Service-Learning in an Interdisciplinary Mathematics and Economics Course

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Steven Zucker's, of Johns Hopkins [Notices of the AMS August 2010],

Most annoying is the use of outcomes from freshmen and sophomores in "service" courses. These students have a foot, or even their head, in high school; they tend to view the instructor as the primary source of their learning, like a high school teacher. The instructor might well aspire to get them used to the idea of the textbook as source. Bowing to student wishes, he or she might instead do following:

- try to ensure that the students "get" the basic points in the classroom;
- give lectures that can be followed without preparation, building the subject slowly from the bottom up;
- give lots of examples in class;
- drop topics from the syllabus when convenient;
- give light homework assignments and use the assigned problems as models for the exams;
- give practice exams that are similar to the actual exams;

Student is to

- Gain the ability to use what has been learned in new situations;

- Accept that most of the learning takes place outside of the class.

➢ Thus the student is responsible for learning the material. I think that the instructor's main responsibility is to promote actual learning.

Linked Courses

- Students write, discuss, and present about applications of mathematics in the linked courses:

  - *Mathematics in Action: Social and Industrial Problems*
    - ✓ *NSF Sponsored Course*
    - ✓ *First taught in 1996*
    - ✓ *Satisfies Finite Mathematics Requirement*

  - *Introduction to Computing*

Mathematics Course

- ***Mathematics in Action: Social and Industrial Problems***
  - Client-driven Project Based Learning
  - Team Taught
  - Satisfies Finite Mathematics Requirement
    - ✓M110 *Excursion Mathematics* (Liberal Arts & Science)
    - ✓M118 *Finite Mathematics* (Business)
    - ✓T102 *Mathematics for Teachers* (Education)

- **Interdisciplinary faculty team teach** students from business, liberal arts, science, nursing, education, and public administration students.

Computer Technology Course

- *Introduction to Computing*

  - Linked to *Mathematics in Action*
  - Team Taught
  - Satisfies computer technology requirement
    - ✓ A106 *Introduction to Computing*

      (Liberal Arts & Sciences and Education)
    - ✓ K201 *The Computer in Business*

      (Business)

PBL(Client Driven)

- Student teams are assigned to complete Service-Learning projects from actual industrial and social organizations
  - Teachers Credit Union
  - Ashley Ward Company
  - South Bend Times
  - South Bend School Corporation
  - Penn-Harris-Madison School Corporation
  - North Village Mall
  - Indiana University South Bend
  - American Diabetes Association

Emphasis

- Courses emphasize learning, writing, and discussing mathematics and computer technology applications through working out service-learning projects.

Project Themes - Mathematics

- **Mathematics:** projects are selected to emphasize discrete math tools
  - Counting principles
  - Descriptive Statistics
  - Probability and Bayes' Formulas
  - Systems of Equations and Matrices
  - Optimization
  - Linear Programming

- **IT:** projects are also selected to emphasize IT tools
  - Spreadsheet software
  - Database software
  - Statistical software
  - Word Processing software
  - Presentation software
  - Web Page Design software

Student Teams

- To optimize the interactions between students with diverse academic interests, each team consists of students from several disciplines, such as business, nursing, science, education, and public and environmental affairs.

- Team formation algorithm:
  - ✓ First examination performance
  - ✓ Demographics
  - ✓ Proximity to project organization
  - ✓ Academic discipline

Getting Involved: Defining the Problem

- Given a particular project student teams start by meeting client organizations, discussing, formulating and writing research issues, problems, and questions.
  - For example in a project for the American Diabetes Association, the team focused on
    - Fund Raising Events

  and narrowed those to events in the upcoming year. Then

Getting Involved: Data Needs

- Student teams then focus on data needs and on acquiring the mathematical, statistical, and computer skills necessary to solve these problems.

  - For example for the ADA problem, the mathematical tool, linear programming, and the technological tool, Excel's "Solver Module", are obvious choices for optimization problem involving constraints.

  - The LP technique requires information on the gains from the various events that might be offered, the resource requirements of those events, and resource capacities.

  - It moreover requires discussing and writing assumptions on how many times a particular event can be offered (i.e., a fund raising walk cannot be held every weekend), as well as the role of random factors such as the weather.

Team Defines the Problem

- Team Investigates and Writes about the Client Organization (after meeting with the organization personnel)
  - The ADA team, investigates and writes about the history of ADA and its fund raising activities .
- Team Defines the Problem
  - "How should the director allocate her time, volunteers' time, and financial resources to maximize the net revenues from the organization's fund raising events?"
- Team Puts the Problem into its own terms.

Teams Write Journals, Communicate, & Build-up Portfolios

- ADA Team Focuses on Fund Raising Events
- ADA Team Narrows Problem to Those in Upcoming Year
- ADA Team & Instructors Investigate Necessary Modeling and Technological Tools
  - ✓ Constraints optimization problem using integer programming
  - ✓ Technology: Excel's "Solver" module
- Team members write journals and communicate their ideas with each other and instructors. They also, keep draft project pieces and add documents in their course portfolios.

Teaching Students and Coaching Teams

- In the classrooms, students learn core mathematical techniques, computing tools, and concepts.

- Outside of the classroom team members discuss the problems.

Reports and Presentations

- Finally, each team writes a comprehensive report and makes a presentation in class and at its resource organization.

REPORT OUTLINE FOR TEAM PROJECT

- **INTRODUCTION** - ***This section contains background information on your organization***
  - The organization's primary activities
  - The goods and services the organization produces
  - The organization's customers or clients
  - The size of the organization
  - The organization's location
  - How long the organization has been operating
  - Individuals you talked to at the organization and their positions
  - Other factors you think might be important as background information

REPORT OUTLINE FOR TEAM PROJECT

- **STATEMENT OF PROBLEM** - ***This section discusses the problem the organization had your team investigate***
  - Summary of the problem that you are investigating
  - The importance to your organization of finding a solution to the problem (alternatively, what is the cost to your organization of not solving the problem?)
  - Views of the problem based on discussions with your organization's personnel
  - Ways the team redefined the problem to make it more manageable and doable

REPORT OUTLINE FOR TEAM PROJECT

- **METHODOLOGY** - ***This section describes the research approach taken to solve the problem***
  - The approach the team took to solve the problem.
  - Discuss the steps you followed in attempting to solve the problem
    - The assumptions you make along the way to solving the problem
    - The data you obtained and/or collected
    - Data weaknesses, shortcomings, or other data problem
    - The mathematical tools and principles you used to solve the problem (describe tools learned in the course that you used to solve the problem)
    - The various difficulties you encountered along the way
    - The way you resolved these problems
    - The problems you were unable to resolve

REPORT OUTLINE FOR TEAM PROJECT

- **SOLUTIONS** - ***This section contains the solutions your team found for your organization's problem***

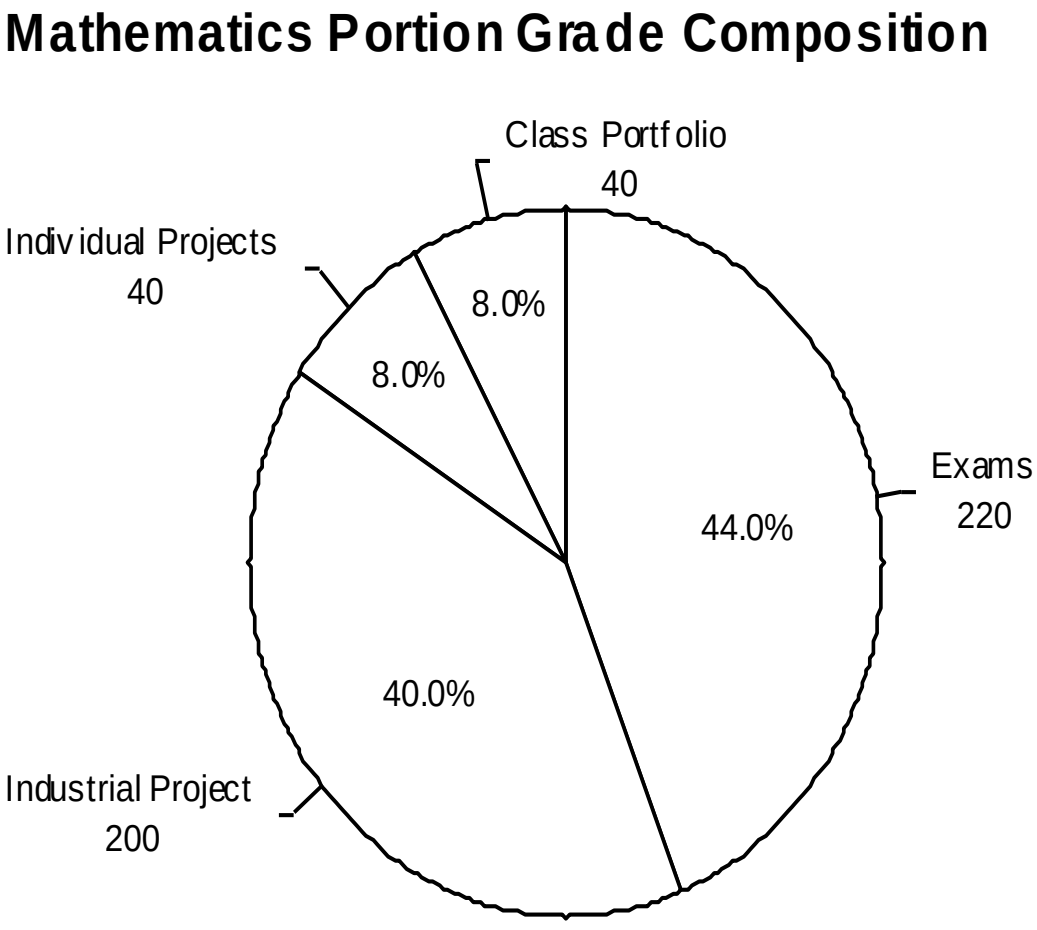
  Present the findings from your research that will help your organization solve its problem

  - Present the evidence that led you to your findings. In presenting your evidence to support your findings, be as specific as is possible. Where possible, present the evidence:
    - Verbally (talk about it)
    - Numerically (put the evidence into tables)
    - Mathematically (compute relevant probabilities, mathematical solutions, etc.)
    - Graphically (make bar charts, pie charts, etc.)
  - Based on your evidence and findings, make specific recommendations
  - Where necessary, qualify these recommendations (e.g. are there assumptions, data weaknesses, unperformed computations, etc. that might make you less confident in your recommendations? If yes, mention them)

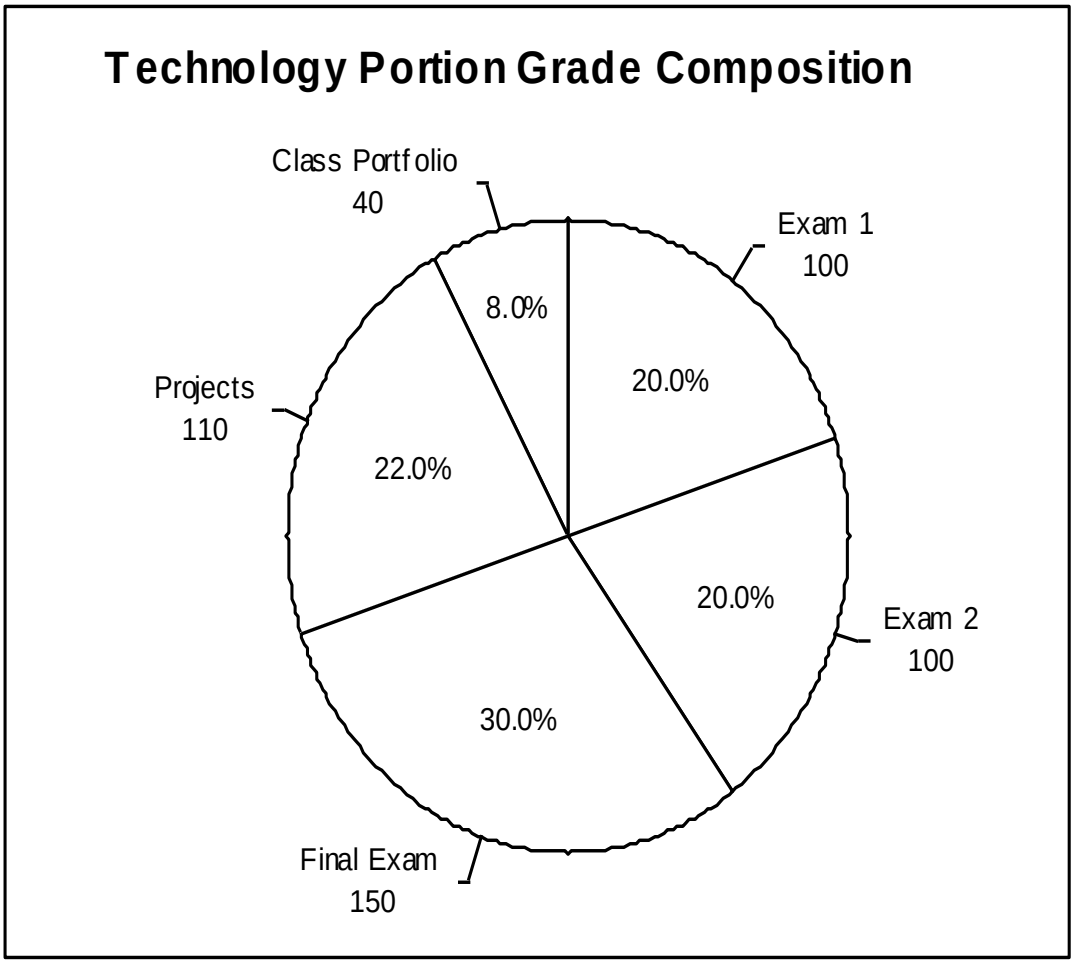
REPORT OUTLINE FOR TEAM PROJECT

- **FINAL COMMENTS** - ***This section discusses future work and other comments you might want to make about your study.***
  - Discussion of additional work that might be done to shed more light on problem
  - Other remarks about the problem that you think are relevant

Evaluation: Mathematics



Evaluation; Technology



Project Progression

- Projects used in the course proceed through a series of steps summarized below.

- Each step requires writing, discussing and communicating applications of mathematics.

- For example, in the spring semester of 2000, a student team completed a project for the South Bend regional office of the American Diabetes Association dealing with how the organization might best allocate its resources to maximize its net fund raising revenues.

Early Work on Project

- **0)** Preliminary Steps: A semester before the course was offered, the faculty made efforts:
  i. request for project**,**
  ii. initial contact,
  iii. exploration of potential projects**,**
  - narrowed the project, and modeling.

- **1)** Teams are formed (3rd week of semester).

- **2)** Team meets with organizational personnel and writes reports and discusses the problem (4th week of semester).

Background and Problem Definition

- **3)** Team investigates and writes about the history of the ADA and its fund raising activities (after meeting with organization personnel)

- **4)** Team defines problem:

  "How should the director allocate her time, volunteers' time, and financial resources to maximize the net revenues from the organization's fund raising events?"

  and attempts to put problem into its own terms (4th or 5th week of semester).

- **5)** Team focuses on fund raising events (6th or 7th week of semester).

- **6)** Team narrows problem to those events in the upcoming year (8th to 10th week of semester).

Modeling Project

- **7)** Team and instructors investigate necessary modeling and technological tools (8th to 11th week of semester):
  - Constrained optimization problem using integer programming
  - Technology: Excel's "Solver" module

Information and Data Needs

- **9A)** Team works with organization Director to collect data about resources and event revenues (starting in 9th week):
  - Revenues and variable cost for each event
  - Financial resources required for each event
  - Volunteers' time required for each event
  - Director's time required for each even
  - Limitations on the availability of financial and time resources

Assumptions and Limitations

- **9B)** Team also makes assumptions:
  - Limitations on the number of times a particular event could be held
  - The role of weather conditions to the success of an event

Interpretation, Sensitivity and Post Optimality

- **10)** Team interprets computer results and discusses these with instructors (11th and 12th weeks of semester)

- **11)** Team makes recommendations and does sensitivity and post optimality analyses (12th and 13th weeks of semester)

Reporting

- **12)** Team completes technical report (5th week through 13th week).

- **13)** Team presents findings to organization (14th week).

- **14)** Instructors work with team to finalize technical report (15th week)