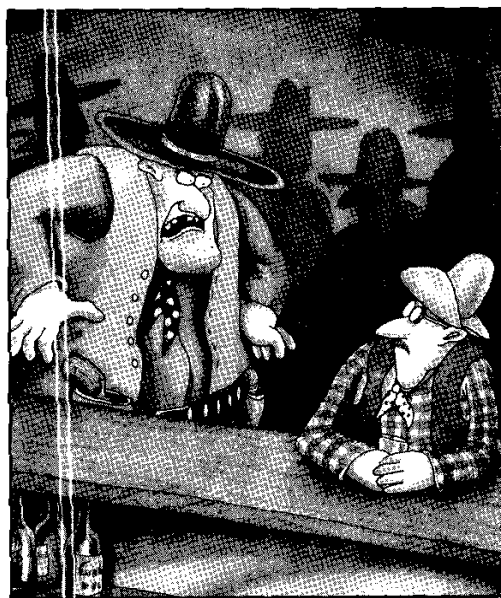
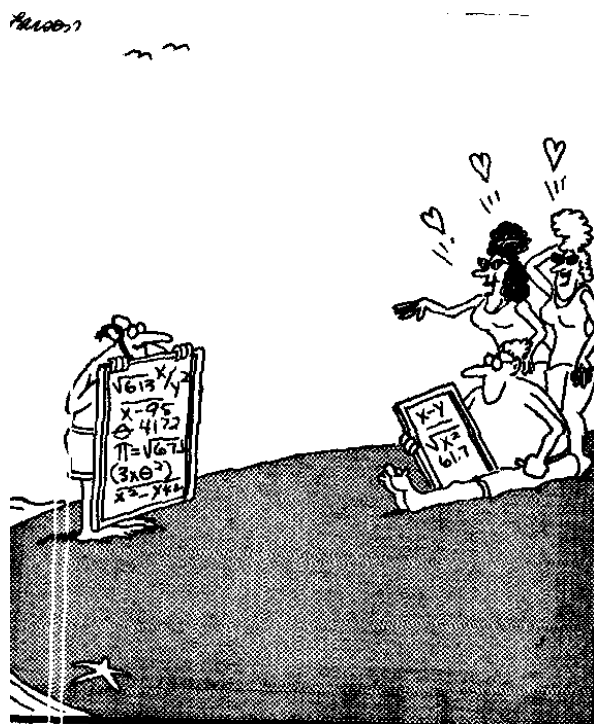


Introduction to Quantitative Analysis - Econ 6808

Course Syllabus - Fall 1999



"I asked you a question, buddy. . . . What's the square root of 5,248?"

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Econ 6808 Introduction to Quantitative Analysis

Edward Morey

Fall 1999 (August 24, 1999)

Course Description: Econ 6808 is a course that will improve your understanding of economic theory, make your other economics courses much easier and improve your basic math skills. It might even be fun. Math should be viewed as a language. Like the other languages we use in economics (e.g., English and graphical analysis), math is a way of representing and conveying information. In principles of economics courses, ideas are presented verbally and graphically. My first reaction when I took principles was that I liked the words but not the graphs. However, after a while I came to realize that graphs have their place. Graphs often make difficult concepts clear by allowing us to *visualize* what is going on. Words are often vague and open to misinterpretation; the English language can be quite imprecise. Graphs tend to convey information more precisely than words. A graph is worth a thousand words. Many econ majors come to love them.

Now I am asking you to learn and love a different language, math. Math allows us to understand much more complicated phenomenon than would be possible if we restricted ourselves to words and graphs. This is due to its precision and compactness. Compact means a lot of stuff (equations, variables, etc.) can be expressed with a small amount of notation. Consider, for example, matrix notation. The preciseness of math forces us to understand what we are doing and forces us to be logically consistent. Economic concepts and models can often be easily and precisely described in terms of mathematical notation when words and graphs would fail or mislead us. Since paper and blackboards only have two dimensions, graphs are restricted to at most three dimensions. Graphs can be very enlightening, but if the phenomenon being studied involves more than three variables, the graph provides an incomplete, and sometimes misleading, picture. In this case, mathematical functions and our ability to manipulate them become very powerful tools of economic analysis. The intent of this course is to teach you the language of mathematics and how to use it to better understand economics. The ability to describe an economic model verbally, graphically, and mathematically will make your economic life a lot easier.

The course considers the mathematics of, and economic applications of, constrained optimization, curvature properties, duality theory, integration, game theory, and equilibrium analysis. Applications include problems in consumer and producer theory, general equilibrium, welfare economics, growth and discounting, oligopoly behavior, game theory, statistics, and econometrics.

The computer software *Mathematica* will be used to develop and solve problems. The graphical capabilities of *Mathematica* will allow us to visualize concepts like production and utility functions.

Prerequisites: The course is required of all M.A. students. I expect you to have done well in the

M.A. math prep course, and to be comfortable with algebra, derivatives, and integration. You will also need a good foundation in intermediate micro theory

Web page: My web site is located at <http://spot.Colorado.EDU/~morey/index.html> . From it you can link to the web page for Econ 6808, or you can go directly to web page for the course at <http://spot.Colorado.EDU/~morey/4545/4545home.html> .

All past and current assignments, review questions, and additional readings will be made available at this site on an as-need basis. Most of my lecture notes are on the web page. I will try to update and modify them as we go.

Mathematica: *Mathematica* is computer software for doing mathematics. It can differentiate, integrate, solve systems of equations and create great graphics. *Mathematica* is available on the computers in the computer room for Econ graduate students. We will also utilize *Mathematica* next semester in Econometrics 6818.

Class format: Lecture/problem solving/discussion/computer

Economic theory, critical thinking and problem solving will be stressed. Class format will include both individual and group problem solving. After completing the course, you will be better able to critically evaluate economic theories.

You will spend a considerable amount of class time interactively formulating and solving problems and building models. Small groups will often be utilized.

View the readings and my lectures as complements rather than substitutes. A lot of the basic material that you will be responsible for will be presented in lecture and is material that is not explicitly in the readings.

Once a week, you will meet with the T.A. to work on problems. Go prepared to ask questions.

You will likely have present you paper topic in class

Details: There will be problem sets, projects and short exams. Some of these activities will be done using *Mathematica*. Your best (N-1) grades on these activities will constitute 40% of your course grade, and the final 35% of your course grade unless you do better on the final than on these activities, in which case, these activities will constitute 30% and your final 45% of your course grade. A short paper will constitute 25% of your course grade. The final will be cumulative.

Review questions: Review questions will be handed out for each section of the course.

Knowledge of these review questions will be will be **very helpful** when taking the exams. I strongly encourage you to write out answers to the review questions and discuss them with you classmates. You will want to form study groups.

In class I will ask many questions. I also expect you to ask questions. In addition to these question, I will often give you the opportunity to earn, or lose, points by verbally answering specific questions. Participation in this latter activity is completely voluntary.

Group Assignments: Some of the assignments will be done in groups. I will tell you in advance if an assignment is a group endeavor. You choose your own group. The group will work together and just turn in one assignment. Everyone in the group will get the same grade for that assignment. Group activities are one of my ways of giving you an incentive to work and study together.

The Paper: The purpose of the paper will be to show how the mathematical techniques and theory learned in class can be used to address an economic problem that you find of interest. You will be encouraged to either build a simple mathematical model of economic behavior or critique a journal article that utilizes a mathematical model to analyze economic behavior. Your paper can be a *Mathematica project*. Please discuss your paper topic with me before you write your paper. The final copy of your paper will be due in my office around December 3. If you get a preliminary version to me a week before Thanksgiving, I will return it to you with comments before Thanksgiving.

Office Hours: My office hours will be Tues from 3:15 - 4:15, Thursdays from 10:00 to 11:00, and by appointment. My office is Econ 122. To make an appointment, catch me after class or contact me by email (Edward.Morey@Colorado.edu) - suggest some times. It might take me a day or two to return your email.

Correct Class Behavior:



Readings

Mathematics for Economic Analysis (Knut Sydsaeter and Peter Hammond). This is a new text for this course. In the past, I have used *Fundamental Methods of Mathematical Economics* (Alpha Chiang). Chiang has been actively used for many years. I decided to change after reading some of *Mathematics for Economic Analysis*. I found it clear, rigorous, and modern, so decided to give it a try. I will need to know what you think. Remember it is book on math for economists not mathematical economics.

Intermediate Microeconomics (Hal Varian). An intermediate micro book that is both elegant and rigorous. It will be a great background book for both this course and your micro theory course.

The Mathematic Book: 3rd edition (Stephen Wolfram). It used to be called *A System for Doing Mathematics by Computer*. It is the manual for the *Mathematica* software. While it is not necessary to purchase this manual, many students find it to be a worthwhile investment. While the latest version is most current, older versions are not without value. You can utilize *Mathematica* next semester in Econometrics 6818. I use it a lot when I teach 6818.

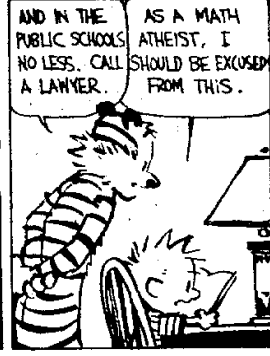
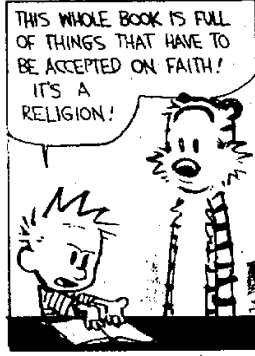
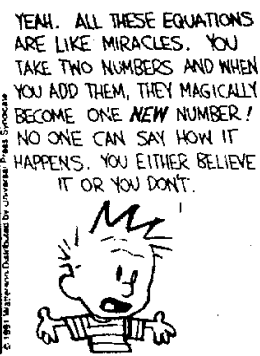
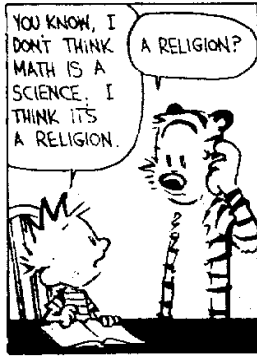
Introduction to the Theory of Statistics (Mood, Graybill and Boes). This book is old and famous, and an excellent introduction to statistics. We will use it in both Econ 6808 and it will help you with Econometrics (Econ 6818). I have owned and used this book for many years.

Numerous other readings (book chapters, journal articles, etc.) will supplement the above books. I will make them available online and/or designate a class librarian.

There is no need to purchase Mathematica: While it is not necessary to purchase *Mathematica* for the course, one can purchase a PC version. A student version can be acquired from the Buffalo Chip or the Colorado Bookstore. There is both a DOS and MAC version. I'm told the student version does everything the regular version does, but slower. The regular version requires more hardware than the student version. If you consider buying *Mathematica*, first make sure you have the hardware to run it, even the student version takes a considerable amount. Also wait until you have played with it some on the CU system.

Mathematics and Religion:

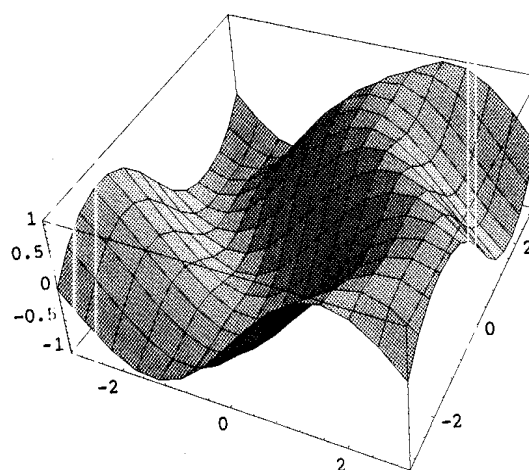
CALVIN AND HOBBS



Introduction to Quantitative Analysis (Preliminary Outline and Reading):

I do not anticipate covering the complete outline. Which sections we cover will depend on class interests and in how much depth we consider topics. The topics we don't get to are a good source for paper material. The intent is give you new tools and perspectives for analyzing and modeling economic behavior, not to learn some specific bundle of facts and theories, so we have latitude as to how best approach the task at hand. In addition to learning specific math tool, you need to learn how to identify and learn the tools you need to do your work.

I. An introduction to the *Mathematica* software



A. The readings are:

1. "TECHNOLOGY: CONNECTIONS; Mathematica is a software program that puts joy back in the numbers game," NYT, Nov 10,97 (mathamat.pdf)
2. *A Brief Tour of Mathematica* (mathtour.pdf)
3. *A Quick Introduction to Mathematica for Windows* by Juan Blyde (mathwin.pdf)
4. *The Mathematic Book* (Stephen Wolfram). This is the manual for the *Mathematica* software

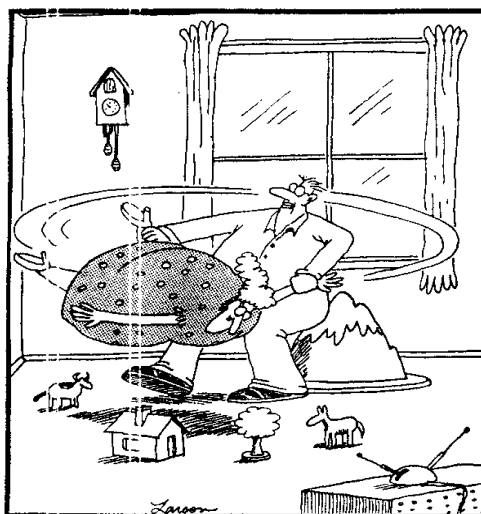
B. Where? -in the computer lab or at home

C. How? -on your own, with the help of your fellow students, and with Amanda's help.

D. When? - start playing now.

II. Economic applications of constrained optimization

Searching
for the max



On the next pass, however, Helen failed
to clear the mountains.

A. The readings are:

1. "Useful Invention Or Absolute Truth: What Is Math?", NYT, Feb 10, 1998 (whatmath.pdf)
2. My lecture notes on *Minimization and Maximization* (min&max.pdf). Bring your copy to class.
3. My brief lecture notes: *Consumer Theory in a Nutshell* (ct-nutsh.pdf)
4. The following chapters from Varian's Intermediate Micro Book provide good reviews of consumer theory and producer theory: Chapter 3 (Preferences), Chapter 4 (Utility), Chapter 5 (Choice), Chapter 18 (Technology), Chapter 19 (Profit Maximization) and Chapter 20 (Cost Minimization).
5. *Mathematics for Economic Analysis* Chapters 4 (Single-Variable Differentiation), Chapter 5 (More on Differentiation), Chapter 6 - section 6.1-6.3 (limits, continuity, continuity and differentiability), Chapter 7 - section 7.2 (The extreme value theorem), Chapter 9 (Single-Variable Optimization), Chapter 17 (Multivariate Optimization) and Chapter 19 (Linear Programming) .

B. Brief review of producer and consumer theory

C. The mathematics of optimization: substitution

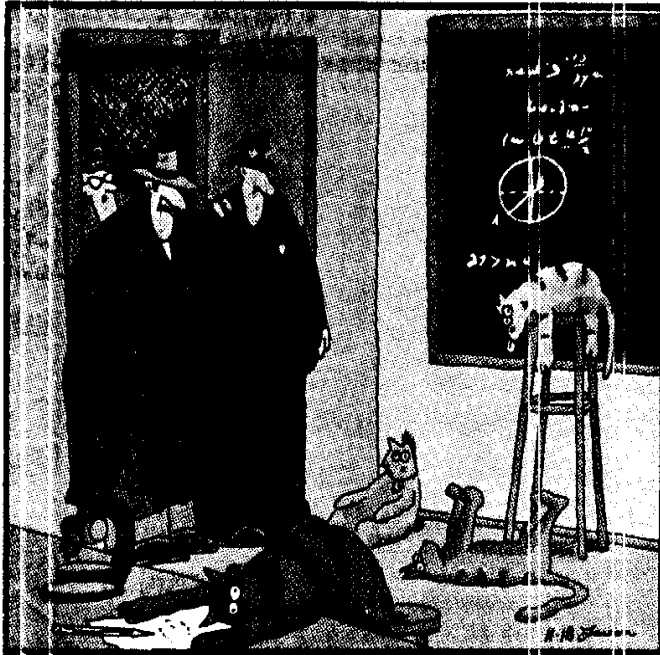
D. Economic applications: producer theory and consumer theory

E. The mathematics of optimization: the lagrangian technique

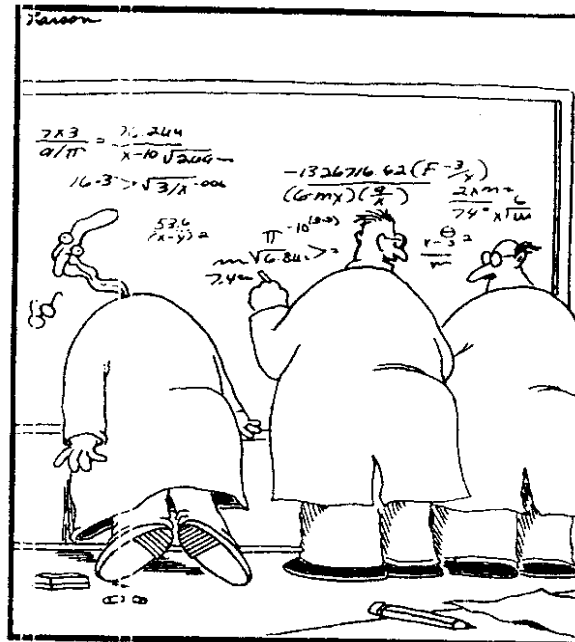
F. Economic applications of the lagrangian technique to problems in producer and consumer theory

G. Economic applications of linear programming

Potential Dangers from Course



"Notice all the computations, theoretical scribbles and lab equipment, Norm. ... Yes, curiosity killed these cats."



"Hal Webster's blown his cerebral cortex."

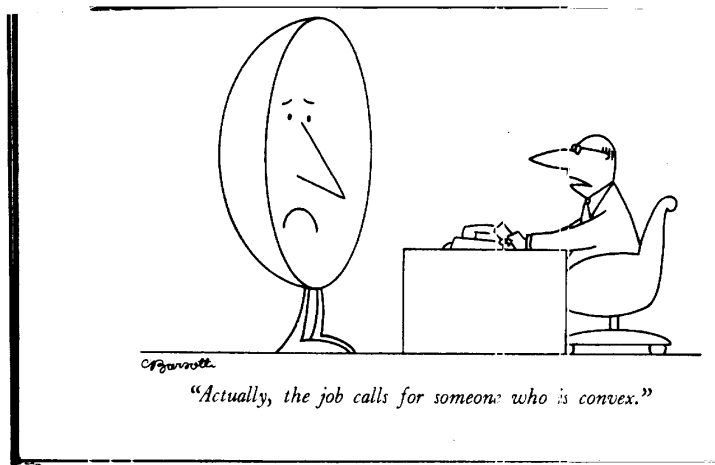
III. Economic Curvature

A. The reading are

1. My lecture note on curvature properties (curve.pdf)
2. *Mathematics for Economic Analysis*, Chapters 9 and 17, particularly sections 9.5, 9.6, and 17.5 - 17.10
3. "Properties of the cost function" -Microeconomic Analysis, pp 72-74 (costfun.pdf)

B. Concavity, convexity, quasiconcavity and quasiconvexity defined

C. Some economic applications: producer and consumer theory



IV. Economic Applications of Duality Theory

A. The readings are

1. "Properties of the Expenditure Function" - Microeconomic Analysis - Varian, pp 104 - 106.
- B. production and cost
- C. direct utility functions, indirect utility functions and expenditure functions

V. Integration: An introduction and some simple economic applications

A. The readings are

1. Lectures 1-4 on integration (integlcx.pdf. x = 1,2,3,4)
 - a. Lecture 1: Introduction to integrations with some simple economic examples
 - b. Lecture 2
 - c. Lecture 3: applications of integrations: present value of streams of benefits and costs
 - d. Lecture 4: now briefly consider indefinite multiple integrals
 2. My lecture notes: An Economic/Statistical Application of Integration: Probability Theory (probabil.pdf)
 3. My lecture notes: jointden.pdf
 4. *Mathematics for Economic Analysis*, Chapters 10 (Integration) and 11 (Further Topics in Integration)
 5. *Introduction to the Theory of Statistics*, Chapter 2 (Random Variables, Distribution Functions, and Expectations), Chapter 3 - sections 1 and 3 (specific continuous distributions), Chapter 4 - sections 1, 2.1, and 2.3. Concentrate on the cases where the random variable(s) is a continuous rather than discrete.
- B. The mathematics of integration
- C. Economic applications: deriving total functions (cost, production, etc.) from their corresponding marginal functions; and consumer's surplus
- D. Integration and probability theory
- E. Present value, discounting and exponential growth
- F. Economic problems: investments, optimal storage, when to cut the trees, etc.
- G. The mathematics of multiple integration
- H. Economic applications of multiple integration

VI. Game theory and oligopolistic behavior

A. The readings are:

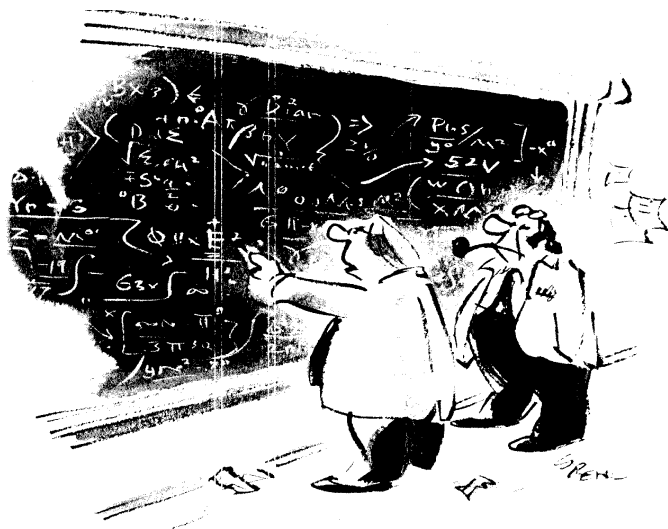
1. My lecture notes on Game Theory (game.pdf)
2. "The Lost Years of a Nobel laureate, NYT, Nov 13, 1994 (lostyrs.html)
3. "Between Genius and Madness, NYT, June 14, 1998 (genius&m.html)
4. Review of "A Beautiful Mind", NYT, June 11, 1998 (mad&back.html)
5. Chapter 1 of A "Beautiful Mind" (<http://www.nytimes.com/books/first/n/nasar-mind.html>)

- 27:
6. Varian, Hal R., Intermediate Microeconomics: a Modern Approach Chapter Game Theory
 7. Poundstone, Richard, Prisoner's Dilemma pages 37-64 and 101-131.
 8. Axelrod, Robert, The Evolution of Cooperation If you have \$9 lying around, buy it and read it. A number of my students have read it and enjoyed the experience. It is not technical.
 9. There are many game theory texts. If you want to get into game theory in more detail, may I suggest Games and Information: An Introduction to Game Theory by Eric Rasmusen, published by Basil Blackwell (ISBN 0-631-15708-3)
- B. A brief introduction to strategic behavior: modeling the interactions among small numbers of economic agents.
 - C. Simple game theory
 - D. Economic applications of game theory

VII. General equilibrium: Interactions amongst economic agents

- A. An introduction to economic models that assume equilibrium outcomes
- B. The mathematics of solving systems of linear and nonlinear equations
- C. Competitive models
- D. Noncompetitive models

What to look for in "proofs"



"Here's your problem—you forgot the sleaze factor."

How Undergraduates Can Succeed: Study Together, and in Small Classes

By ANTHONY DePALMA

College students who study together, meet frequently with advisers and enroll in at least one small class every semester are most likely to excel, according to a report being made public today by Harvard University.

The report, which is expected to influence the way many courses are taught at other colleges and universities, also found that contrary to popular notions about college top students prefer courses that require substantial amounts of writing. They also consider foreign language courses, where classes are small and there is frequent interaction between teacher and students, close to being an academic ideal, the report found.

After five years of study the Harvard researchers concluded that the most effective strategy for an undergraduate to pursue is to make alliances with fellow students, faculty members and advisers, and not try to brave college alone.

"The thing for a student to avoid," said Richard J. Light, a professor of education at Harvard who was director of the assessment project, "is signing up for all large classes, drifting in and out anonymously, sitting in the eighth row working quietly and then going back to the library or a dorm room and applying the seat of the pants to the seat of the chair."

A Five-Year Assessment

The report is the second of two parts of a five-year assessment of what constitutes effective teaching and learning at Harvard and, by extension, at all universities. The first part of the assessment, published last year, found that students learned better and professors were more effective in courses where progress could be tracked through frequent tests, quizzes and one-minute exams at the end of a lesson. Some of its findings and recommendations have been widely copied.

"What the Harvard assessment report identified is important for learn-



Joe Wrinn for The New York Times

Richard J. Light, a Harvard professor and director of the assessment project, recommends avoiding anonymity in large classes.

A new report at Harvard offers tips for students and professors.

ing in all kinds of settings," said Claire L. Gaudiani, president of Connecticut College, a private liberal arts college in New London. Dr. Gaudiani said that in 1990 she encouraged all faculty members at her college to examine the first report and consider following some of its suggestions, and

would do the same with the second report.

The report being made public today contains some recommendations that are simple and easy to adopt. Among them are these:

¶When students are unwilling or unable to organize into study groups that meet outside the classroom, professors ought to set up such groups and require that readings be completed before the groups meet.

¶In courses with several writing assignments professors should ask a few students each week to prepare their papers early so they can be photocopied and distributed for class discussion. Researchers found this encourages students to work harder on their papers and enhances the level of class discussions.

¶Students should not try to get all their required classes out of the way as soon as possible, but each semester should mix in at least one small group or seminar class.

¶Professors in science and mathematics should encourage cooperative learning and study groups rather than place too much importance on competitive grades, which drives interested nonmajors from the field.

Faculty Accessibility

The researchers also found that while students were generally satisfied with their professors' availability during office hours, they did not feel comfortable trying to talk informally to faculty members about personal matters, a failing that often contributed to a sense of dissatisfaction with the academic environment.

Harvard officials concede the shortcoming. "It is clearly the case that some faculty could do a better job of making themselves more accessible," said David Pilbeam, associate dean for undergraduate education at Harvard. But he said it was up to the students to buttonhole busy professors.

"We don't have Mr. Chips here," he said. "If students want that, they should go somewhere else, to a small

liberal arts college."

Among the institutions that studied the first report was the State University of New York at Plattsburgh. Henry C. Morlock, a professor of psychology there, said he has incorporated the one-minute exam into his introductory course, calling it "one of those nice little tricks, effortless and cheap, that tells me what's not getting across to the students."

Group Study Teams

This is one of the hardest things in teaching to know, especially in large classes, he said, adding, "In small classes you can see the puzzled looks on their faces and ask what's wrong, but you can't do that in a big lecture."

Even in small liberal arts colleges, where large classes are not an issue,

the first report prompted change. Bonnie Allison, a professor of child development at Connecticut College, said that after reading the report she was especially impressed with the projected effectiveness of group study teams, which are common in law school settings but not in undergraduate courses.

For her "Children and Society" class, she said, she organizes the 14 students into four groups. Each group is assigned a different Supreme Court case involving children's issues. After reading the decision and determining its most important points, the students present it to the class.

"I read the case more carefully and took very clear notes because I knew I would have to give a presentation about it," said Kristina L. Putalik, a child development major from

Armonk, N.Y., who studied a 1986 case on high school students' First Amendment rights. She and the three other members of her group met in the college library to go over the case, and then spent 45 minutes discussing what it meant.

In a recent class Ms. Putalik gave the background of the case and the others presented the legal implications, and all our fielded questions from their classmates. Then the next study group presented a different case, which the class later discussed.

Ms. Putalik said she came away with a deeper understanding of the issues and a firmer grasp of the cases. "I just find that I learn better from discussions and talking to other people about the same material," she said.