral Presentation:		
Mechanics (professional dress, speak clearly and loudly, logical flow, etc.)*	10	
Demonstrates knowledge, able to answer questions, etc.*	10	
Effective use of visual aids (PowerPoint, Excel graphs, photos, transparencies, etc.)	10	
Civic Engagement: Evidence of action taken as a result of your findings	20	
<b>Total</b>	<b>150</b>	

\* Excellent/outstanding (9 or 10 points)  
 Good/substantial (evidence of substantial effort, slight problems in analysis 7 or 8 points);  
 Adequate (weak but evidence of some effort or comprehension 5 or 6 points);  
 Fair/minimal (minimal effort or comprehension 3 or 4 points);  
 Poor/nonexistent (lack of effort or comprehension 1 or 2 points);

## Stage 1 Evaluation

Project Group Topic: \_\_\_\_\_

Actual Due Date: \_\_\_\_\_(Week 7)

Date Received: \_\_\_\_\_

<b>Item</b>	<b>Excellent</b>	<b>Satisfactory</b>	<b>Needs Improvement</b>	<b>Missing</b>	<b>NA</b>	<b>Possible Points</b>	<b>Points Earned</b>
On Time						1	
Annotated Bibliography						1	
Paragraph Summary						1	
Glossary of Terms						1	
Photocopy of the Notes						1	
<b>TOTAL</b>						<b>5</b>	

Group Work Contribution Observed:

Comments:

## Stage 2 Evaluation

Project Group Topic: \_\_\_\_\_

Actual Due Date: \_\_\_\_\_(Week 10)

Date Received: \_\_\_\_\_

<b>Item</b>	<b>Possible Points</b>	<b>Points Earned</b>	<b>Additional Possible Upon Revision</b>
On Time	1		
Outline of Plan of Action	1		
Survey Instrument	2		
Sampling Method	1		
OR			
Case Study Description	2		
Supporting Documents	1		
<b>TOTAL</b>	<b>5</b>		

Comments:

### Stage 3 Evaluation

Project Group Topic: \_\_\_\_\_

Actual Due Date: \_\_\_\_\_ (Week 15)

Date Received: \_\_\_\_\_

Item	Excellent	Satisfactory	Needs Improvement	Missing	NA	Possible Points	Points Earned
On Time						1	
Revised Outline of Plan of Action, if appropriate						0 or 1	
Copy of all data collected, calculations performed, resulting graphics						2	
Paragraph summarizing what your group learned						1	
Statement of your conclusion						1	
<b>TOTAL</b>						<b>5 or 6</b>	

#### ITEMS TO CONSIDER

Questions for all groups doing a survey:

- Did you discuss or present evidence on how representative your sample is?
- Should your reader believe this survey? Why or why not?
- Double (triple) bar graphs show comparisons better than pie charts.
- Include copies (originals of your surveys).

Questions for case study group:

- How well did you document your case study?

Questions for all groups:

- Is your mathematics correct?
- Are all the mathematical calculations there?
- Is your mathematical language accurate?
- Is your writing repetitive? Does it make the same points over and over? There is no need for “fill”!
- Does your writing flow logically? Is it clear what point(s) you are making?
- Pay attention to proper use of apostrophes.
- Proof read (out loud) for typos and incorrect spellings that spell check cannot find. Ask a friend to read it and to be frank with you!!
- Consider what your planned response or action item will be for Stage 4. Clear it with your instructor by \_\_\_\_\_. **Suggestion:** Briefly describe it to her in writing or by email by \_\_\_\_\_.

### Stage 4 Evaluation

Project Group Topic: \_\_\_\_\_

Actual Due Date: \_\_\_\_\_(Week 15)

Date Received: \_\_\_\_\_

<b>Item</b>	<b>Excellent</b>	<b>Satisfactory</b>	<b>Needs Improvement</b>	<b>Missing</b>	<b>NA</b>	<b>Possible Points</b>	<b>Points Earned</b>
On Time						1	
Report: Structure						1	
Writing						1	
Mathematics						1	
Response						1	
<b>TOTAL</b>						<b>5</b>	

Comments:

## Student Response on Group Work (version 1)

Name: \_\_\_\_\_

1. What project are you working on?
2. Who are your team members?
3. How many times have you met as a team during work on this Stage?
4. List at least one of your individual contributions (if any) towards the project.
5. In your opinion who on your team has contributed significantly more than the rest to your project so far?
6. In your opinion who on your team has contributed significantly less than the rest to your project so far?

## Student Response on Group Work (version 2)

Date: \_\_\_\_\_

Project Topic: \_\_\_\_\_

Your Name: \_\_\_\_\_

List the work you have done to date on the project (for example, I contributed to survey design; I wrote the annotated bibliography; etc.)

Names of Group Members	Percent of Contribution So Far
Yourself	

Any comments or concerns about how your group work is going:

Suggestions to the Instructor:

### Oral Presentation Evaluation Sheet

Group Topic:	Evaluator's Name:
Directions: Rate on a scale of 1 to 5, 5 being best. Add comments.	
Introduction Captures Attention	1 2 3 4 5
COMMENT:	
Logical Flow to Talk	1 2 3 4 5
COMMENT:	
Clear Explanations, Able to Answer Questions	1 2 3 4 5
COMMENT:	
Use of Audio Visual	1 2 3 4 5
COMMENT:	
Professional Demeanor	1 2 3 4 5
COMMENT:	
Civic Engagement Component	1 2 3 4 5
COMMENT:	

## Chapter 5

### Additional Material Developed

#### Introductory Notes for Instructors

In this chapter we present the additional course materials we developed that relate to or extend the standard MATH 102 course content. You will find new examples for the topics of number sense and making large numbers meaningful that can be used in a cooperative group setting; an exercise based on an actual jury trial where the outcome hinges on correctly comparing linear and volumetric measurements; an expanded discussion of sampling theory; a discussion of how to find a 90% confidence interval; and a conceptual discussion of the Central Limit Theorem and how it relates to confidence intervals. We have also included the new computer spreadsheet lab exercise we wrote to ensure that students would know how to represent data graphically for their final presentations.

#### Making Sense of Numbers (Use with Sections 2A and 2B of Bennett and Briggs)

#### Introductory Notes to the Instructor

These problems appear in (or were inspired by) *Innumeracy* by John Allen Paulos, Hill and Wang, New York, 1988. The underlying mathematical topics are the first material discussed in the course and these problems are ideal for students to work in pairs or small groups. The first problem can initiate discussion about what is a reasonable starting point, and the women in the classroom are more likely to contribute suggestions for the initial rate. Interest in the answer to the second problem can be generated by asking **before** the computation if the students think they have lived as long as a million or a billion seconds. Most college students like “scary movies,” so the third problem can be quite engrossing to them. We used Los Angeles as a comparison because of our location there.

1. (Silly question) How fast is your hair growing in miles per hour? SUGGESTION: Ask the students- What is a reasonable starting point? You can use an initial estimate of 6 inches per year as a rate of hair growth.
2. (Time flies) How long does it take for 1 million seconds to pass? Have you lived that long? How about a billion seconds? (Answers: about 11.6 days; yes; almost 32 years.)
3. (Ghoulis figures) What is the volume of human blood in the world? (Answer: The average adult male has about 6 quarts of blood, adult women slightly less, children considerable less. Thus using an estimate that, on average, each of the approximately 6.5 billion people in the world today has about 4 quarts (which is 1 gallon) of blood, we get about 6.5 billion ( $6.5 \times 10^9$ ) gallons.) What would be the dimensions of a cube that would hold it all? Since there are about 7.5 gallons per cubic foot (can you verify this?), there are approximately  $8.7 \times 10^8$  cubic feet of human blood in the world. If this were packed into one cube, the length of one side would be  $\sqrt[3]{8.7 \times 10^8}$  feet or about 950 feet. So all human blood would fit into a cube that was about 950 feet (not much more than the length of 3 football fields – a football field is 100 yards or 300 feet long) on a side. How much higher would Lake Mead rise if all the human blood in the world were poured into it? NOTE: Lake Mead, when full, covers 247 square miles. (Answer: 247 square miles is  $6.9 \times 10^9$  square feet. So it would raise the level of Lake Mead about 0.13 feet. NOTE: Showing a nice picture of Lake Mead from the web would be interesting.) If walls were built around an area as large as the city of Los Angeles, all the blood in the world would cover the region to a depth of how many inches? NOTE: The city of Los Angeles covers 465 square miles. (ANSWER: about .8 inches, or a little more than three quarters of an inch.)
4. (Your turn) Make up a question of your own involving large or small numbers. Answer it.

## Mathematics and Civil Justice (Use with Section 2A of Bennett and Briggs)

### Introductory Notes for Instructors

The following article by Robert Mitchem appeared in the *California Mathematics Council Communicator*, volume 17, number 2, Dec. 1992, p 36. We recommend giving the first three paragraphs to the students to read and then asking them to play the role of juror. After they have had time to read and discuss the case with a partner, move to a whole class discussion. This article underscores the importance of having a numerically literate citizenry.

### Mathematics and Civil Justice – A Personal Experience

“Recently I served on a jury in a civil case involving possible medical malpractice. Quite unexpectedly, elementary mathematics played a role in the jury’s decision. This experience may provide motivation for teaching length, area, and volume to secondary and post secondary students.

The plaintiffs (I’ll call them Mr. and Mrs. Jones) sued a physician, Dr. Smith, for unnecessarily removing Mrs. Jones’ uterus against her wishes during surgery for ovarian cancer. Certain written evidence, such as medical documents, was presented, and the plaintiffs and defendant gave oral testimony during the trial. Since the written records supported the physician, the plaintiffs’ case clearly rested on their testimony being more believable than the doctor’s. The lawyer for Mr. and Mrs. Jones needed to show that Dr. Smith was less than a credible witness. Furthermore, in order to reach a decision against the defendant in a civil trial, plaintiffs must only establish “the preponderance of evidence” rather than “beyond a reasonable doubt” which is the standard in criminal cases.

One of the main points in trying to discredit Dr. Smith centered on the size of the uterus. In one of his written reports, Dr. Smith stated that Mrs. Jones’ uterus was 2 to 3 times normal size. Dr. Smith also testified that the maximum length of a normal uterus was 6 or 7 cm. The plaintiff’s lawyer presented a report from the pathologist who examined the uterus after removal. That report stated that Mrs. Jones’ uterus was 9 cm long. The attorney claimed that 3 times 6 cm would be 18 cm while 3 times 7 would be 21 cm, which was not close to 9 cm.

I immediately wanted to protest his calculations since  $(9/6)^3 = 3.375$  and  $(9/7)^3 = 2.125$ , which supported the doctor’s claim; but I refrained from comment.

After the attorneys gave their summaries and the judge gave his final instructions, the jury moved to the jury room for deliberations. During our discussions, it became apparent that other jury members did not understand the fallacy in the argument about uterus size. Since this was a major part of the plaintiff’s case, I explained to the other jurors that, for a three dimensional object, if each dimension grows only 28% then the three dimensional object grows about twice its normal size.  $(1.28)^3 = 2.097$ . I also pointed out that a 50% increase in one dimension means that the object increases to about three times its volume.  $(1.5)^3 = 3.375$ . The pathologist’s report did not contradict the doctor. For this and other reasons, the jury unanimously found for the defense.

The disappointing thing for me, as a mathematics educator, was not only that the jurors did not originally see the difference between length (one dimension) and volume (three dimensions), but that even Dr. Smith’s attorney did not see the fallacy or discuss the misconception in his summary. As teachers we have a responsibility to stress the importance of dimension as we help students develop an understanding of these fundamental concepts.”

### **Making Large Numbers Meaningful** (Use with Section 3A of Bennett and Briggs)

Many people have a hard time grasping the magnitude of large numbers and most of us have little practical experience with large numbers. An initial discussion can begin with the request to name several groups that consist of (i) thousands of objects; (ii) millions of objects; (iii) billions of objects; (iv) trillions of objects. Ask students to try to give answers to these questions that relate to their personal situation. Be prepared with your own ‘personalized’ answers. Here are ours based on our own university.

POSSIBLE ANSWERS: (i) There are between 5000 and 6000 undergraduates at LMU. It is about 3000 miles across the United States. The average amount of student loans owed by undergraduates on graduation day is \$16,000. (See model project, page 36.) (ii) The total tuition (at \$25,000 a year) paid by 5000 students is \$125,000,000 or \$125 million. By the way the US population is approaching 300 million. 1 million seconds is only 11.6 days. (iii) Over 4 years at LMU, 5000 undergraduate students pay over \$500,000,000 (half a billion dollars) in tuition. In 8 years time, LMU collects more than a billion tuition dollars. By the way, the world’s population is approaching 6.5 billion. 1 billion seconds is almost 32 years. (iv) I am not at all sure how to make a trillion relate to my personal situation. A trillion (1,000,000,000,000) seconds would be over 30,000 years. According to [http://www.brillig.com/debt\\_clock/](http://www.brillig.com/debt_clock/) (see also <http://www.publicdebt.treas.gov/opd/opdpenny.htm>) the national debt is over \$7 trillion as of July 26, 2005. This is over \$26,000 per person in the US. The distance from the earth to the sun is about 150 million kilometers which is 150 trillion millimeters. (NOTE: Look at the size of a millimeter on a ruler.)

### **Putting Numbers in Perspective** (Use with Section 3B of Bennett and Briggs)

The following material appears in or was inspired by Placing the Buffalo Slaughter in Perspective in Fusaro and Kenschaft (2003).

There are many environmental or social justice issues that involve large numbers, including the slaughter of 45 million buffalo during the latter part of the nineteenth century, primarily 1865-1885. This drastic slaughter of buffalo, had a profound effect on the Native American population. By 1903, only 1644 buffalo remained (Garretson, 1938). An estimated 30 to 60 million buffalo inhabited North America at the beginning of the 19<sup>th</sup> century. To increase our understanding of the dramatic change in magnitude of the buffalo population since the 1800’s, we will compare the buffalo population with the *current* human population of the regions the buffalo inhabited. (NOTE: The following figures are based on 1994 data, not current data.) From B.A. Fusaro and P. Kenschaft (2003, p. 73), the primary range of the buffalo at the beginning of the 1800’s encompasses the better part of 13 states and two Canadian provinces: Arkansas, Colorado, Idaho, Iowa, Kansas, Minnesota, Missouri, Montana, Nebraska, North Dakota, Oklahoma, South Dakota, Wyoming, Alberta and Saskatchewan. At this time an estimated 30 to 60 million buffalo inhabited North America. Using the average value, say 45 million, let’s assume that two-thirds of these roamed the primary range, giving us a buffalo population of (.67)(45,000,000) or 30,000,000. How can we understand the value of this number? A percentage comparison to the human population (1994 population data) enables us to see:

$$\frac{N(\text{Buffalo primaryrange})}{N(\text{Humans in same range})} = \frac{30,000,000}{32,549,110} = 0.9217.$$

We find that this buffalo population was as large as 92% of the 1994 human population of these states and provinces, nearly one buffalo per person. Can we imagine eradicating 92% of the human population

of this region within a 20-year period by slaughter? Can you find comparative statistics for the number of Native Americans that were killed during the latter part of the 19<sup>th</sup> century?

A widely used photograph (see Geist, 1996 and Hodgson, 1994) gives another way to assess the magnitude of the buffalo slaughter. The photograph depicts two men standing on a giant pile of buffalo skulls that had been collected to be ground for fertilizer. The conical pile of bones is described as being 50 feet high. Assuming a 45-degree slant to the conical pile, find the volume. Using the fact that buffalo skulls have dimensions approximately 1 foot by 2 feet by 1 foot, estimate the total number of skulls in the pile.

From McHugh (1972) we find another estimate of the magnitude of the slaughter based on records of trainloads of buffalo bones transported eastward. To approximate the number of buffalo represented by these shipments, McHugh estimates the weight of an average skeleton (58 pounds) and divides this figure into the total weight of bones shipped over a given period. From 1872 to 1874 the Santa Fe Railroad carried 10,793,350 pounds of buffalo bones. If the Union Pacific and Kansas Pacific Railroads handled the same amount in that three-year period, how many buffalo does that represent? (Answer: 560,000) Shipping data from Texas reveals that the typical boxcar held 29,400 pounds of bones. How many buffalo were held in the typical boxcar? (510) If a typical boxcar was 1850 cubic feet in volume, what is the volume of a single buffalo skeleton? (3.6 cubic feet) A description of one stack of bones by a section of the Santa Fe railroad track in Colorado was “piled twelve feet high, nearly that wide at the base, one half mile long. (McHugh, 1972, p 280)” Assuming the cross-sectional shape is rectangular, estimate the number of buffalo skeletons in the pile. (The volume is 380,000 cubic feet or some 100,000 buffalo skeletons.)

### **References for Putting Numbers in Perspective**

- Fusaro, B.A. and P. Kenschaft (eds.). *Environmental Mathematics in the Classroom*, Washington DC: Mathematical Association of America, 2003, 72-3.
- Garretson, M.S. *The American Bison*. New York: New York Zoological Society, 1983.
- Geist, V. *Buffalo Nation: History and Legend of the North American Bison*. Stillwater, MN: Voyageur Press, Inc., 1996.
- Hodgson, B. “Buffalo: Back home on the range,” *National Geographic*, 1994 (5) 64-89.
- McHugh, T. “On the way to extinction,” *The Time of the Buffalo*. (Chapter 22) New York: Alfred Knopf, 1972.

## Sampling Methods (Use with Section 5A of Bennett and Briggs)

### Introductory Notes for Instructors

Those students whose project involves a survey especially need to be made aware of the importance of sampling methods before they begin conducting their surveys. Before discussing sampling methods, we introduce the concept of a representative sample. Then, we introduce sampling methods by discussing a potential campus survey and possible means of sampling for such a survey. As we proceed, we stop to make formal definitions of sampling methods and to make a list of the advantages and disadvantages for each method. The worksheet below is used as a guide for this discussion and student note-taking. In it, the five sampling methods (convenience sampling, quota sampling, systematic sampling, simple random sampling, and stratified random sampling) are defined and we ensure that in the discussion, the following points are made regarding the advantages and disadvantages of each method.

#### Convenience sampling

Advantages: This method is *convenient*.

Disadvantages: There is great potential for bias since the sample is likely to not be representative of the population.

#### Quota sampling

Advantages: This method is often better than convenience sampling since it ensures certain subcategories of the population are represented in the sample.

Disadvantages: There are possibly other important categories of the population that are important, yet not accounted for. It can be difficult/impossible to know before sampling all of the important factors, and hence categories, that should be included. Also, if the quotas for each category do not reflect the appropriate proportion of the population, results can be biased.

#### Systematic sampling

Advantages: This method can be fast and easy if there is some kind of a “directory” of the population available. e.g. a phone book, or a computer database of patient records.

Disadvantages: We can't be sure there won't be some unforeseen bias. E.g., every tenth patient record just happens to be that of a female...

#### Simple random sampling

Advantages: This method is very good at picking a representative sample (provided the sample size is large enough).

Disadvantages: This method can be difficult/time consuming/impossible to carry out.

#### Stratified random sampling

Advantages: This method can be good at picking a representative sample, provided that appropriate proportions are used for each category.

Disadvantages: Improper proportions used for each category will bias results. It can be difficult/time consuming to carry out.



- 
6. Would it be better to obtain a list of all LMU students and then pick every 20<sup>th</sup> students on the list to respond to the survey? Why or why not?

This is an example of systematic sampling: Systematic Sampling – sample picked in a systematic way.

7. The advantages and disadvantages of systematic sampling are:

- 
8. Would it be good to obtain a list of all LMU students and then “randomly” pick students from the list to respond to the survey? Why or why not?

This is an example of simple random sampling: Simple Random Sampling – sample picked in a way to ensure every member of the population has equal chance to be chosen.

9. The advantages and disadvantages of simple random sampling are:

- 
10. Would it be good to divide LMU students into 4 categories:

female commuters    male commuters    males living in the dorm    females living in dorm

then take a simple random sample from each of these 4 groups? Why or why not?

This is an example of stratified random sampling: Stratified Random Sampling – sample picked by first identifying nonoverlapping subgroups within a population, then drawing a simple random sample from each subgroup.

11. The advantages and disadvantages of stratified random sampling are:

## The Central Limit Theorem

Suppose that we want to estimate the proportion of some population having a certain characteristic. For example, we may ask what proportion of all LMU students knows the location of the LMU Student Health Center. One way to find this proportion is by polling all LMU students. However, often such an exhaustive survey is not practical or is very expensive to conduct. An alternative to polling everyone is to use sampling techniques. We take a random sample from the population and use the sample results to make inferences about the population proportion. Then a natural question to ask is: how close is our approximation to the true proportion? A mathematical theorem called the *Central Limit Theorem (CLT)* can be used to answer this question. Finding the margin of error discussed in the text is a direct application of the CLT.

Suppose we take many samples of the same size from a single population and find the proportion for each sample taken. The distribution of these proportions is called the *sampling distribution*. In the case of the proportion, the *Central Limit Theorem* states that for a large sample size, the sampling distribution (of the proportions from many samples of the same size) is approximately normal. Moreover, the theorem also says that the mean of the sampling distribution is the true proportion for the entire population. For a sequence of interactive tutorials on sampling distributions and the CLT visit <http://wise.cgu.edu/>.

### Confidence Intervals for a Population Proportion When the Sample Size is Large ( $n \geq 30$ )

In the above example of estimating the proportion of all LMU students who know the location of the LMU Student Health Center, we want to find an interval in which the true proportion lies and we want to be reasonably confident about our answer. To find this estimate, we select a sample of size  $n$  ( $n \geq 30$ ) from the population and compute the sample proportion  $\hat{p}$ . We are interested in finding an interval around  $\hat{p}$  such that there is a large probability that the actual proportion  $p$  falls inside of this interval. This interval is called a **confidence interval** and the large probability is called the **confidence level**. Thus the confidence level is a measure of the reliability of the confidence interval we find.

Then (using the *CLT*) a 90% confidence interval for  $p$  is given by:

$$\hat{p} \pm \left( 1.645 \sqrt{\frac{\hat{p}(1-\hat{p})}{n}} \right),$$

where  $\hat{p}$  is the proportion of the sample, and  $n$  is the sample size.

A 95% confidence interval for  $p$  is given by

$$\hat{p} \pm \left( 1.96 \sqrt{\frac{\hat{p}(1-\hat{p})}{n}} \right),$$

where  $\hat{p}$  is the proportion of the sample and  $n$  is the sample size. The quantities  $\left( 1.645 \sqrt{\frac{\hat{p}(1-\hat{p})}{n}} \right)$  and  $\left( 1.96 \sqrt{\frac{\hat{p}(1-\hat{p})}{n}} \right)$  are the **margins of error** for the 90% and 95% confidence intervals respectively.

Note: When  $\hat{p}$  is close to 0.5, the 95% confidence interval formula is well approximated by  $\hat{p} \pm \sqrt{\frac{1}{n}}$ , because in this case

$$\left( 1.96 \sqrt{\frac{\hat{p}(1-\hat{p})}{n}} \right) = \left( 1.96 \sqrt{\frac{0.5(1-0.5)}{n}} \right) \approx 0.98 \sqrt{\frac{1}{n}} \approx \sqrt{\frac{1}{n}}.$$

Notice that  $\sqrt{\frac{1}{n}}$  is the approximation for the margin of error given in our textbook.

You may wonder where the 1.645 and 1.96 numbers come from. These are the standard normal values or z-values,  $z$ , for which 90% and 95% of the area under the standard normal curve falls between  $-z$  and  $z$ . There is a connection between these numbers and the numbers shown in Table 6.3 of your textbook that we used to convert z-scores to percentiles. Recall that the  $n$ th percentile corresponds to the z-score  $z$  for which  $n\%$  of the area under the standard normal curve is to the left of  $z$ . If we remember that  $(100-n)\%$  of the area falls to the right of the z-score and the standard normal curve is symmetric, we see that  $n\% - (100-n)\%$  of the area under the standard normal curve falls between  $-z$  and  $z$ . For the  $n = 95^{\text{th}}$  percentile this means that  $95\% - (100-95)\% = 90\%$  of the area under the standard normal curve falls between  $-z$  and  $z$  for the z-score corresponding to the  $95^{\text{th}}$  percentile. Checking table 6.3 in your textbook shows that the z-score corresponding to the  $95^{\text{th}}$  percentile, and therefore corresponding also to the z-score for which 90% of the area under the standard normal curve falls between  $-z$  and  $z$ , is (approximately) 1.645. A similar analysis leads (approximately) to the value 1.96 corresponding to the  $97.5^{\text{th}}$  percentile, corresponding to the z-score for which 95% of the area under the standard normal curve falls between  $-z$  and  $z$ , and hence to a 95% confidence interval.

**Example:** Estimate the proportion of all LMU students who know the location of the LMU Student Health Center. More specifically, find 90% and 95% confidence intervals for this proportion.

Solution: Let  $p$  denote the proportion of all LMU students who know the location of the LMU Student Health Center. Next, suppose, we select a random sample of size  $n = 50$  students. Out of these 50 students, suppose that 29 students know where the Student Health Center is.

Thus the sample proportion  $\hat{p} = \frac{29}{50} = .58$

$$\begin{aligned} \text{Then a 90\% confidence interval for } p \text{ is: } & \hat{p} \pm \left( 1.645 \sqrt{\frac{\hat{p}(1-\hat{p})}{n}} \right) \\ & = 0.58 \pm \left( 1.645 \sqrt{\frac{.58(1-.58)}{50}} \right) \\ & \approx 0.58 \pm .11 \end{aligned}$$

So the 90% confidence interval can be written as (.47, .69) and the margin of error is .11.

That is, we are 90% confident that between 47% and 69% percent of LMU students know where the Student Health Center is located.

A similar computation for a 95% confidence interval for  $p$  using the formula  $\hat{p} \pm \left( 1.96 \sqrt{\frac{\hat{p}(1-\hat{p})}{n}} \right)$

gives the margin of error  $E = 0.137$  and the confidence interval (.443, .717). In this case, is it

reasonable to use the approximate formula  $\hat{p} \pm \sqrt{\frac{1}{n}}$  to find the 95% confidence interval? Since  $\hat{p} = .58$  which is fairly close to .5, we may use the approximate formula. Here the approximate margin of

error  $E = \sqrt{\frac{1}{n}} = \sqrt{\frac{1}{50}} = .141$  and the confidence interval is (.439, .721). We see that this formula gives a reasonably good approximation.

### Confidence Intervals for a Population Mean When the Sample Size is Large ( $n \geq 30$ )

Suppose that we want to estimate the unknown population mean  $\mu$  of a certain measurement. For example, we may ask what is the mean number of dollars LMU students spent on textbooks in preparing for the fall semester. If it is not practical to poll all LMU students, we will take a random sample and use the sample results to make an inference about the true mean number of dollars spent. We begin by selecting a random sample of size  $n$  ( $n \geq 30$ ) from the population and compute the sample mean  $\bar{x}$  and sample standard deviation  $s$ . We are interested in finding an interval around  $\bar{x}$  such that there is a large probability that the actual mean  $\mu$  falls inside of this interval. This interval is called a **confidence interval** and the large probability is called the **confidence level**. Thus the confidence level is a measure of the reliability of the confidence interval we find. The 90% confidence interval for  $\mu$  is given by:

$$\bar{x} \pm \frac{1.645\sigma}{\sqrt{n}}$$

and the 95% confidence interval is given by:

$$\bar{x} \pm \frac{1.96\sigma}{\sqrt{n}}$$

where:  $\bar{x}$  is the sample mean

$\sigma$  is the standard deviation of the *population*

$n$  is the sample size ( $n \geq 30$ ).

However, in many situations, the standard deviation of the population,  $\sigma$ , is not known in which case we may replace  $\sigma$  by the standard deviation of the sample,  $s$ . Thus the 90% and 95% confidence intervals become:

$$\bar{x} \pm \frac{1.645s}{\sqrt{n}} \text{ and } \bar{x} \pm \frac{1.96s}{\sqrt{n}} \text{ respectively.}$$

where:  $\bar{x}$  is the sample mean

$s$  is the standard deviation of the *sample*

$n$  is the sample size ( $n \geq 30$ ).

**Example:** Estimate the mean number of dollars LMU students spent on textbooks in preparing for the fall semester. More specifically, find a 90% and a 95% confidence interval for this mean.

**Solution:** Let  $\mu$  denote the mean number of dollars LMU students spent on textbooks in preparing for the fall semester. Next, suppose we select a random sample of size  $n = 75$  students. After finding how much each of these 75 LMU students spent on textbooks in preparing for the fall semester, suppose we

calculated the mean of this sample of 75 students to be \$942 and the standard deviation of this sample to be  $s = \$98$ . Then a 90% confidence interval for  $\mu$  is:

$$\bar{x} \pm \frac{1.645s}{\sqrt{n}} = 942 \pm \frac{1.645 \cdot 98}{\sqrt{75}} \approx \$942 \pm 19$$

So, the 90% confidence interval for the mean number of dollars LMU students spent on textbooks in preparing for the fall semester is (\$923, \$961). That is, we are 90% confident that the mean number of dollars LMU students spent on textbooks in preparing for the fall semester is between \$923 and \$961.

A similar computation for a 95% confidence interval gives a confidence interval of (\$920, \$964). In this case, we could say we are 95% confident that the mean number of dollars LMU students spent on textbooks in preparing for the fall semester is between \$920 and \$964.

## Computer Spreadsheet Lab: Making Charts and Graphs

**Introduction.** At times, a graphical representation of data is more preferable than a page full of numbers even if the data is formatted attractively. The old saying “a picture is worth a thousand words” has particular relevance to organizing data. A bar graph, histogram, pie chart, or other graphical display often provides the clearest and most efficient summary of data. Excel makes it easy to create and modify charts and graphs based on data in an Excel worksheet. In today’s lab, you will use Excel to construct various graphs and charts of data.

### Part I Social Issues (City of Los Angeles race issues and the LAPD)

Race has often played a role in police abuse cases in Los Angeles, with minority residents believing that officers are overly aggressive and abusive in minority communities. According to the Christopher Commission: “The problem of excessive force is aggravated by racism and bias” within the LAPD. African-Americans and Latinos have long complained that when they are stopped for even minor traffic infractions, they are forced to lie face down, flat on the ground with their arms outstretched (Source: A report by the Human Rights Watch, <http://www.hrw.org/reports98/police/uspo735.htm>). As a community activist, you would like to find out for yourself if there is any truth in these allegations using the mathematics you have learned in this class.

Open the “Graphing\_Data.xls” file and select the “population” worksheet and complete the following.

- Pie Chart or Circle Graph:** To get a basic idea of race distribution of the population of Los Angeles, create a pie chart of the population by:
  - Make sure any selected cell in the worksheet is not a cell containing data or adjacent to a cell containing data. Pull down the Insert Menu and select **Chart**.
  - Under ‘Chart Type’, select **Pie** and the first sub-type. Click **Next**.
  - Click in the ‘Data Range’ box, then go to the worksheet and select all of the data contained in A6 through F6. Then click on the Series tab, click inside the ‘Category Labels:’ box and then go to the worksheet and select A5 through F5. Then click the ‘Name:’ box and type “Population of the City of Los Angeles (2000).” Click **Next**.
  - At this point, the dialog box that appears should be “Chart Wizard – Step 3 of 4 – Chart options.” Select the “Legend” tab and deselect ‘Show legend’ to ensure that no legend will appear on your chart. Select the “Data Labels” tab and click the “Show label and percent” button. Click **Next**.
  - The last dialog box asks if you want to embed the chart (as an object) in the current worksheet or if you want to create a new worksheet for the chart. Select the ‘object in:’ button and click **Finish**. The chart will now appear on your screen.
  - Repeat (a) – (e) with appropriate modifications to draw the pie chart for “Number of Traffic Stops Made ...” and for the “Number of Citations Issued ...”
- Pie Chart or Circle Graph (continued):** Next resize and move the three pie charts you obtained in part 1 so that you can view all three at the same time without obstructing the question boxes below them on the screen and answer the following questions. (Move the chart by clicking anywhere inside the chart and dragging it to the new location. Enlarge the chart by clicking and dragging one or more of the small black squares that border the chart.) Answer the following questions by typing your answers into the box below each question in the Excel worksheet.

- a) Do the data sets and their pie charts appear to support the allegation by minority groups about mistreatment by the LAPD? Explain.
  - b) Did you find the pie charts useful in answering the previous question? Why or why not?
  - c) Describe an issue of interest to you that might be investigated with pie charts.
3. **Bar Graph:** Select the “age distribution” worksheet and complete the following. To get a basic idea of age distribution of the population of Los Angeles, create a bar chart of the population by:
- a) Make sure any selected cell in the worksheet is not a cell containing data or adjacent to a cell containing data. Pull down the Insert Menu and select **Chart**.
  - b) Under ‘Chart Type:’, select **Column** and the first sub-type. Click **Next**.
  - c) Click in the ‘Data Range:’ box, then go to the worksheet and select all of the data contained in B4 through B16. Then click on the Series tab, click inside the “Category (X) axis labels:” box and then go to the worksheet and select A4 through A16. Then click the ‘Name:’ box and type “Age Distribution of the City of Los Angeles (2000).” Click **Next**.
  - d) At this point, the dialog box that appears should be ‘Chart Wizard – Step 3 of 4 – Chart Options.’ Select the “Legend” tab and deselect ‘Show legend’ to ensure that no legend will appear on your chart. Click **Next**.
  - e) The last dialog box asks if you want to embed the chart as an object in the current worksheet or if you want to create a new worksheet for the chart. Select the ‘object in:’ button and click Finish. The chart will now appear on your screen.
  - f) Repeat (a) – (e) with appropriate modifications to draw the bar graph using Excel’s column type for the percent of the people in each category.
4. **Bar Graph (continued):** Next resize and move the two graphs you obtained so that you can view both at the same time without obstructing the question boxes below them on the screen and answer the following questions. (Move the chart by clicking anywhere inside the chart and dragging it to the new location. Enlarge the chart by clicking and dragging one or more of the small black squares that border the chart.) Answer the following questions by typing your answers into the box below each question in the Excel worksheet.
- a) What age group corresponds to the tallest bar?
  - b) This bar is about twice as high as the preceding bar. What might be the reason for this? Hint: compare the age ranges.

## **Part II Environmental Issues (Ballona Wetland)**

Suppose that living here in Westchester, you have taken a civic interest in both the Playa Vista development taking place adjacent to campus and in the efforts to preserve the Ballona wetlands, just north and west of LMU campus. Assume that you have joined an organization whose goal is to restore the Ballona wetlands and have worked a few days in their volunteer program to begin restoring the wetlands. You know that the State of California has purchased the wetlands so that the land and water comprising this irreplaceable habitat will not be threatened by development. However, the wetlands are in a state of deterioration because of past development, non-native plant invasions, non-native predators, and pollution.

In order to gain further information on the “health” of the wetlands, LMU Biology professor John Dorsey and his team have placed sensors at a strategic spot in the wetlands. These sensors have collected temperature, turbidity (cloudiness), dissolved oxygen, water depth, and pH data over time. You are part of the group of people who begin to analyze this data.

Select the “BallonaData” worksheet and complete the following.

5. **Line Graph:** First, to get a basic idea of the tidal flow, create a “Water Depth Over a 24 Hour Period” line chart by:
  - a) Make sure any selected cell in the worksheet is not a cell containing data or adjacent to a cell containing data. Pull down the Insert Menu and select **Chart**.
  - b) Under chart type, select **Line** and the first sub-type. Click **Next**.
  - c) Click in the ‘Data Range:’ box, then go to the worksheet and select all of the data contained in column F (the column with depth data). Then click on the Series tab, click inside the ‘Category (X) axis labels:’ box and then go to the worksheet and select all of the data contained in column B (the column with the time data). Click **Next**.
  - d) At this point, the dialog box that appears should be “Chart Wizard – Step 3 of 4 – Chart options.” Select the Titles tab and enter the chart title “Water Depth Over a 24 Hour Period” in the chart title box and appropriate labels for the X and Y axes in the appropriate boxes. Select the Legend tab and deselect ‘Show legend:’ to ensure that no legend will appear on your chart. Click **Next**.
  - e) The last dialog box asks if you want to embed the chart (as an object) in the current worksheet or if you want to create a new worksheet for the chart. Select the ‘object in:’ button and click Finish. The chart will now appear on your screen.
6. **Line Graph** (continued): Now enlarge, modify and enhance the chart by:
  - a) Move the chart to the top of the worksheet page and enlarge the chart.
  - b) Double click somewhere in the middle of the chart area (not on the line graph, but near the middle of the plot). This will bring up a dialog box that allows you to change the color of the background (area box). Change the background color to white.
  - c) Click on any part of the titles you entered if you need to edit them. Place the cursor in the appropriate place and make the changes needed. (For a title that appears vertically, you will need to double click before editing.) Click anywhere outside of the chart when you are finished.
7. **Line Graph** (continued): Answer the following questions about this line graph. Type your answers into the box below each question in the Excel worksheet.
  - a) At approximately what time is the water at its deepest point? (Pointing the mouse to the highest point on the graph will help you.)
  - b) At approximately what time is the water shallowest?
  - c) Reflective question: What do you think is the reason for this difference in the water level?
8. **Scatter Plot:** The pH level of water is important to living organisms, especially aquatic life and rapid pH changes can be detrimental to these organisms.

The dissolved oxygen content of water is also very important to aquatic life. Water becomes oxygenated by contact with the atmosphere, by moving water and by photosynthesis of plants

(grown in water). Higher levels of dissolved oxygen support a variety of plants and animals. Lower levels of dissolved oxygen can be caused by an increase in water temperature, reduced stream flow and/or an increase in bacteria from sewage or excess nutrients that consume oxygen.

These factors lead you to wonder if there is any correlation between dissolved oxygen content and pH in the water of the wetlands. So, you decide to use Excel to create a scatter plot of the dissolved oxygen concentration vs. pH data. Select the “BallonaData2” worksheet and complete the following.

- a) Make sure any selected cell in the worksheet is not a cell containing data or adjacent to a cell containing data. Pull down the Insert Menu and select **Chart**.
  - b) Under ‘Chart Type:’ select **XY (Scatter)** and the first sub-type. Click **Next**.
  - c) Click the Data Range tab. Click in the ‘Data Range:’ box, and delete anything that might already be in the box. Click the Series Tab, then the Add button. Click in the ‘X Values:’ box, delete anything that might already be in the box, then go to the worksheet and select all of the data contained in G3 through G98 (the pH column). Next click in the ‘Y Values:’ box, delete anything that might already be in the box, and then go to the worksheet and select all of the data contained in E3 through E98 (the DO column). Click **Next**. At this point, the dialog box that appears should be “Chart Wizard – Step 3 of 4 – Chart options.” Select the Titles Tab, enter an appropriate chart title, and appropriate labels for the X and Y axes. Select the Legend Tab and deselect ‘Show legend’ to ensure that no legend will appear on your chart. Click **Next**. Click Finish in the window that appears next.
9. **Scatter Plot** (continued): Answer the following questions about this scatter plot by typing your answers into the box below each question in the Excel worksheet.
- a) Does it appear that in general, lower levels of pH tend to correspond to lower levels of dissolved oxygen? Explain.
  - b) How strong/weak is this tendency? Explain.
  - c) Describe the location of any outliers you see.

### Sample Data Table for Use in Spreadsheet Lab

<b>Population of the City of Los Angeles (2000)</b>						
(Source: <a href="http://losangeles.areaconnect.com/statistics.htm">http://losangeles.areaconnect.com/statistics.htm</a> )						
( <a href="http://www.losangelesalmanac.com/topics/Population/po241a.htm">http://www.losangelesalmanac.com/topics/Population/po241a.htm</a> )						
White	Black	Hispanic	Asian	Native	Other	Total
1,099,188	415,195	1,719,073	369,254	29,412	62,698	3,694,820
<b>Number of Traffic Stops Made by the Los Angeles City Police during 07/01/2003 - 12/31/2003</b>						
(Source: Los Angeles Police Department, Field Data Statistics)						
White	Black	Hispanic	Asian	Native	Other	Total
83,502	47,389	95,134	19,866	361	5,587	251,839
<b>Number of Citations Issued by the Police After a Traffic Stop</b>						
White	Black	Hispanic	Asian	Native	Other	Total
8,751	36,455	11,689	18,280	322	5,088	80,585

## Chapter 6 Evaluation and Reflections

### Evaluation

In this chapter we give a summary of the various evaluations we have undertaken to measure the success of the projects-based course (1) against our original course goals, and (2) in comparison to the standard quantitative literacy course on our campus. These include the SALG, focus groups, survey comparisons, pre/post tests results, and pre/post knowledge survey results. We end the chapter with some final reflections on the projects-based course.

#### SALG

As a means of obtaining student evaluation on various aspects of the course in general, we made use of the on-line Student Assessment of Learning Gains (SALG) tool (<http://www.wcer.wisc.edu/salgains/instructor/>) that was developed by the SENCER project grant (<http://www.sencer.net/>). This free site is offered as a service to the college-level teaching community. This instrument is a powerful tool, can be easily individualized, provides instant statistical analysis of the results, and facilitates formative evaluation. At the site, any instructor in any discipline who would like feedback from their students about how various course elements are helping their students to learn can begin with a general template survey form and modify it to meet their own needs. However, all projects supported by SENCER, were directed to use a special SENCER SALG survey template. At the time we began work on our project, there was a single version of the SENCER SALG template. We found a number of the questions to be too oriented to science courses to be useful with a math class. We created more math-oriented versions of these questions and have used the math-oriented version of the SENCER SALG.

Students were given, at the beginning of the semester, an assignment to complete the pre-course SALG survey and, at the end of the semester, an assignment to complete the post-course survey. While the SALG was easy to administer, and most students completed the assignments, we discovered some problems with the instrument. When students log on to complete the survey, the default setting in the system is the “pre-test.” We discovered that a number of students accidentally completed the pre-course survey when they should have been completing the post-course survey. This resulted in the pre-course survey results being somewhat biased and the post-course survey results being incomplete.

Both students in the standard and the projects-based course completed the SALG survey. In comparing results between the two groups of students, we see only small differences. Perhaps this is largely due to the similarity in course content and the fact that the standard course was already fairly successful in meeting its basic goal of developing quantitative literacy. In addition, it was not possible to include a specific question about how “the projects” influenced student learning as the same SALG instrument was used with students in the standard course where projects were not assigned. Therefore we used other forms of assessment in addition to the SALG, and we describe below where the other assessment tools did show greater differences between the two groups of students.

#### Three Focus Groups

Prior to developing the projects-based approach we held a small focus group in Fall 2004 with students in the standard course to find out what they thought of the concept. From this we learned that they were most concerned about collaboration issues (would they end up doing all the work?) and the additional time and work-load demands of adding a project to the existing coursework.

In Fall 2005 we conducted a focus group with 19 volunteers (out of a total enrollment of 97) from the 4 sections of the projects-based quantitative literacy course. The students generally agreed that mathematics was NOT a favorite subject. They observed that the projects approach afforded them an opportunity to demonstrate their skills and abilities beyond what “cramming for a final exam would.” This group of students replied quite positively when asked if the projects approach should be retained (15 yes, 3 no, 1 not sure).

In Spring 2006 we conducted a focus group during class-time that was attended by 10 (out of an total enrollment of 11) students. This group of students enlightened us about their discomfort with the open-ended nature of the projects and the lack of direction about exactly which mathematical methods to apply at each stage.

### Course Survey Comparisons

During 2005-6 we surveyed 62 students in several sections of the standard course and 29 of the students in the projects-based course. They gave strikingly similar responses about the usefulness of mathematics, which demonstrates that the standard version of the course was already doing a good job of reaching one of its goals. However, students in the projects-based course had much greater awareness of community issues after the course as shown in the graph below.

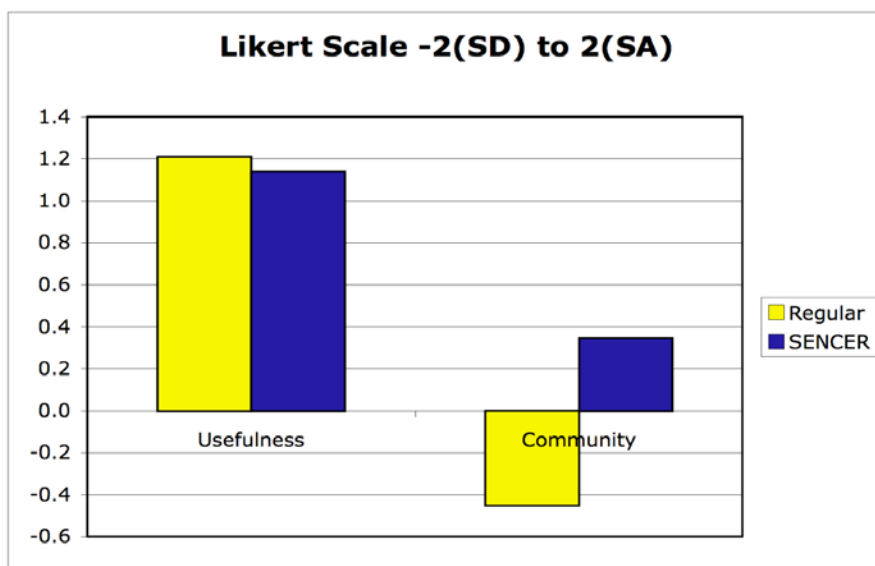


Figure 1

For students in the projects-based class we also asked some questions that related directly to the projects. We found that 79% agreed that their projects enabled them to connect their classroom learning (elementary statistics, mathematics of finance, computer spreadsheets) to the real world and 79% also said it helped them practice and learn mathematical or analytical skills. In addition, 59% reported that the project experience taught them non-mathematical skills (e.g., working with people, time management, writing/distributing a survey).

### Pre and Post Tests Results

All students in the projects-based course took a 9 problem multiple-choice pre and post-test. The problem topics were: percentages, putting numbers in perspective, savings plans, credit cards, loans, representative samples, the normal distribution, margin of error, and spreadsheets. The pre and post-test

did not have identical problems, but problem types were matched, so that pre and post-test comparisons could be made for each problem type. A sample pre-test can be found in Appendix B. The following bar chart summarizes the results by question type.

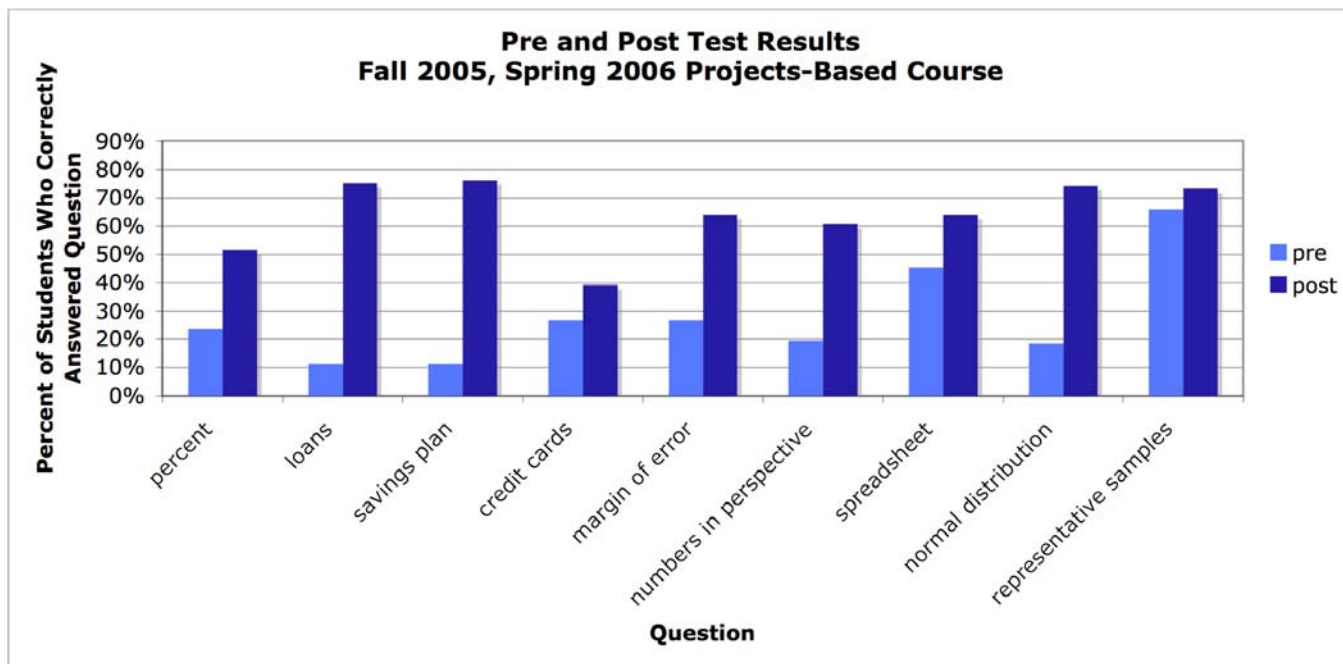


Figure 2

Every question type shows a gain in the percentage of students who were able to answer correctly, although the areas of credit cards, spreadsheets, and representative samples did not show as large a gain as in the other types of questions. Note, however, for the questions on spreadsheets and representative samples, students did fairly well on the pre-test and so we would not expect to see a very large gain. The disappointing post-test performance on the credit card question may be due to the fact that the topic is covered by a handout that supplements the text and therefore the students may not consider it important.

Students in the standard course also took pre and post-tests. For these students, the pre and post-test was a 12 problem multiple-choice test. Nine of the twelve problem types correspond to problem types that appeared on the projects-based pre and post-test. (In fact, the problems came from the same problem bank.) The mean percent correct on both the pre and post-test are very similar for the standard vs. projects-based courses, as the chart below indicates.

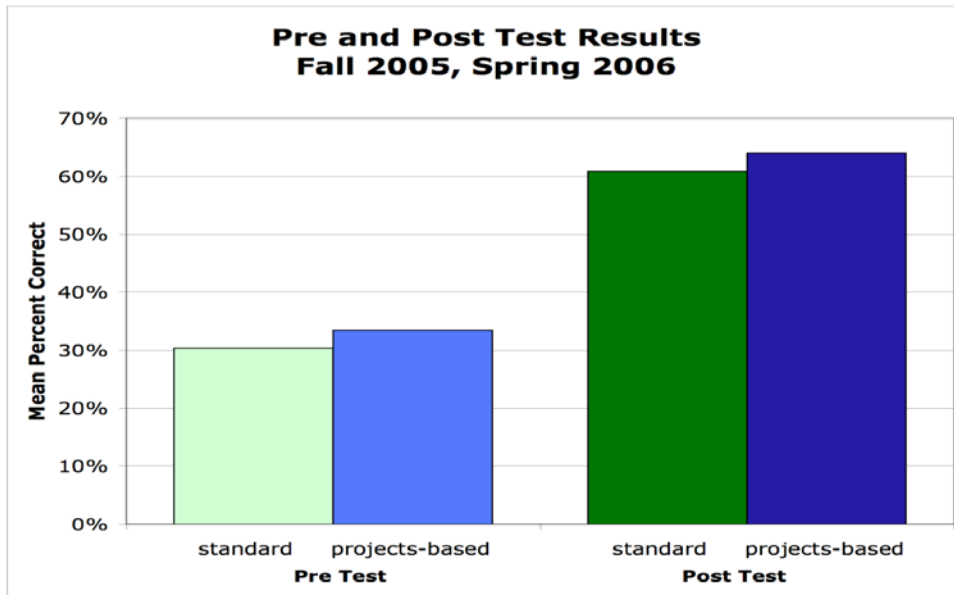


Figure 3

The next chart shows a comparison between the results from the standard and projects-based course in these nine problem areas. The greatest difference between the post-test results is that the percentage of students from the projects-based course who were able to answer correctly a question relating to interpreting the margin of error exceeded the percentage of students from the standard course by approximately 20 percentage points. We speculate that the survey-based projects encouraged students to think more carefully about interpreting a margin of error.

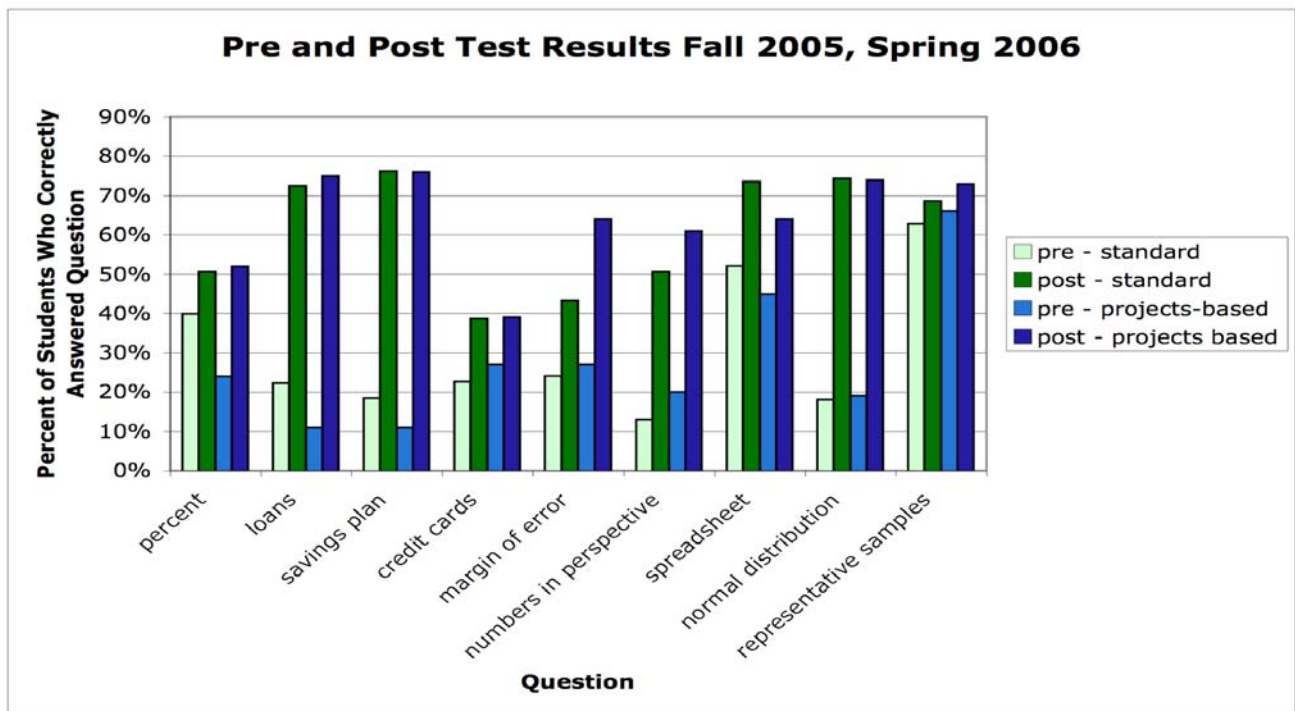


Figure 4

## Pre and Post Knowledge Survey Results

A knowledge survey contains content questions that test mastery of particular course learning objectives. The questions are presented in the same order as the material is presented during the semester. Students take knowledge surveys at the beginning and the end of the semester. They respond to the questions, not by providing answers, but by indicating on a three-point scale how confident they are that they could correctly answer the question. Knowledge surveys can address both basic skills and complex open-ended questions. Time limitations would prevent students from directly answering all the questions on a thorough knowledge survey, but they can rate their confidence to provide answers in a fairly short time period. Tests can only address a limited portion of a course, while knowledge surveys can cover one in depth. Class averages on knowledge surveys have been shown to be good representations of the class's knowledge and abilities.<sup>14</sup> The knowledge survey we constructed for our projects-based course in Spring 2006 can be found in Appendix C. The bar chart below summarizes the results.

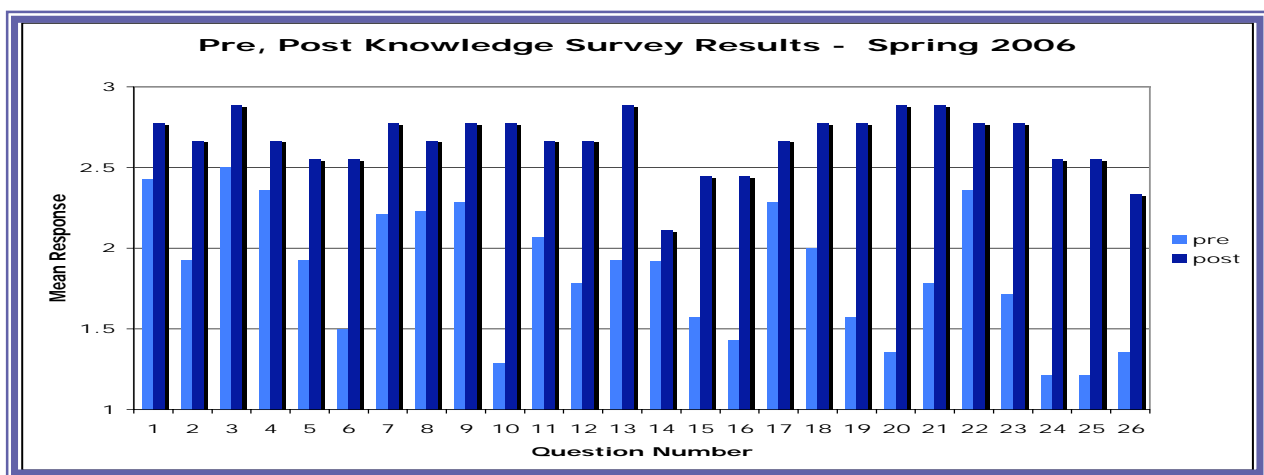


Figure 5

Questions 1–9 on the knowledge survey are questions relating to number sense (percents, significant digits, putting numbers in perspective), and many of these topics are topics students have seen in the past, so it is not surprising that the pre-knowledge survey ratings are fairly high. Question 3 concerns the four steps of the problem solving process, a topic that was given only a 10 minute review at the outset of the course, so it is not surprising that the post-knowledge survey does not show improvement on that question 3. Question 10 related to Simpson's paradox, a topic that was not actually covered in the course, so we should not expect the post-knowledge survey to show improvement on that item. Questions 12–18 relate to financial matters (savings plans, loans, taxes, investments) and the results show good improvement in the students' confidence in their ability to solve these problems. Questions 19–26 relate to statistics, and again show good improvement in the students' confidence in their ability to solve these problems.

## Conclusions about Student Learning

The pre- and post-tests and knowledge surveys give evidence of students' improved quantitative skills. On the course surveys nearly 80% of students in the projects-based sections agree that the projects approach helped them to connect their classroom learning to the real world and gave them an opportunity to practice and learn mathematical or analytical skills. But the "best college teachers" hold,

<sup>14</sup> Knufer, Edward, and Delores Knipp. "The Knowledge Survey: A Tool for All Reasons." *To Improve the Academy*, 2003 v21, 59-78.

and we agree, that meaningful learning involves not only content mastery but also changes in attitude and beliefs.<sup>15</sup> A typical student taking the quantitative literacy course to meet her general education requirement in mathematics often does not like mathematics very much. This underlying dislike of mathematics can still come through at the end of the course; for example, a student agreed with the statement *The project helped me connect my classroom learning to the real world* and then went on to write: *More so than any other boring math class*. However, the course surveys also indicate that after the course students are more aware of the usefulness of mathematics and of local community issues. What may be the most significant impact is the hardest to assess – namely, the potential benefits gained from the project experience of tackling an open-ended question as a member of a team. We do know that nearly 60% of those surveyed reported that the project experience taught them non-mathematical skills.

### **Did We Meet Our Project Goals?**

The specific goals stated in our original SENCER proposal were to:

- (1) develop an alternate version of our current math core class (MATH 102 Quantitative Skills for the Modern World) that would be accessible to students with only a high school math background and in which students learn and apply mathematics to address problems in the greater Los Angeles area (and hence became ‘civically engaged’);
- (2) have each of the three mathematics faculty on the team teach at least one section of the course during the academic year 2005-6;
- (3) recruit other faculty to teach this SENCERIZED version of the course.

Goal (1) has been met subject to the very local campus and community nature of our projects rather than drawing on the greater Los Angeles area for project topics. We discuss some of the reasons for limiting the scope of the project topics to the very local community in the section below titled “Selecting Project Topics” (page 88). We exceeded Goal (2) because the three mathematics faculty on the team taught a total of 5 sections of the revised course during 2005-6. Our success at Goal (3) remains to be seen. It is the case that 15 faculty attended the Mathematics Department seminar talk we gave on April 10, 2006 and that 9 faculty (6 full-time tenure track, 2 part-time and 1 full-time non-tenure track) attended the two-hour dissemination workshop we presented on May 10, 2006. The latter was intended to familiarize potential instructors of the course with the projects-based approach and materials we have developed. Of the 9 faculty present, 100% “Agreed” or “Strongly Agreed” with all three of the following statements:

*As a result of attending this workshop I have a better idea about:*

*The rationale for teaching MATH 102 with projects*

*The materials that are available to teach MATH 102 with projects*

*How to teach MATH 102 with projects.*

When asked if they would willingly volunteer to teach the projects-based version of the quantitative literacy course 56% said “yes” and 44% said they were “not sure.” Every person who responded “not sure” went on to comment that it was the extra time commitment that made him or her hesitate. Those who responded positively commented; “It would be fun.” “It sounds cool.” “Great way to engage students with material – gives students a valuable experience.” “Seems rewarding, but wouldn’t do it with other new preparations.”

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<sup>15</sup> Bain, Ken. *What the best college teachers do*. Cambridge, MA: Harvard University Press, 2004, 16-17.

One of the original developers will be teaching the projects-based course in Fall 2006. We plan to provide access to the final version of the materials we have developed to all faculty with experience teaching this course and invite them to adopt the projects approach.

### **Did the Students Achieve the Intended Learning Outcomes?**

In the Introduction on page 7 we listed the following three desired learning outcomes:

**Awareness/attitude, Performance, Engagement:**

- A.** Students will be aware of the usefulness of math in addressing real world problems, and will have greater confidence toward using mathematics
- P.** Students will be able to describe, analyze, and make recommendations about community or environmental problems arising in the LA area using appropriate mathematical tools
- E.** Students will be engaged in a community issue during the course and more likely to be engaged in civic issues in the future.

In our survey of 29 projects-based quantitative literacy students, 97% responded that they agree or strongly agree that mathematics is useful and the knowledge survey (Figure 5 on page 85) results indicate that students leave the course with greater confidence in their ability to respond to mathematical questions or situations based on course material (Outcome A). All but one of our 110 students contributed to a project that used mathematical tools to describe, analyze and make recommendations regarding a campus or community issue (Outcomes P and E). The projects-based quantitative literacy students we surveyed left the course with greater awareness of campus or community issues (Outcome E), especially as compared to the regular quantitative literacy students (Figure 1) on page 82. By no means do we expect that this one experience has made these students into expert policy analysts nor will it insure that they become active citizens after graduation. However, studies cited in Derek Bok's *Our Underachieving Colleges*<sup>16</sup> (189) indicate that courses that encourage civic engagement increase student interest in and commitment to involvement in civic affairs. In addition, the projects, while structured, allowed for multiple approaches and numerous conclusions, and created a learning environment where the students were expected to apply the course information and concepts to a variety of new situations, which is yet another practice recommended by Bok (117).

We now examine the content goals the projects-based quantitative literacy course shared with the regular quantitative literacy course:

- Prepare students for other core science classes (topics that do this are percentages, scientific notation, significant digits, basic statistics)
- Produce students with quantitative and analytical skills useful in day-to-day living (topics that do this are understanding quantitative statements, basic probability, statistics, math of finance, and to a lesser extent theory of voting).

As mentioned on page 8 in order to incorporate the projects, the course omitted the topics of probability and theory of voting; the students did perform as well or better on the post-test (Figure 4 on page 84) than the regular quantitative literacy students on the remaining topics. In addition, we are pleased to

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<sup>16</sup> Bok, Derek. *Our Underachieving Colleges: A Candid Look at How Much Students Learn and Why They Should Be Learning More*. Princeton: Princeton University Press, 2005.

see that the course measures up rather well to the habits of mind and basic quantitative methods<sup>17</sup> Bok (68-69) considers to be integral to the development of critical thinking.

## Reflections

### Selecting Project Topics

In Fall 2004 we surveyed 28 undergraduates at LMU to find out what topics would most interest them. We presented a list of 21 topics and asked them to check whether they had “High,” “Medium,” “Low,” or “No” interest in each topic. They were also given a chance to suggest a topic of interest. The top four topics of interest were:

Tuition
Textbook cost
Financial Aid
Saving for retirement

And the bottom four were:

Marijuana use
LMU gender distribution
LMU Ethnic distribution
Airport noise

Topics like HIV/Aids, LA poverty, and LA traffic fell in the middle. (Appendix A contains the complete list presented in order of student interest.) An obvious conclusion is that financial issues that directly impacted students were of greatest interest. When we look at the three project topics that resulted from the Design Your Own option – Campus Parking, Student-work Hours, and Future Financial Planning – again we see students selecting issues that are financial and/or very “close to home.”

Our original intent was for the projects to be much more environmentally oriented and we worked hard to identify a feasible project topic related to the Ballona wetlands that are adjacent to our campus. (See Ballona insect survey on page 17.) We also utilized data on Ballona wetlands water temperature, turbidity (cloudiness), dissolved oxygen, water depth, and pH that LMU Professor John Dorsey obtained from his submerged sensors in the new computer spreadsheet lab (pages 77-80) we wrote for students to learn to draw charts and graphs. The Ballona insect survey project, undertaken by two (out of 23) groups in Fall 2005, presented us with many difficult logistical challenges beyond being mathematicians undertaking a field biology project. These included: new stringent state restrictions beginning in August 2005 regarding removing even one insect sample from the wetlands for identification; providing transportation for students, not having camera equipment capable of taking sufficiently sharp photos for positive identification; having to make daily visits for two weeks to capture, photograph and release; having two experts recommend different locations for the traps; and being unable to gain access on several days because our lock was locked out of the ‘daisy chain.’ In addition to these logistical challenges, the mathematical topics that could be applied in this project were really quite elementary compared to the other projects. We did not offer the insect survey project in the Spring 2006 and, reluctantly, we have decided to abandon it in the foreseeable future.

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<sup>17</sup> The habits of mind include the ability to recognize and define problems clearly, gather relevant facts, perceive many plausible solutions, and exercise good judgment in choosing the best alternatives. Bok recommends a reasonable grasp of statistics and probability, practice applying basic mathematical knowledge to everyday problems and situations such as income taxes and budgets, and a facility with computers.

## **Group Work Issues**

As expected, we encountered some problems relating to students working in groups. A small number of students did not adequately participate in their groups, a small number of others tried to be too controlling of their groups, etc. In fact, two (out of a total 29 groups that formed during the year) even kicked a student out. In one case the instructor substituted an exam for the student's project component. In the other the student completed a more limited project on his own. In both cases the student received less than full credit for the project component. Overall we feel that the problems we encountered with group work were as manageable as the sorts of problems that can arise with final exams. In Chapter 3 of this manual we discussed some of the "best practices" for incorporating collaborative learning into courses and presented our rationale for using collaborative group projects based on Chickering and Gamson's *7 Principles* along with our own campus' Core Committee recommendations.

## **Open-ended Nature of the Projects**

Many of our students felt somewhat uncomfortable with the open-ended nature of the projects. A student in one of the focus groups at the end of the course commented that (he felt) in high school they were given very specific instructions and procedures for their work, and as a freshman it had been quite difficult for him to know how/what specifically to work on with his project. This sentiment was echoed by several other students present at the time. In response, we created a list of the mathematical topics from the course and indicated how they might be applied in a typical investigation. Students could then refer to the list to help them decide at each project stage specifically what mathematics they could or should be doing for their project. The list, titled "What Mathematics Should We Do for Our Project," can be found in Chapter 2.

## **Revising Submitted Work**

As student groups submitted work for each stage of the project, the instructor read the work and returned corrections and suggestions for improvement. We expected that the corrections and suggestions would be acted upon and that later stages and the final report would incorporate these. We found that several groups failed to do so. It seems that students need very explicit instructions indicating that they are expected to incorporate the improvements suggested.

## **Civic Engagement Response**

In the last stage of the project, students were to undertake an active response to their findings. For some projects, this meant writing an article or a letter to the editor for a newspaper, writing a letter to a representative, or presenting findings to a sponsoring entity. However, because this had to be carried out at the end of the semester when students are pressed for time, most of the responses were completed for the purposes of the assignment and not carried further. For example, most of the groups that wrote a letter to the editor included the letter in what was turned-in to the instructor, but did not actually follow-up by sending the letter to a newspaper for (possible) publication. Ideally we would like to see the students actually send their letters to the editor, but find it understandable that they typically do not because of time pressures.

## **Final Presentations**

Once the action, analysis, and conclusion phases of the project were complete, the students are capable of putting together high quality PowerPoint presentations without help from the instructor. We found that we did not need to spend any time teaching students to use PowerPoint – within every group, there were students that were proficient at PowerPoint. In general, the final presentations were well-organized, creative, and all group members participated in the presentation. It is worth noting that the presentation

requirement provides a type of authentic assessment not typically available to students in a traditional quantitative literacy course. For students majoring in the arts, or for students with good verbal skills it affords a means to showcase their talents.

### **Rationale for Civic Engagement**

For faculty already familiar with SENCER's goals or significantly involved with SENCER there is little need to present an argument supporting civic engagement as a desired learning outcome. Nevertheless, the reader may appreciate the following rationale and references in making the case on their own campus.

Public pressure is mounting on higher education to demonstrate its value. Discussions of this topic frequently include proposals for the K-12 "No Child Left Behind"-type testing to be expanded to higher ed. Simultaneously professional organizations such as ABET, the Accrediting Board for Engineering and Technology (2004) and the National Academy of Engineering (2004) are calling for students to be educated in a global societal context. Preparing students to be good citizens was traditionally viewed the responsibility of elementary and secondary education. More recently, civic engagement is seen as an imperative for higher education. Groups such as the Association of American Colleges and Universities (2003) have mounted initiatives and devoted publications to the role of civic engagement in a liberal education. Community service, and especially service learning, is an oft-cited approach. Many institutions, including our own, collect data on the number of hours our students, faculty and staff spend on community service. These efforts are laudable, but they are often unconnected to the curriculum (Vaz, 2005). A better form of civic engagement, one that is more likely to prepare students for citizenship, occurs when students undertake an open-ended inquiry, grounded in the curriculum, in response to community needs. This approach enables students to connect theory and practice and bring knowledge to bear on real world problems. It promotes the type of engagement described by Burns (2001) as "the production of new knowledge and placement of that knowledge in the service of moral aims."

We hope that our project and this manual can make a small contribution to this effort.

### **Civic Engagement Bibliography**

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**Appendix A Project Topics Survey Results**  
(Presented in a 'weighted order' from most to least interest)

Topic/Interest Level	High	Medium	Low	No
Tuition	20	5	3	0
Textbook cost	17	6	3	2
Financial aid	15	7	4	2
Saving for retirement	13	7	7	1
LA homeless	10	11	6	1
LA livable wage	8	14	5	1
Investing money	12	7	7	2
Ocean pollution	12	6	9	2
Grade inflation	12	8	4	4
HIV/STD	10	10	6	2
LA poverty	9	10	8	1
LA traffic	9	11	5	3
Alcohol use	9	9	9	1
Drinking water	10	8	7	2
Recycling	8	8	9	3
Credit card debt	8	8	7	5
Smog	8	8	5	7
Marijuana	5	9	10	4
LMU gender distribution	7	5	10	6
LMU ethnic distribution	7	4	11	6
Airport noise	0	4	12	12

## Appendix B Sample Pre/Post Test

Name:

Section:

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**Directions:** Choose the correct answer to each problem. You may find the following formulas helpful in answering some of the questions.

Compound Interest Formula

$$A = P\left(1 + \frac{r}{n}\right)^{ny}$$

Annual Percentage Yield

$$APY = \left(1 + \frac{r}{n}\right)^n - 1$$

Savings Plan Formula

$$A = P \times \left[ \frac{\left(1 + \frac{r}{n}\right)^{ny} - 1}{\frac{r}{n}} \right]$$

Loan Payment Formula

$$PMT = \frac{P\left(\frac{r}{n}\right)}{1 - \left(1 + \frac{r}{n}\right)^{-ny}}$$

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1. According to the *Almanac of Jobs and Salaries*, the average starting salary offered to bachelor's degree candidates in engineering in 2004 was \$32,300, which was down 5% from the previous year. What was the average starting salary offered to bachelor's degree candidates in engineering in the previous year?

- a) \$34,000
- b) \$33,915
- c) \$30,685
- d) \$32,910
- e) I don't know.

2. After looking over your budget, you determine that you can afford at most \$1800 in monthly home mortgage payments. If you can obtain a 30-year home mortgage with an APR of 5.0% compound monthly, what is the largest loan principal you can afford? Round your answer to the nearest dollar.

- a) \$335,307
- b) \$966,279
- c) \$432,000
- d) \$275,000
- e) I don't know.

3. You begin saving for your daughter's college education by depositing \$150 at the end of each month into a savings account with an annual percentage rate of 4.4% compounded monthly. How much will be in the account after 15 years?

- a) \$79,055.11
- b) \$27,000.00
- c) \$38,146.02
- d) \$32,144.02
- e) I don't know.

4. You just received a \$750 bill for your credit card, which has an annual interest rate of 18%. Your credit card company uses the unpaid balance method (i.e. charges interest on the unpaid balance) in order to calculate the interest you owe. Suppose you make a \$150 payment now, and make no new charges to your credit card in the next month. What will be the balance on your next credit card bill (a month from now)?

- a) \$600.00
- b) \$609.00
- c) \$612.73
- d) \$735.00
- e) I don't know.

5. During the week of May 20 - 23, 2004 an ABC News/Washington Post poll was conducted by telephone among a random sample of 1,005 adult Americans. Given pro and con arguments, 63 percent of those polled said the use of torture of prisoners is never acceptable, even when other methods fail and authorities believe the suspect has information that could prevent terrorist attacks. The margin of error of this poll at the 95% confidence level was 3%. Which of the following statements is most accurate?

- a) There is a 95% chance that between 60% and 66% of the people surveyed during the week of May 20 -23, 2004 believed that the use of torture of prisoners is never acceptable.
- b) There is between a 92% and 98% chance that during the week of May 20 -23, 2004, 63% of all adult Americans believed that the use of torture of prisoners is never acceptable.
- c) There is a 95% chance that during the week of May 20 -23, 2004, the actual percentage of all adult Americans who believed that the use of torture of prisoners is never acceptable was between 60% and 66%.
- d) During the week of May 20 -23, 2004, the actual percentage of all adult Americans who believed that the use of torture of prisoners is never acceptable was between 58% and 66%.
- e) I don't know.

6. Shortly after the first U.S. case of mad cow disease was found in Washington State, a number of facts about the beef industry were reported in various new sources. As reported, 18 billion pounds of beef were consumed in the U.S. in 2003. There are 290 million people in the U.S. Approximately how many pounds of beef were consumed per person in 2003? Be sure to use the correct number of significant digits in your final answer.

- a) 62 pounds
- b) 62.1 pounds
- c) 620 pounds
- d) 6.2 pounds
- e) I don't know.

7. You have just decided to use the spreadsheet Excel to track all of your automobile related spending. You have entered the appropriate row and column labels and some information about your expenditures. The spreadsheet now looks like:

	A	B	C	D	E	F	G	H
1	<b>Type of Expense</b>	<b>Amount</b>	<b>Date</b>					
2	Car payment	\$325.79	1/22/04					
3	Car insurance	\$289.00						
4	Gasoline	\$13.80						
5								
6	<b>Total</b>							
7								
8								

Because you have three expenses, all of which were paid in the same day, you do not wish to re-type the same date over again. What command can you use in order to put the date 1/22/04 into cells C3 and C4?

- a) Copy
- b) Copy Down
- c) Fill
- d) Fill Down
- e) I don't know.

8. A study was conducted to find people's average daily calorie consumption in the U.S. It was found that the daily calorie consumption of the people who participated in the study was normally distributed with a mean of 1250 and a standard deviation of 220. Approximately what percent of the people who participated in the study had an average daily calorie consumption between 1250 and 1470 calories?

- a) 47.5%
- b) 34%
- c) 68%
- d) 84%
- e) I don't know.

9. Researchers wish to determine the opinions of people in the 18 - 24-year age group on capital punishment. Which of the following would be the best sample of people to participate in this study?

- a) A random sample of 500 marines in this age group
- b) A random sample of 500 college students in this age group
- c) A random sample of 500 registered voters in this age group
- d) A random sample of 500 persons at a trendy mall in this age group.
- e) I don't know.

## Appendix C: Knowledge Survey

### MATH 102 Knowledge Survey Used in Spring 06

(Note: A revised knowledge survey with extraneous questions removed appears in Appendix D)

**Directions:** This is a knowledge survey, not a test. The purpose of this survey is to serve as a study guide and to help you and the instructor evaluate the change produced in your knowledge by this course. In this knowledge survey, you won't actually try to answer any of the questions provided. Instead you will rate (on a three-point scale) your confidence to answer the items based on your present knowledge. **On this survey, Circle a "3" response if you feel confident that you can now answer the question completely and correctly (as on a graded test). Circle a "2" response if you can now complete at least 50% of the solution, or if you know precisely what information you need and where to get it (in less than 30 minutes) to provide a complete and correct solution. Circle a "1" response if you are not confident that you could provide a complete and correct solution.**

What constitutes a successful response to this survey is an accurate self-assessment, one that neither overestimates, nor underestimates the knowledge that you currently have. Do your best to provide a very honest assessment of your present knowledge. If you circle a "3" or "2" that states you have significant background to answer a question, you should be confident that if your professor asks you to demonstrate that ability by actually answering the so-designated questions, that you could actually respond for graded test purposes (responding 3 would mean ready to answer on a closed book test, 2 would mean ready to answer on an open book/notes test).

Question	Rating		
1. Determine the number of square inches in 12 square yards.	1	2	3
2. The speed limit posted as you leave Tecate, Mexico is 50 km/hr. Find the corresponding limit in miles per hour.	1	2	3
3. Describe the recommended four steps in the problem solving process.	1	2	3
4. A department store advertised an 80% off sale on fall apparel. The ad also contained a coupon for an extra 15% off to be applied to the reduced price of any sale or clearance purchase. Find the final price of a \$150 suit (ignore tax).	1	2	3
5. Is it possible to go on a diet and decrease your calorie intake by 125%? Explain why or why not.	1	2	3
6. Describe any likely sources of random or systematic errors in measuring the numbers of popped kernels in "large" boxes of popcorn at a movie theater.	1	2	3
7. Show that you understand the difference between absolute error and relative error by giving two examples: one where the absolute error is large but the relative error small, and the other where the absolute error is small but the relative error is large.	1	2	3
8. Use the appropriate rounding rules to answer the following with the correct precision or number of significant digits: Find the total weight of a 50 kg bag of sand and a 1.25 kg box of nails.	1	2	3
9. On what basis, if any, would you question the following statistic: The population of the United States in 1860 was 31,443,321.	1	2	3
10. Describe Simpson's Paradox and give an example where it might occur in your future.	1	2	3
11. Approximately 0.2 percent of college students in the US are HIV-positive. If 20,000 Michigan State students are tested for HIV with a test that is 90% accurate (meaning it will return a positive result 90% of the time when given to a person who is infected with HIV and return a negative result 90% of the time when given to a person who is not infected), answer the following: Of those who test positive, what percent will actually be HIV-positive?	1	2	3
12. Suppose you win a \$100,000 raffle. You wisely invest half of it in a savings account that pays interest with an APR of 5% that will be compounded quarterly. Find how much you will have in the account in 10 years.	1	2	3
13. What does the Annual Percentage Yield (APY) of an investment measure?	1	2	3

14. Suppose you want to start a savings program for a down payment on a house. In 10 years you would like to have \$125,000. Your financial advisor can find an account with an APR of 7% that will be compounded monthly. Find how much you will have to deposit into the account per month in order to have the \$125,000 in 10 years.	1	2	3
15. You wish to buy a new car and can afford to pay at most \$400 per month in car payments. If you can obtain a 4-year loan with an APR of 3.2% compounded monthly, what is the largest loan principle you can afford to take out? Round your answer to the nearest dollar.	1	2	3
16. You just received a \$1000 credit card bill, and you card has an annual interest rate of 18%. Your credit card company uses the unpaid balance method (i.e. charges interest on the unpaid balance) in order to calculate the interest you owe. Suppose you make a \$200 payment now, and make no new charges to your credit card in the next month. Find the balance on your next credit card bill a month from now.	1	2	3
17. The United States has a progressive income tax. Explain what that means.	1	2	3
18. Which is more valuable to a taxpayer, a tax deduction or a tax credit? Explain why.	1	2	3
19. Describe at least three misleading perceptual distortions that arise in graphics.	1	2	3
20. A company has 10 employees, making the following annual salaries: 3 make \$20,000, 2 make \$30,000, 4 make \$50,000 and 1 makes \$1,200,000 per year. Explain whether the median or the mean would be a better representation of the “average” salary at the company.	1	2	3
21. Two grocery stores have the same mean time waiting in line, but different standard deviations. In which store would you expect the customer to complain more about the waiting time? Explain.	1	2	3
22. What are quartiles of a distribution and how do we find them?	1	2	3
23. Give a five-number summary and depict it with a boxplot for the following set of data: {2, 5, 3, 4, 4, 4, 6, 7, 5, 2, 10, 8, 4, 15}.	1	2	3
24. The body weights for 6-month old baby boys are normally distributed with a mean of 17.25 pounds and standard deviation of 2 pounds. Your 6-month old son Jeremiah weighs 21.25 pounds. Jeremiah weighs more than what percentage of other 6-month old baby boys?	1	2	3
25. In order to determine how many students at LMU have ever used a fake ID to buy liquor, we survey the students in this class and find 40% of them have done so. We conclude 40% of LMU students have used a fake ID to buy liquor. Discuss possible sources of bias in the sample and comment if the conclusion is justified.	1	2	3
26. A survey of 1,001 randomly selected Americans, age 18 and older, was conducted April 27-30, 2000, by Jobs for the Future, a Boston-based Research firm. They found that 94% of Americans agree that “people who work full-time should be able to earn enough to keep their families out of poverty.” Explain what is meant by saying the margin of error for this poll at the 95% confidence interval is 3%	1	2	3
27. Formulate the null and alternative hypotheses for a hypothesis test of the following case: A consumer group claims that the amount of preservative added to Krunch-Chip brand of potato chips exceeds the 0.015 mg amount listed on the packages.	1	2	3
28. Describe the two possible outcomes for the hypothesis test in #27.	1	2	3
29. A random sample of Krunch-Chip potato chip bags is found to have a mean of 0.017 mg of preservative per bag. Suppose 0.03 is the probability of obtaining this sample mean when the actual mean is 0.015 mg preservative per bag as the company claims in #27. Does this sample provide evidence for rejecting the null hypothesis? Explain.	1	2	3

## Appendix D: Revised Knowledge Survey

### MATH 102 Knowledge Survey

**Directions:** This is a knowledge survey, not a test. The purpose of this survey is to serve as a study guide and to help you and the instructor evaluate the change produced in your knowledge by this course. In this knowledge survey, you won't actually try to answer any of the questions provided. Instead you will rate (on a three-point scale) your confidence to answer the items based on your present knowledge. **On this survey, Circle a "3" response if you feel confident that you can now answer the question completely and correctly (as on a graded test). Circle a "2" response if you can now complete at least 50% of the solution, or if you know precisely what information you need and where to get it (in less than 30 minutes) to provide a complete and correct solution. Circle a "1" response if you are not confident that you could provide a complete and correct solution.**

What constitutes a successful response to this survey is an accurate self-assessment, one that neither overestimates, nor underestimates the knowledge that you currently have. Do your best to provide a very honest assessment of your present knowledge. If you circle a "3" or "2" that states you have significant background to answer a question, you should be confident that if your professor asks you to demonstrate that ability by actually answering the so-designated questions, that you could actually respond for graded test purposes (responding 3 would mean ready to answer on a closed book test, 2 would mean ready to answer on an open book/notes test).

Question	Rating		
1. Determine the number of square inches in 12 square yards.	1	2	3
2. The speed limit posted as you leave Tecate, Mexico is 50 km/hr. Find the corresponding limit in miles per hour.	1	2	3
3. A department store advertised an 80% off sale on fall apparel. The ad also contained a coupon for an extra 15% off to be applied to the reduced price of any sale or clearance purchase. Find the final price of a \$150 suit (ignore tax).	1	2	3
4. Is it possible to go on a diet and decrease your calorie intake by 125%? Explain why or why not.	1	2	3
5. Describe any likely sources of random or systematic errors in measuring the numbers of popped kernels in "large" boxes of popcorn at a movie theater.	1	2	3
6. Show that you understand the difference between absolute error and relative error by giving two examples: one where the absolute error is large but the relative error small, and the other where the absolute error is small but the relative error is large.	1	2	3
7. Use the appropriate rounding rules to answer the following with the correct precision or number of significant digits: Find the total weight of a 50 kg bag of sand and a 1.25 kg box of nails.	1	2	3
8. On what basis, if any, would you question the following statistic: The population of the United States in 1860 was 31,443,321.	1	2	3
9. Suppose you win a \$100,000 raffle. You wisely invest half of it in a savings account that pays interest with an APR of 5% that will be compounded quarterly. Find how much you will have in the account in 10 years.	1	2	3
10. What does the Annual Percentage Yield (APY) of an investment measure?	1	2	3
11. Suppose you want to start a savings program for a down payment on a house. In 10 years you would like to have \$125,000. Your financial advisor can find an account with an APR of 7% that will be compounded monthly. Find how much you will have to deposit into the account per month in order to have the \$125,000 in 10 years.	1	2	3
12. You wish to buy a new car and can afford to pay at most \$400 per month in car payments. If you can obtain a 4-year loan with an APR of 3.2% compounded monthly, what is the largest loan principle you can afford to take out? Round your answer to the nearest dollar.	1	2	3

13.	You just received a \$1000 credit card bill, and your card has an annual interest rate of 18%. Your credit card company uses the unpaid balance method (i.e. charges interest on the unpaid balance) in order to calculate the interest you owe. Suppose you make a \$200 payment now, and make no new charges to your credit card in the next month. Find the balance on your next credit card bill a month from now.	1	2	3
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15.	Which is more valuable to a taxpayer, a tax deduction or a tax credit? Explain why.	1	2	3
16.	Describe at least three misleading perceptual distortions that arise in graphics.	1	2	3
17.	A company has 10 employees, making the following annual salaries: 3 make \$20,000, 2 make \$30,000, 4 make \$50,000 and 1 makes \$1,200,000 per year. Explain whether the median or the mean would be a better representation of the “average” salary at the company.	1	2	3
18.	Two grocery stores have the same mean time waiting in line, but different standard deviations. In which store would you expect the customer to complain more about the waiting time? Explain.	1	2	3
19.	What are quartiles of a distribution and how do we find them?	1	2	3
20.	Give a five-number summary and depict it with a boxplot for the following set of data: {2, 5, 3, 4, 4, 6, 7, 5, 2, 10, 8, 4, 15}.	1	2	3
21.	The body weights for 6-month old baby boys are normally distributed with a mean of 17.25 pounds and standard deviation of 2 pounds. Your 6-month old son Jeremiah weighs 21.25 pounds. Jeremiah weighs more than what percentage of other 6-month old baby boys?	1	2	3
22.	In order to determine how many students at LMU have ever used a fake ID to buy liquor, we survey the students in this class and find 40% of them have done so. We conclude 40% of LMU students have used a fake ID to buy liquor. Discuss possible sources of bias in the sample and comment if the conclusion is justified.	1	2	3
23.	A survey of 1,001 randomly selected Americans, age 18 and older, was conducted April 27-30, 2000, by Jobs for the Future, a Boston-based Research firm. They found that 94% of Americans agree that “people who work full-time should be able to earn enough to keep their families out of poverty.” Explain what is meant by saying the margin of error for this poll at the 95% confidence interval is 3%	1	2	3
24.	Formulate the null and alternative hypotheses for a hypothesis test of the following case: A consumer group claims that the amount of preservative added to Krunch-Chip brand of potato chips exceeds the 0.015 mg amount listed on the packages.	1	2	3
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26.	A random sample of Krunch-Chip potato chip bags is found to have a mean of 0.017 mg of preservative per bag. Suppose 0.03 is the probability of obtaining this sample mean when the actual mean is 0.015 mg preservative per bag as the company claims in #24. Does this sample provide evidence for rejecting the null hypothesis? Explain.	1	2	3