Creating a Coherent Gateway for STEM Teaching and Learning at MSU

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Why Gateway Courses?

“The first two years of college are the most critical to the retention and recruitment of STEM majors.”

– PCAST, 2012
“DBER and related research have not yet prompted widespread changes in teaching practice among science and engineering faculty. **Strategies are needed to effectively promote** the translation of findings from DBER into practice.”
## Categories of Change Models

<table>
<thead>
<tr>
<th>Aspect of System to be Changed</th>
<th>Intended Outcome</th>
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<tbody>
<tr>
<td>I. Disseminating: <strong>CURRICULUM &amp; PEDAGOGY</strong></td>
<td>Prescribed</td>
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<tr>
<td>Change Process: Tell/Teach individuals about new teaching conceptions and/or practices and encourage their use.</td>
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<td>Examples: dissemination/training (SER, FDR), focused conceptual change (FDR)</td>
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<td>II. Developing: <strong>REFLECTIVE TEACHERS</strong></td>
<td>Emergent</td>
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<td>Change Process: Encourage/Support individuals to develop new teaching conceptions and/or practices.</td>
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<td>Examples: reflective practice (FDR), curriculum development (SER), action research (FDR, SER)</td>
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<td>III. Enacting: <strong>POLICY</strong></td>
<td>Prescribed</td>
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<tr>
<td>Change Process: Prescribe new environmental features that Require/Encourage new teaching conceptions and/or practices.</td>
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<td>Examples: policy change (HER), strategic planning (HER)</td>
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<td>IV. Developing: <strong>SHARED VISION</strong></td>
<td>Emergent</td>
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<td>Change Process: Empower/Support stakeholders to collectively develop new environmental features that encourage new teaching conceptions and/or practices.</td>
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<td>Examples: institutional transformation (HER), learning organizations (HER)</td>
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</tbody>
</table>

*Figure 1. Overview and conceptual underpinnings of the four categories of change strategies.*

- Henderson, Beach, Finkelstein; JRST 2011
Enacting Policy

Figure 1. Overview and conceptual underpinnings of the four categories of change strategies.
Enacting Policy

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STEM Alliance

- Focused on instruction and student learning
- Promote interaction between colleges, research groups, etc
- Three meetings so far
- ~60-80 faculty/meeting
- Next meeting in August; about this project
Enacting Policy

Figure 1. Overview and conceptual underpinnings of the four categories of change strategies.
Developing Reflective Teachers

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STEM Gateway Fellows

• For faculty interested in working on instruction in gateway courses
• First cohort is 9 Fellows from across physics, chemistry, biology, statistics
Developing Reflective Teachers

**Figure 1.** Overview and conceptual underpinnings of the four categories of change strategies.
Developing Shared Vision

- **I. Disseminating:** CURRICULUM & PEDAGOGY
  - **Individuals:**
  - **Prescribed:** STEM Alliance
  - **Emergent:** Disciplinary Discussions

- **II. Developing:** REFLECTIVE TEACHERS
  - **STEM Gateway Fellowship**

**Figure 1.** Overview and conceptual underpinnings of the four categories of change strategies.
Disciplinary Discussions

• Engage faculty from the disciplines in conversations about:
  • What should students know?
  • What should students be able to do with that knowledge?
  • How can we tell if students are able to do these things?
Inert Knowledge

- Physics: For every action, there is an equal and opposite reaction
- Chemistry: Atoms want full shells
- Biology: Mitochondria is the powerhouse of the cell
Traxoline

It is very important that you learn about Traxoline. Traxoline is a new form of zointer. It is montilled in Ceristanna. The Ceristannians gristeriate large amounts of fevon and then bracter it to quasel traxoline. Traxoline may well be one of our most lukized snezlaus in the future because of our zointer lescelidge.
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3. How is Traxoline quaselled?
Science isn’t just content

“Science is more than a body of knowledge. It’s a way of thinking; a way of skeptically interrogating the universe with a fine understanding of human fallibility.” – Carl Sagan, January 5th, 1995
Disciplinary Discussions

• Focus on:
  • Scientific Practices
  • Crosscutting Concepts
  • Disciplinary Core Ideas

Scientific Practices

1. Asking questions
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Crosscutting Concepts

1. Patterns
2. Cause and effect
3. Scale, proportion, and quantity
4. Systems and system models
5. Energy and matter: Flows, cycles, and conservation
6. Structure and function
7. Stability and change

Disciplinary Core Ideas

1. Essential to the study of the discipline
2. Required to explain lots of phenomena
3. Provide a way to generate new ideas and predictions
Disciplinary Core Ideas

- **Physics**
  - Energy, Heat, & Work
  - Charge & Current
- **Chemistry**
  - Matter is composed of atoms
  - Molecular structure predicts macroscopic properties
- **Biology**
  - Evolution
  - Cell Theory of Life
Disciplinary Discussions

- Currently underway in physics, chemistry, and biology
- Discussing first and second semester courses
- Developing 3D-L performance expectations & assessments
Developing Shared Vision

Figure 1. Overview and conceptual underpinnings of the four categories of change strategies.
Disseminating Curriculum

Figure 1. Overview and conceptual underpinnings of the four categories of change strategies.
Course Transformations

Engaging faculty in discussions of core ideas and practices promotes change

Changes in assessments

Changes in classroom instruction
Experimental Courses

- DBER faculty are already teaching/developing courses more aligned with 3D-L
  - Biology and chemistry started last year
  - Physics begins in the fall
- Provide environments to refine 3D-L aligned instruction and assessments
Curriculum Development

- Experimental courses & disciplinary discussions are the basis for developing the departments’ introductory curricula
Supports for Cultural Change

Figure 1. Overview and conceptual underpinnings of the four categories of change strategies.
Data collection

• Collecting exams, homework, and learning objectives from affected courses
• Video recording three classes from each course
• Collecting course grades
• Interviewing students enrolled in transformed courses
• Surveys
• Persistence data
Measuring Change

- Retention
- Motivation & Attitudes
- Gender and under-represented minority differences
- How do the assessments change? (3D-LAP)
- How does the instruction change? (3D-LOP)
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• Cori Fata Hartley
• Tammy Long
• Physics/Bio/Chem Faculty
Discussion Questions

• What other data should we collect?
• What other measures of change should we be looking at?
Figure 1. Overview and conceptual underpinnings of the four categories of change strategies.