

A Required Discrete Mathematics Course is No Less Important for Mathematics Majors than Calculus I

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Why do students
major in
mathematics?

Typical answers
by both students
and college
mathematics
faculty:

Mathematics
provides good
career
opportunities

These careers include:

K-12 teaching

College teaching

**A stepping stone to law school or
medical school or other professional
programs**

Work in industry (including in the financial industry)

Actuarial sciences

Information sciences (including computer programming)

General government work

Defense Department work

Intelligence services

Statistics consulting

Data science

Publishing

MANY OTHERS!

Many employers value hiring mathematics majors because they see it as a "hard" and "competitive" major.

Students find
the subject
appealing

They have been
signaled they
have
mathematical
talent

*Many other
reasons!*

What courses are
required for the
mathematics
major? (and why?)

At different times since majors were first introduced in college the requirements for majoring in mathematics have changed.

Today, common required
mathematics courses include:

Three semesters of Calculus,
including multivariate Calculus

Linear algebra

Modern (Abstract) algebra

Introduction to proofs

Real analysis (advanced Calculus)

Many degree programs now have different tracks and relatively few courses required in all tracks. However, experience with both *continuous* and *discrete* aspects of mathematics is an issue that should cut across these different tracks.

There is an increasing trend towards requiring courses in "proof."

Why? (Most careers don't require proving theorems)

Some programs no longer require differential equations, often the only course where students see applications of Calculus.

Why these required courses?

a. Inertia - we do what we think worked well recently

b. "Tradition" (reflecting our own experiences)

c. We give too much attention to the needs of students who hope to get a doctorate degree.

The courses I was *required* to take to major in mathematics when I studied at Queens College, now a part of CUNY, (1959-1963)

Analytic Geometry

Calculus I

Calculus II

Theory of Equations

Solid Analytic Geometry

Advanced Calculus I

Advanced Calculus II

Discrete Mathematics

What is it?

Some history:

Finite mathematics

Introduction to Finite Mathematics (1957)

Developed by John Kemeny to provide social science majors with powerful new tools to get insight into their subjects

Also version with J. L. Snell and G. L. Thompson from 1957

Birth of Computer Science (CS)

(Early computer science degree programs were housed in Mathematics or Electrical Engineering Departments)

Eventually, as the field of computer science grew and matured such departments split so that computer science became a department of its own.

Discrete mathematics as a CS service course.

Growing interest in mathematical modeling.

Initial CS programs required Calculus probably more to screen students than because it was a needed "skill."

Discrete can be contrasted with the finite and continuous.

A finite set is discrete but there are discrete sets that are infinite.

Books devoted to discrete mathematics cover a *very wide* array of topics. More than can be done in one semester.

*What courses have should be
required of mathematics majors?*

Ones that meet the needs
of many students

Ones that make us be more
efficient in what we teach.

Topics to include in a required discrete mathematics course:

a. Graph theory

i. Trees

Breadth and depth first search

ii. Traversability (edges; vertices)

iii. Matchings

iv. Algorithms

Some models to cover:

i. Chinese postman problems

ii. TSP

iii. Minimum cost spanning trees

b. Combinatorics

c. Modular arithmetic

d. Solving recursion equations
(difference equations)

e. Hamming and edit distance

f. Bin packing and machine scheduling

g. Gale/Shapley stable marriage theorem

Many more topics than can be done in a semester.

There is also much to be recommended about *requiring* a year long course Mathematics 101-102 that covers Calculus I and discrete mathematics topics.

The required courses for a mathematics major typically represent a mixture of:

- a. Courses that are deemed so important that all graduates with a mathematics major should have been exposed to the content of these courses
- b. Courses that help make it efficient to "deliver" the material in other required courses

Example: The integers mod n are a rich source of important mathematical ideas. Unless they show up early in a required course, one might have to spend time discussing them in a course in number theory, linear algebra, modern algebra, geometry, etc.

Currently discrete mathematics is not typically a required course for mathematics majors, and many mathematics departments in the past taught it primarily as a service course for Computer Science majors, though mathematics majors could take the course as an elective.

Many computer science departments have not been pleased with the version of Discrete Mathematics offered on their behalf.

Specifically, not enough treatment of trees (a special kind of graph) and algorithms.

Some CS Departments have "taken back" teaching their discrete mathematics course from mathematics so as to serve their students better.

Efforts to have discrete mathematics a required course for majors, done through the CUPM process have FAILED. It is not a good idea to wait another 10 years for the next CUPM report!

What can

you do?

If you find my arguments convincing,
together with others that you may have, and
you teach in a Mathematics Department:

Lobby and work to make
Discrete Mathematics a required
course in your department!!

To the extent that
Provosts/Deans/Department Chairs
expect within the profession calls
for changes in a major rather than
what the school mathematics faculty
want, lobby CUPM to recommend
that *Discrete Mathematics* be made
a required course!

Thanks for your attention!

Questions?