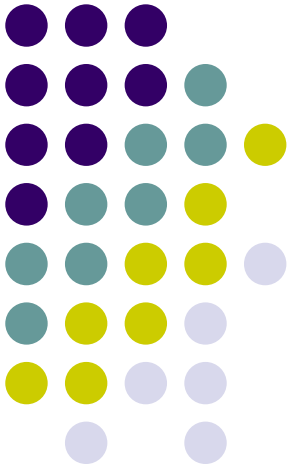
Evolution of Pre-service Program at Fitchburg State College

Mathematics: Foundation for STEM
October 17, 2007

by Mary Ann Barbato



The Initiation

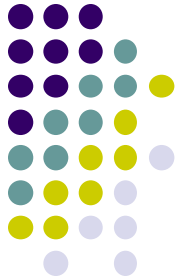
- 2004: Observed Edutron courses with Dr. Christine Cosgrove, FSC Mathematics Dept.
  - Analyzed teaching strategies and techniques
  - Noted sources and technology
- Began meetings with Edutron and FSC Education Dept. (2005)
  - Goal: Revamp the math curriculum for ed. majors.
  - Dr. Claire McAndrew(chair) and Dr. Mark Snyder, FSC Mathematics Dept. became involved

First Action ("Test Run")

Algebra course for ed. majors designed and taught by Dr. Cosgrove and I in Fall 2006

- Special remediation for ed. students who did not pass Algebra Accuplacer (met 4 cr. hrs. per wk.)
- Deep arithmetic review of isolated topics; algebra w/ focus on real number properties & applications
- Justified algorithms, used multiple methods, had students present regularly (camera projector)
- Precise definitions, terminology and instructions
- No calculators on quizzes and exams
- Offered a second time in Fall 2007 (needs to be "approved" to be offered again)

3 Mathematics Courses

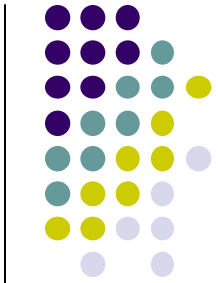


After much discussion, we agreed to require 3 mathematics courses for ed. majors (post remediation). To be approved in fall 2007

- **Informal Geometry** (old course)
- **Informal Number Theory** (new course, approved spring 2007, to be taught for 1st time in fall 2008)
- **Informal Mathematical Modeling** (new course, to be approved in fall 2007)

Courses to be taught by full time math faculty.

Informal Geometry



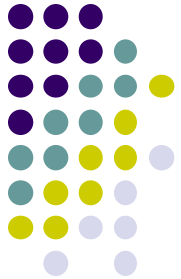
- Euclidean Geometry Review (points, line, angles, intersecting line theorems, types of triangles and elementary triangle theorems, quadrilaterals, Pythagorean Theorem)
- Polygons (including regular, simple, convex, and star)
- Symmetry of polygons (rotations, reflections, and compositions)
- Tessellations of polygons (including regular and semiregular)
- Transformational Geometry (translations, rotations, and reflections in patterns, and compositions of these)

- Measurement(length, area, volume, the metric system & conversions between units & systems)
- Polyhedra (regular & semiregular, symmetry)
- Magnification and Similarity
- Elementary Topology (topological equivalence, networks, Four-Color Problem)

Two or three from the following topics as time permits.

- Fractals
- Number Patterns in Geometry
- Conway Criteria for Tessellations
- Symmetry and Transformation Groups

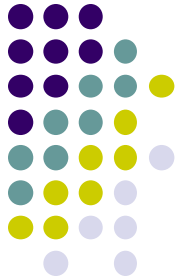
Informal Number Theory



- Integers, positive & negative numbers, primes, rational & irrational numbers; sieve of Eratosthenes
- Number bases: decimal numbers, place value
- Modeling numbers (number line, …)
- Arithmetic with integers: associative, commutative and distributive laws; algebraic foundations of the rules.
- Arithmetic algorithms (adding, subtracting, multiplying); algebraic foundations
- Mental arithmetic & multiplying by powers of 10 and by 9
- Divisibility rules: powers of 10, and 2, 5, 4, 9, 3, primes; algebraic foundations

- Prime Factorization, GCF, LCM
- Mental division; algebraic foundations
- Euclidean Algorithm: GCDs, measuring times & volumes
- Arithmetic with fractions; models & procedures, division algorithms, Modular (clock) arithmetic
- Ratio & Proportion; applications (probability, scaling laws) and models; units & dimensions, converting units
- Sequences and series [arithmetic, geometric, harmonic, Fibonacci], recursive relations, geometric interpretations
- Numbers & geometry I; figural numbers, Pythagorean Theorem
- Numbers and geometry II: graphing lines, graphing non-linear relationships, Fermat's Last Theorem, elliptic curves

Informal Mathematical Modeling



Items below taught to give students a deep understanding of the corresponding concepts.

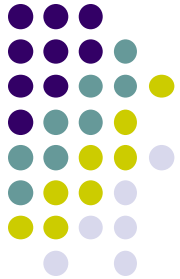
- Relations (concept, examples, applications)
- Functions: independent & dependent variables, domain, range, function notation, different forms (maps, table, set of points, equation, graph), applications.
- Sequences defined as functions & recursively.
- Linear functions: slope & average rate of change applications, linear growth & decay models, line of best fit, view as transformations of identity function f(x) = x. Inverses of linear functions with a focus on applications (e.g. encoding/decoding).

- Systems of linear equations (2 equations, 2 unknowns) with a focus on applications.
- Systems of linear inequalities (2 inequalities, 2 variables) with a focus on applications.
- Quadratic functions with a focus on their graphs, applications and multiple ways of determining properties.

Items below taught to expose students to the corresponding concepts.

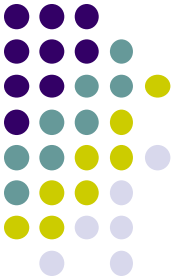
- Exponential functions: focus on graphs & applications.
- Polynomial functions (with degree ≤ 4) as products of linear functions with a focus on graphs and applications.
- Basic rational functions (quotient of two linear functions) with a focus on graphs and applications.

Select one or more of the following as time permits



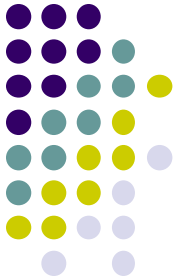
- Logarithmic functions introduced as exponents with a focus on applications (e.g. the Richter scale)
- Root functions as inverses of power functions with a focus on reinforcing the arithmetic concept of various roots
- Absolute value functions with a focus on reinforcing the arithmetic concept of absolute value and applications
- Transformations of non-linear functions with a focus on the effects of adding to and/or multiplying a quantity by a given constant.

Ideal Properties of Courses



- Precise definitions & instructions
- Multiple methods & representations
- Justifying steps
- Some “no calculator” problems
- Regular student presentations
- Classwork & discussions
- Connections to each other
- Applications

Under Discussion



- Arithmetic Accuplacer
- Team Teaching
- Math Education Minor