How stretched is my plan(t)?

Christophe Golé
Smith College

Plan
Applied math at Smith
Course development: Modeling for the Sciences
Biomathematical Sciences Concentration

MOSAIC, IMA 2010
How stretched is my plan(t)?

Christophe Golé
Smith College

Plan

Applied math at Smith

Course development: Modeling for the Sciences

Biomathematical Sciences Concentration

1. **Applied math at Smith**

2. **Course development: Modeling for the Sciences**

3. **Biomathematical Sciences Concentration**
Calculus in context: History

• Started in the 70’s at Hampshire College, where students read primary sources early on in their career
Calculus in context: History

- Started in the 70’s at Hampshire College, where students read primary sources early on in their career
- NSF funded in 1988 - 95, as a Five College initiative. Many people involved. Peter Lax head of advisory committee...
Calculus in context: History

- Started in the 70’s at Hampshire College, where students read primary sources early on in their career.
- NSF funded in 1988 - 95, as a Five College initiative. Many people involved. Peter Lax head of advisory committee...
- “What astounded us, though, was the revelation that differential equations could really be at the center [of a calculus course] – thanks to the use of computers.”
Calculus in context: History

- Started in the 70’s at Hampshire College, where students read primary sources early on in their career.
- NSF funded in 1988 - 95, as a Five College initiative. Many people involved. Peter Lax head of advisory committee...
- “What astounded us, though, was the revelation that differential equations could really be at the center [of a calculus course] –thanks to the use of computers.”
- The book starts with a system of 3 nonlinear ODEs (S.I.R. epidemic model) before introducing derivatives.
Calculus in context: History

- Started in the 70’s at Hampshire College, where students read primary sources early on in their career
- NSF funded in 1988 - 95, as a Five College initiative. Many people involved. Peter Lax head of advisory committee...
- “What astounded us, though, was the revelation that differential equations could really be at the center [of a calculus course] –thanks to the use of computers.”
- The book starts with a system of 3 nonlinear ODEs (S.I.R. epidemic model) before introducing derivatives.
- emphasizes concepts over techniques, geometry over algebra, graphs over formulas, brute force over elegance, numerical solutions over closed-form solutions.
Calculus in context: aftermath

• Almost no one teaches with Calculus in Context anymore
Calculus in context: aftermath

- Almost no one teaches with Calculus in Context anymore
- Lack of modularity?
How stretched is my plan(t)?

Christophe Golé
Smith College

Plan

Applied math at Smith

Course development: Modeling for the Sciences

Biomathematical Sciences Concentration

Calculus in context: aftermath

- Almost no one teaches with Calculus in Context anymore
- Lack of modularity?
- Technology (programming in Quickbasic)?
Calculus in context: aftermath

- Almost no one teaches with Calculus in Context anymore
- Lack of modularity?
- Technology (programming in Quickbasic)?
- Life, and personalities ... ?
Calculus in context: aftermath

- Almost no one teaches with Calculus in Context anymore
- Lack of modularity?
- Technology (programming in Quickbasic)?
- Life, and personalities ... ?
- Yet: At Smith, we’re revamping our Calculus course for student with good HS calc preparation - will still include modeling, differential equations, as well as use of real data.
How stretched is my plan(t)?

Christophe Golé
Smith College

Plan
Applied math at Smith

Course development: Modeling for the Sciences

Biomathematical Sciences Concentration

Numerical methods and differential equations for engineering

• Taught with MATLAB
Plan

Applied math at Smith

Course development: Modeling for the Sciences

Biomathematical Sciences Concentration

Numerical methods and differential equations for engineering

- Taught with MATLAB
- Root finding, linear systems of equations, ODEs and stability, curve fitting, modeling
How stretched is my plan(t)?

Christophe Golé
Smith College

Plan

Applied math at Smith

Course development: Modeling for the Sciences

Biomathematical Sciences Concentration

Numerical methods and differential equations for engineering

- Taught with MATLAB
- Root finding, linear systems of equations, ODEs and stability, curve fitting, modeling
- Problem: “Ghetto” course, almost exclusively engineering students
Numerical methods and differential equations for engineering

- Taught with MATLAB
- Root finding, linear systems of equations, ODEs and stability, curve fitting, modeling
- Problem: “Ghetto” course, almost exclusively engineering students
- Solution?: Modeling in the Sciences, open to all science majors (inc. economics).
How stretched is my plan(t)?

Christophe Golé
Smith College

Plan

Applied math at Smith

Course development: Modeling for the Sciences

Biomathematical Sciences Concentration
Aim of “Modeling for the sciences”

- Integrate scientific computing, math modeling and science in one course
Aim of “Modeling for the sciences”

- Integrate scientific computing, math modeling and science in one course
- Target population: sophomores or well prepared 1st years - of all scientific persuasions
Aim of “Modeling for the sciences”

- Integrate scientific computing, math modeling and science in one course
- Target population: sophomores or well prepared 1st years - of all scientific persuasions
- Gateway course to the new Biomathematical science concentration
MTH/CS 205 Modeling in the Sciences. This course integrates the use of mathematics and computers for modeling various phenomena drawn from the natural and social sciences. Scientific topics, organized as case studies, will span a wide range of systems at all scales, with special emphasis on the life sciences. Mathematical tools include elementary data analysis, discrete and continuous dynamical systems and Markov chains. The course will use scientific software such as Mathematica or MATLAB, and will provide elementary training in programming. Prerequisites: Calculus II, Computer science I recommended.
How stretched is my plan(t)?

Christophe Golé
Smith College

Plan

Applied math at Smith

Course development:
Modeling for the Sciences

Biomathematical Sciences Concentration

People in development team
(June 2010)

• Ileana Streinu (CSC), Denise Lello (BIO), Chris Golé (MTH)
People in development team
(June 2010)

- Ileana Streinu (CSC), Denise Lello (BIO), Chris Golé (MTH)
- Students ranging from high school to postbac, with or without computer experience.
How stretched is my plan(t)?

Christophe Golé
Smith College

Plan
Applied math at Smith

Course development: Modeling for the Sciences

Concentration

Development process

6 weeks group work including:

- Students reading chapters of textbook, and presenting them
Development process

6 weeks group work including:

- Students reading chapters of textbook, and presenting them
- Students going through Mathematica and MATLAB tutorial and labs and editing, developing them
How stretched is my plan(t)?

Christophe Golé
Smith College

Plan
Applied math at Smith
Course development: Modeling for the Sciences
Biomathematical Sciences Concentration

Development process

6 weeks group work including:

- Students reading chapters of textbook, and presenting them
- Students going through Mathematica and MATLAB tutorial and labs and editing, developing them
- Students proposing new activities and exercises
Lessons learned

- Students love Mathematica’s snazzy, accessible animation (Manipulate) capabilities
Lessons learned

- Students love Mathematica’s snazzy, accessible animation (Manipulate) capabilities
- They prefered MATLAB for procedural programing and *its debugging*
Lessons learned

- Students love Mathematica’s snazzy, accessible animation (Manipulate) capabilities
- They prefered MATLAB for procedural programing and *its debugging*
- They like graphics: use Mathematica manipulations, linear transformations, photographic data
Remaining questions

• How much of Mathematica? How much MATLAB?
Remaining questions

- How much of Mathematica? How much MATLAB?
- How much structured curriculum, how much open projects?
Remaining questions

- How much of Mathematica? How much MATLAB?
- How much structured curriculum, how much open projects?
- What book, if any? (Issue: book with technology become quickly obsolete. Books without miss an important part.) (we looked at Tung, Mooney, Moler, Ellner)
How stretched is my plan(t)?

Christophe Golé
Smith College

Plan
Applied math at Smith
Course development: Modeling for the Sciences

Biomathematical Sciences Concentration

The Biomathematical Sciences Concentration allows students to integrate the study of mathematics, statistics, computer science and engineering with biology, biochemistry and neuroscience. **Requirements:**
Biomathematical Sciences Concentration

The Biomathematical Sciences Concentration allows students to integrate the study of mathematics, statistics, computer science and engineering with biology, biochemistry and neuroscience. **Requirements:**

- Gateway course: Modeling in the sciences
Biomathematical Sciences Concentration

The Biomathematical Sciences Concentration allows students to integrate the study of mathematics, statistics, computer science and engineering with biology, biochemistry and neuroscience. **Requirements:**

- Gateway course: Modeling in the sciences
- Bio students take 3-4 intermediary math & stats & cs, and vice versa.
Biomathematical Sciences Concentration

The Biomathematical Sciences Concentration allows students to integrate the study of mathematics, statistics, computer science and engineering with biology, biochemistry and neuroscience. **Requirements:**

- Gateway course: Modeling in the sciences
- Bio students take 3-4 intermediary math & stats & cs, and vice versa.
- two distinct multidisciplinary research experience, one for credit
Biomathematical Sciences Concentration

The Biomathematical Sciences Concentration allows students to integrate the study of mathematics, statistics, computer science and engineering with biology, biochemistry and neuroscience. **Requirements:**

- Gateway course: Modeling in the sciences
- Bio students take 3-4 intermediary math & stats & cs, and vice versa.
- two distinct multidisciplinary research experience, one for credit
- Capstone: a higher level course in BIO, MTH or CS, (e.g. computational biology, dynamical systems) or an honor’s thesis