Building sustainable systems that support success of underrepresented students

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Growth & Demographics of Physics Majors

- 3 Year Average:
  Up ~1500% since early 1990’s (127 today)

- 3 Year Average:
  Up ~400% since early 1990’s (normed to undergrads)

- Better than National Trend
Take Away: A diverse set of students are succeeding at FIU

Why?
Research underpinning development of supportive systems

Community Matters
• Academic and Social Integration key to retention
  (Tinto, 97; Nora, 06)
• Classroom entry point to community (Kreamer, 97)
• Identify as physics person
  (Hazari et al., 10)
• Self Efficacy better predicts success and persistence
  (Hackett & Betz, 1989; Sawtelle forthcoming)

Learning Environment Matters
• Attend to Introductory Classes (Waxman, Padron, Garcia, 07)
• Develop Deep Understanding (Lynch, 00)
• Engaging (Barba & Reynolds, 98)
• Collaborative (Cabrera et al., 02)
FIU Physics Educational System

Context
Recruitment
Support

Educational Reform
Community
Advocacy

Learning as participation
Induction
Participation
Engagement
Research
HSI
Center for High Energy Physics Research and Education Outreach (CHEPREO)

- Goal of increasing participation in science at FIU
- Substantial Education Outreach component coupled with EPP / Grid Computing / Networking “Cool Science”
- Comprehensive Approach:
  - Outreach / Classroom Reform / Physics Education Research
  - Research and Learning Community
  - Learn How to Support All Students
- Began in 2003 / Located in Miami, Florida
- NSF Grant #0312038, #0802184
CHEPREO’s EO Activities

Modeling Physics Classes
- Authentic scientific experiences embedded in instruction
- Lecture-free environment
- Students are active collaborators
- Instructors use scientific rigor to evaluate learning impact

Physics Learning Center
- Physical space where students engage academically and socially
- Facilitates collaboration and integration into physics
- Nucleus of Learning Community
Learning Environment
Modeling Instruction

• What do Scientists do?
  • Build / Validate / Deploy Models
  • Can Learning Follow that Path?
  • What is value of students doing science to learn science?

• Modeling Instruction Replicates Scientist’s Activities

• Studio Course: Lab + Lecture time combined / no lecture

• Build, validate, deploy, extend and communicate models through inquiry labs and activities, conceptual reasoning and problem solving
Learning Environment
Modeling Classes

FCI Scores Modeling and Lecture

- Modeling (N=258)
- Lecture (N=758)

Pre:
- Modeling: 31.5%
- Lecture: 33.1%

Post:
- Modeling: 61.9%
- Lecture: 47.9%

Raw Gain:
- Modeling: 30.4%
- Lecture: 14.8%
Learning Environment
FCI by Ethnicity

FCI Scores In Modeling By Ethnicity

- Mod UR (N=199)
- Mod MAJ (N=55)

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<td>36.7%</td>
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Learning Environment
Modeling Classes - Attitudes toward Physics

- Improved Attitudes for Physics
- First Measured in Intro Physics
Learning Environment
Success Rates in Intro Physics

Impacting Students’ Success

Overall DFW Reduction by a factor > 4
Learning Environment
Modeling Classes - Self Efficacy

- Self Efficacy - Ones belief in their ability to complete a task
- Strongly related to physics identity.
- Self Efficacy as measured by Sources of Self Efficacy in Science Classes-Physics
  - For all students, Pre Instruction Self Efficacy predicted success in introductory physics
  - No shifts in Self Efficacy in Modeling students, Large negative shifts in lecture classes. (Sawtelle et al., 2010)
Learning Environment
Modeling Classes - Fostering Collaboration

“Who do you work with to learn physics?”

Square = Student
Line = Reported Study Partner

30 Modeling students
39 lecture students

(24 isolates)
Learning Environment: Modeling classes - Summary

- Clear improvements in conceptual understanding
- Markedly better student success rate
- Improved attitudes toward science
- No shifts in Self-efficacy - especially social persuasion which is predictive of success for women.

- Fosters collaboration among students

However, it is insufficient to explain growth of # of physics majors...
Learning Community: Physics Learning Center

- Conference room, Lounge with kitchen
- Modeling classroom available while Modeling class is not in session.
- Open Lab Hours - Computers / whiteboards
- Academic and Social Interactions
  - SPS Meetings (FIU Club of Year 2008, National Recognition - Gary White of APS)
  - Homework Space
  - Thanksgiving Dinner
  - Game Night
Learning Community:

- Methods of Social Network Analysis

- Students respond to electronic survey - “Who do you work with to learn physics”
  - 99 respondents → 99x99 Matrix

- Demographic questions (Gender, Ethnicity, Major, # of days/week in PLC, Time/week in PLC, Intro Course Type)
  - Sociograms
  - Calculate Centrality
  - Sequential Regression

- Two variables predict centrality (Days/week in PLC + Major)

- Gender and Ethnicity did not contribute

(Brewe, 09; forthcoming)
Learning Community:
PLC by Major

(Brewe, 09; forthcoming)
Learning Community:
PLC by Days/Week

Isolates

(Brewe, 09; forthcoming)
Learning Community
Student Perspective

- Qualitative research into student perception of learning community
- Students interviewed 3 times

From her interviews:
Became a Learning Assistant instructor
Reports increasing integration with into FIU community
Views group work as scientifically authentic and useful for future career goals

Which shows:
Both a formal and informal teacher
Attributes participation in Modeling reduced chances of dropping out
Adopting values of the community she learns in

(Goertzen, forthcoming)
Educational Systems: Comprehensive Educational Paradigm

- Sustainably Education Transform Landscape
- Take comprehensive approach
- Ensure early positive learning environment
- Multiple entry points to physics community
- Make sure they have the opportunity to feel like they belong in physics department.
“When students become excited about their own learning and empowered to help others, they are the best recruiters and teachers of new students. (News flash: students can learn more from their peers than from faculty!) Students must be given departmental space for study and for socializing and resources to support their initiatives. The outcome is magical.”
Thank You
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Advocacy

- Makes stuff happen

- Faculty
  - Funding
  - Program
  - Research to document successes
  - Research opportunities for students
  - Mentoring
  - Promotion of Physics as a major/career
  - Promotion of Physics Teaching

- Students
  - Recruiting
  - Enthusiasm
  - Peer Mentoring
  - Direction
  - Perpetuate the culture

- Administrative - Chairs, Deans, Provost, President
  - Protection
  - Support
  - Position efforts to succeed within university
  - Liaison with broader community