Studying Change in STEM Higher Education

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More at: http://www.stemreform.org


Facilitating Change in STEM Education

Four Categories of Change Strategies from an interdisciplinary literature review

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More at: http://www.stemreform.org

Common Goal

shift from instruction paradigm to the learning paradigm*

<table>
<thead>
<tr>
<th>The Instruction Paradigm</th>
<th>The Learning Paradigm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional Physics class at University of Rochester</td>
<td>Clicker use at UC Riverside</td>
</tr>
<tr>
<td>Workshop Physics Classroom at Dickinson College</td>
<td>White boards at Western Michigan University</td>
</tr>
<tr>
<td>SCALE-UP Physics class at Clemson University</td>
<td></td>
</tr>
</tbody>
</table>


Starting Point:

We know a lot about:

- effective teaching and learning of STEM subjects
- how to apply this knowledge in individual classrooms

Now all STEM classrooms produce knowledgeable, skilled students who have positive attitudes toward science …
Why Change Strategies are Important
Evolving Change Strategies of the Foundation Coalition*

Foundation Coalition:

• What: 6 institutions to develop and implement a new 4-year engineering curriculum
• When: First grant – 1993-1998 ($14M)

Implicit Change Strategies Inferred by Researchers (Clark et. al., 2004)

Initial Change Strategy
Develop the curriculum
Pilot and gather student performance data
Curriculum is adopted

2nd Generation Change Strategy
Develop multiple ways to persuade colleagues
Curriculum is adopted

3rd Generation Change Strategy
Make it work for all students and faculty
Curriculum is adopted

4th Generation Change Strategy
Devise structures to sustain use
Curriculum is adopted

Literature Search: Models of Change in STEM Ed

- ~ 400 Articles
- Primary Databases: Web of Science, ERIC
- Search Terms: change, improvement, reform, teaching, instruction, higher education, college, university, tertiary
- Dates: 1995-2008
- Use Title and Abstract to determine inclusion
- Subset (130) used to identify 4 core strategies and sub-categories & preliminary findings
- Applied to remaining
- Delphi (distilling findings from experts)

Key Findings

- Isolated communities
- Little connection to prior literature
- Little connection to research / experimental studies
- Meta-level categorization scheme suggests 4 key approaches

http://www.stemreform.org
http://homepages.wmich.edu/~chenders/Projects.htm
Two Important Strategic Dimensions

What does the change effort intend to directly impact?

<table>
<thead>
<tr>
<th>Individuals</th>
<th>Environments and Structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>personal characteristics of single individuals, such as beliefs, knowledge, behaviors, etc.</td>
<td>impact characteristics of the system such as rules, physical characteristics of the environment, norms, etc.</td>
</tr>
</tbody>
</table>

Implicit Assumption: Individuals’ actions influenced by own volition

Implicit Assumption: Individuals’ actions influenced by external environments

To what extent is the outcome prescribed in advance?

<table>
<thead>
<tr>
<th>Prescribed Final State</th>
<th>Emergent Final State</th>
</tr>
</thead>
<tbody>
<tr>
<td>final state is known at the beginning of process</td>
<td>final state is developed as part of the process.</td>
</tr>
</tbody>
</table>

Implicit Assumption: Important knowledge known to a few people (e.g., experts). Small group should determine the intended outcome.

Implicit Assumption: Important knowledge throughout the system. Variety of stakeholders should be involved.
Four Categories of Change Strategies

- **Prescribed Final Condition**
  - Tell/teach individuals about new teaching conceptions and/or practices.
  - Encourage individuals to develop new teaching conceptions/practices.
  - Develop new environmental features that require/encourage new teaching conceptions and/or practices.
  - Empower collective development of environmental features that support new teaching conceptions/practices.

- **Prescribed Final Condition**
  - Individuals
  - Environment/Structures
  - Policy
  - Curriculum & Pedagogy
  - Reflective Teachers
  - Shared Vision
  - Learning Organizations

Each Strategy has a Unique Emphasis

- **Prescribed Final Condition**
  - Developing Curriculum & Pedagogy
  - Developing Policy

- **Emergent Final Condition**
  - Developing Shared Vision
  - Developing Reflective Teachers

- **Prescribed Final Condition**
  - Developing Policy
  - Developing Curriculum & Pedagogy
Each Strategy has a Unique Change Agent Role

- Direct/Manage
- Teach/Tell
- Encourage
- Empower/Catalyze

Each Strategy has different Process

- Prescribed Final Condition
- Emergent Final Condition

Adapted from A. Van de Ven, Facilitating Change Conference, Jun 2008:
http://www.wmich.edu/science/facilitating-change/
Each change strategy sees areas of influence of other strategies as outside of their control.

- **Curriculum & Pedagogy**
  - Most faculty do not have the skills to develop effective curricula.
  - Departmental colleagues teach very traditionally and are skeptical of innovation.

- **Environment/Structures**
  - Few rewards for curricular innovation and institutional infrastructure does not support innovative teaching.
  - Faculty are not typically rewarded for instructional innovations.
  - Faculty desire more discussions and collaboration related to their teaching.

- **Individuals**
  - Universal remedies for good teaching are not effective – teaching is context dependent and
  - Faculty are not typically rewarded for instructional innovations.

- **Reflective Teachers**
  - Universal remedies for good teaching are not effective – teaching is context dependent and
  - Faculty are not typically rewarded for instructional innovations.

- **Prescribed Final Condition**
  - Few rewards for curricular innovation and institutional infrastructure does not support innovative teaching.

- **Emergent Final Condition**
  - Departmental colleagues teach very traditionally and are skeptical of innovation.
  - Faculty desire more discussions and collaboration related to their teaching.
Each change strategy sees areas of influence of other strategies as outside of their control.

- Most faculty have no formal training in teaching and learning.
- Faculty do not believe that assessing and reflecting on their teaching would be productive.
- Norms of faculty autonomy make faculty reluctant to critique the teaching of their colleagues.

Key Implication:
working across quadrants
- Identifying Change Levers / Agents
- Top down meets bottom up
- Coordinate Processes
- Attend to scales: temporal, spatial, cultural
facilitated through research

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The person who says it cannot be done should not interrupt the person doing it.

- *Chinese proverb*

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