

Engaging in Pedagogical Development, Applied Scholarship, and Professional Service with SIMIODE

SIAM-ED 2018

Minisymposium on Modeling in Differential Equations Courses –
SIMIODE Resources and Community

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July 9, 2018

Outline

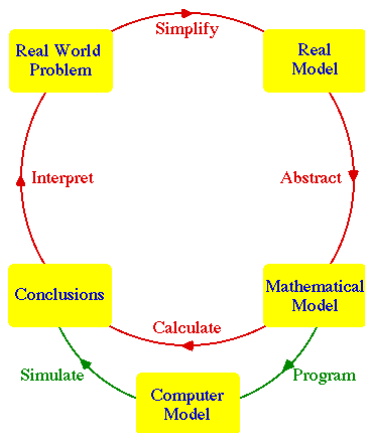
- 1 Motivation
- 2 Improving Pedagogy
- 3 Applied Scholarship
- 4 Professional Service

Goals for Project-Learning Activities

- ① Accountability
 - Track/grade individual contribution in posting and presenting
- ② Communication
 - Oral presentations
- ③ Interdisciplinary
 - Applications require investigation beyond course topics
- ④ Data Integration
 - Generate/access data to analyze
 - Preprocessing
 - Error analysis with model solution
- ⑤ New Problems
 - New context, new format for problem statement

Modeling-Focused Project Integration

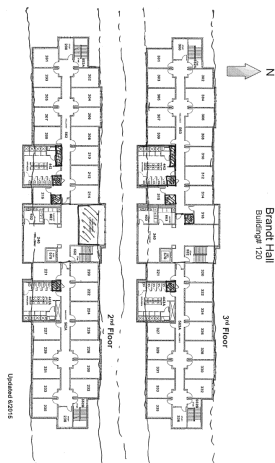
- 1 Generate data motivated by reality to introduce project
- 2 Analyze data to develop model
- 3 Solve and evaluate model
- 4 Segue into topics motivated by the project



Example Project: 1st order equations

Simulating the Spread of the Common Cold

- Generate data with hands-on simulation
- Analyze data for patterns (DFIELD applet)
- Develop, analyze, and solve ODE models with parameters
- Estimate parameters and evaluate model
- Segue into topics motivated by the project
 - Separable method
 - Slope field and phase line
 - Numerical methods



Attributes of Project-Based Learning

- 1 Open-ended driving question
 - 1 Creates a need to know
 - 2 Inquiry to learn something new
- 2 Critical thinking, Collaboration, and Communication
- 3 Student voice and choice
- 4 Incorporates feedback and revision
- 5 Publicly presented

Evaluation through Feedback

- Likert scales encourage focused feedback: *“Projects for this course...”*
 - (1) *Added new perspectives on the content covered in homework”*
 - (2) *Helped me understand and engage with course concepts more fully”*

Mean	Strongly	Disagree:	No Opinion:	Agree:	Strongly
Response	Disagree: 1	2	3	4	Agree: 5
15-16 (1)				4.2	
15-16 (2)				4.1	
16-17 (1)				4.1	
16-17 (2)				4.6	
17-18 (1)				4.1	
17-18 (2)				4.2	

SIMIODE Community

- User
 - Resources: Modeling Scenarios, Technique Narratives, Online Texts, Sample Syllabus
- Author
 - Standard Submissions: News, Links to other resources
 - Peer-reviewed Publications: Modeling Scenarios, Technique Narratives
- Promoter
 - Conference presentations: See examples and share your own
- Organizer
 - SCUDEM: Local host, team coach
 - SIMIODE Events: Information on upcoming competitions, workshops, and conference sessions

Modeling-First Pedagogy

- Resources
 - Repositories, Journals, Databases
- Training
 - SIMIODE Workshops: DEMARC, MINDE, and at SCUDEM
 - Conference Minicourses: MathFest
- Promotion
 - SCUDEM
 - Conference sessions: SIAM-ED, MathFest, JMM, etc.

Resources for Projects

- Repositories
 - SIMIODE: Differential Equations (www.simiode.org)
 - Project MOSAIC: Calculus (mosaic-web.org)
- Journals
 - CODEE journal: Differential Equations Teaching Resources
 - PRIMUS journal: General Math Teaching Resources
 - MAA Journals: Expository Mathematics and Teaching Resources
- Public Data
 - National Oceanic and Atmospheric Administration (NOAA): www.noaa.gov
 - Bureau of Economic Analysis (BEA): www.bea.gov
 - World Health Organization (WHO): www.who.int

Project Implementation Best Practices

- Start small
 - One project in one class
 - Short class-wide project
- Minimize additional workload
 - Reduce evaluation/grading
 - Model group work
 - Course management system
 - Use technology on hand
- Reinforce project purpose
 - Continuity between project and course content
 - Fair division of group work

Example Course Structure

MATH 311: Differential Equations with Linear Algebra (75 minutes, 3 days)

Three 2-Week Projects

- Groups assigned with some choice
- Open-ended problems/problem choice
- Write-up: Series of linked wiki pages
 - Describe the phenomena modeled
 - Derive the model system (assumptions, variables, and initial conditions)
 - Analyze model and solution
- Short oral report in class recorded as a screencast

SIMIODE NSF-Funded Workshops

www.simiode.org/nsfdevworkshop

Next deadline: May 1, 2019

- DEMARC: Differential Equations Model And Resource Creators
 - July 14-20, 2019 at George Fox University in Newberg, OR
- MINDE: Model INstructors in Differential Equations
 - July 20-26, 2019 at George Fox University in Newberg, OR

DEMARC Workshop Overview

A challenging, invigorating, supportive, and innovative faculty development opportunity to create new curricular materials that enhance the teaching and learning of undergraduate differential equations in a modeling-first approach.

- NSF-funded transportation, room and board, and stipend
- Expectations:
 - Create application modules for publication in SIMIODE
 - Serve SIMIODE community as referee
- Training:
 - Personal strategic planning
 - User-driven development
- Collaboration:
 - Activity testing
 - Peer review

Extract Activities from Research

- SIMIODE Modeling Scenarios
- SIMIODE Technique Narratives
- Personal example:

“Modeling Algae Self-Replenishment,” *Journal of Interdisciplinary Mathematics*, Vol. 11, pp. 681-694 (October 2008).

“Algae Population Self-Replenishment,” *SIMIODE*, 6(20) pp. 1–11 (December 2015).

“Algal Blooms Threatening Lake Chapala,” *SIMIODE*, 1(65) pp. 1–13 (July 2016).

Spur Research with Students

- Involve in open-ended class projects
- Introduce to mathematical research
- Encourage research grant applications
- Personal example:

“Steady and Stable: Numerical Investigations of Nonlinear Partial Differential Equations.” Contributed Chapter in A. Wootton, V. Peterson, C. Lee. (eds.) *A Primer for Undergraduate Research: From Groups and Tiles to Frames and Vaccines*, Birkhäuser (2017)



Improve Pedagogy

- SOTL: Scholarship Of Teaching and Learning
- Personal example:

“Simulating the Spread of the Common Cold,” *SIMIODE*, 1(37) pp. 1–13 (November 2016).

“Logistics of Mathematical Modeling-Focused Projects,” *PRIMUS: Special Issue on Project-Based Curricula*, Vol. 28(4), pp. 360–385 (March 2018)

Professional Service

- Review
 - SIMIODE referee
 - Publication user
- Share
 - Departmental discussions
 - Conference talk
- Host & Organize
 - SCUDEM local host or team coach
 - Organize a conference session
- Train
 - Organize a workshop

Student Competition Using Differential Equations Modeling

After eight days with a problem, three-member teams of high school/college students present a 2-page executive summary and 10-minute talk on a Saturday at a nearby regional host site.




Next Competition: SCUDEM III: October 27, 2018
SCUDEM Host Training: MathFest & JMM

(Currently seeking local host sites to add to those shown below)



Thank You

SIMIODE community provides opportunities to **improve your teaching, apply your scholarship, and engage in meaningful service** to the greater mathematical community.

-  Harwood, R.C. 2017. “Steady and Stable: Numerical Investigations of Nonlinear Partial Differential Equations.” Contributed Chapter in A. Wootton, V. Peterson, C. Lee. (eds.) *A Primer for Undergraduate Research: From Groups and Tiles to Frames and Vaccines*. Birkhäuser.
-  Ambrose, S., M. Bridges, M. Lovett, M. DiPietro, M. Normann. 2010. *How Learning Works: 7 Research-based Principles for Smart Teaching*. San Francisco, CA: Jossey-Bass.
-  Mergendoller, J., and N. Maxwell. 2006. The effectiveness of problembased instruction: A comparative study of instructional methods and student characteristics. *The Interdisciplinary Journal of Problem-Based Learning*. 1(2): 49–69.