

Barriers and Promises in STEM Reform Part 2: The Study and Improvement of STEM Change Strategies



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Another Perspective - Published Literature Relevant to College-Level STEM Reform

Main Points

- STEM change agents primarily use a development and dissemination change model
- Change agents from other disciplines use other change models
- STEM change agents do not treat the improvement of change models and strategies as a scientific problem to be solved:
 - **Most articles do not reference any change literature**
 - **Most articles do not document the success (or failure) of change efforts**

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Collaborators



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Three Groups Focused on Change in Undergraduate STEM Instruction

Disciplinary STEM Education Researchers (SER)

Housed in the **STEM disciplines in College of Arts and Sciences or Engineering, Sometimes in College of Education**

Faculty Development Researchers (FDR)

Housed in **Center for Teaching and Learning**

Higher Education Researchers (HER)

Housed in **College of Education or Administration**

Each group has their own professional societies, conferences, journals, etc.

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Three Recent Literature Reviews

Disciplinary Science Education Researchers (SER)

Seymour, E. (2001) Tracking the process of change in us undergraduate education in science, mathematics, engineering, and technology. *Science Education* 86, 79-105.

Faculty Development Researchers (FDR)






Emerson, J. D. and Mosteller, F. (2000) Development programs for college faculty: Preparing for the twenty-first century. In *Educational media and technology yearbook 2000* (Vol. 25) (Branch, R.M. and Fitzgerald, M.A., eds.), pp. 26-42.

Higher Education Researchers (HER)

Kezar, A. J. (2001) Understanding and facilitating organizational change in the 21st century: Recent research and conceptualizations. *ASHE-ERIC Higher Education Report* 28 (4), 1-162. (Available online: <http://dx.doi.org/10.1002/aehe.2804>)

Three Groups - One Common Goal

Transform undergraduate education from the instruction paradigm to the learning paradigm*

The Instruction Paradigm	The Learning Paradigm
 <p data-bbox="435 1696 699 1724">Traditional Physics class</p>	<div style="display: flex; flex-wrap: wrap;"> <div style="width: 50%;">  <p data-bbox="824 1507 954 1543">Clicker use at UC Riverside</p> </div> <div style="width: 50%;">  <p data-bbox="1023 1528 1205 1564">White boards at Western Michigan University</p> </div> <div style="width: 50%;">  <p data-bbox="824 1703 966 1759">Workshop Physics Classroom at Dickinson College</p> </div> <div style="width: 50%;">  <p data-bbox="1002 1724 1187 1759">SCALE-UP Physics class at Clemson University</p> </div> </div>

*From Barr, R. B. and Tagg, J. (1995) From teaching to learning - a new paradigm for undergraduate education. *Change* (November/December), 13-25.

Three Groups - No Communication

No overlap in references! → No communication between groups

Field	Article	Number of References
[SER]	Seymour (2001)	77
[FDR]	Emerson & Mosteller (2000)	34
[HER]	Kezar (2001)	280

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A Larger Literature Review: Preliminary Results*

Current Status:

- **Literature Search**
 - ~400 relevant journal articles identified
- **Preliminary Analysis**
 - Use 130 articles (randomly selected) to develop four categories of change strategies
 - Use 43 articles (subset of the 130) to identify subcategories and analyze i) strength of data presented and ii) connection to change literature
- **Ongoing Analysis (target completion date – Feb 2009)**
 - Complete analysis of remaining articles – modifying categories and coding criteria as necessary
- **Next Steps (Winter and Spring 2009)**
 - DELPHI (distilling knowledge from a group of experts)
 - Validity check (comparison of articles to grant reports)

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Categories of Change Strategies Based on Two Dimensions

1. What does the change effort intend to directly impact?

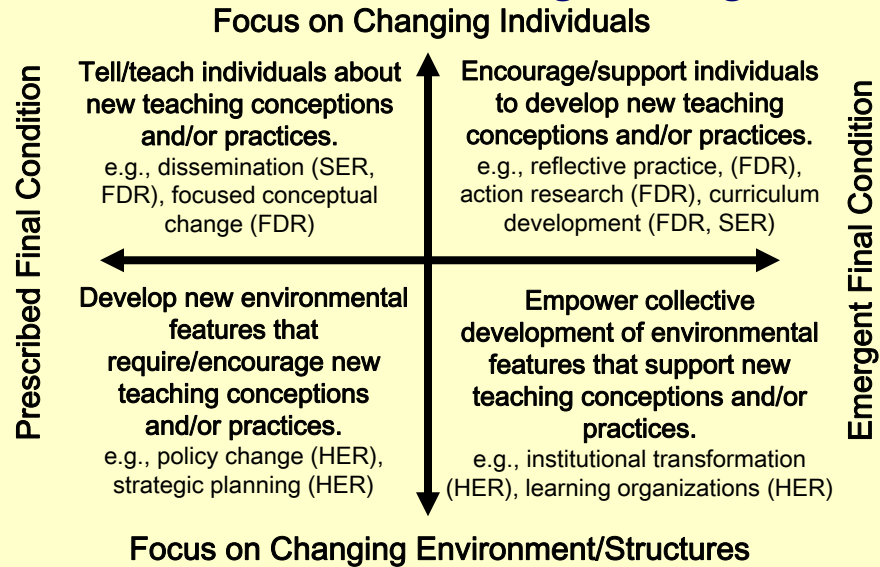
Individuals	Environments and Structures
The change intends to directly impact personal characteristics of single individuals, such as beliefs, knowledge, behaviors, etc.	The change intends to directly impact extra-individual characteristics of the system such as rules, physical characteristics of the environment, norms, etc.

Categories of Change Strategies Based on Two Dimensions

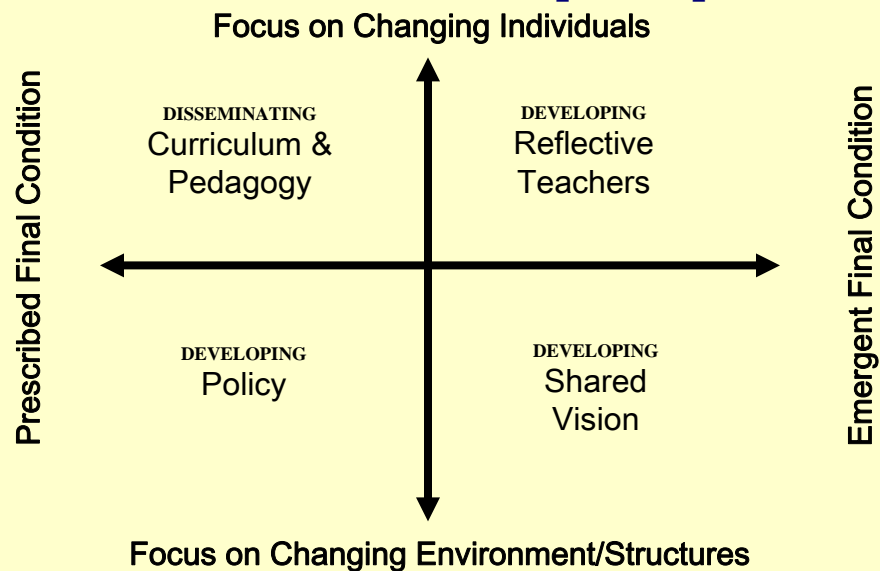
2. To what extent is the outcome prescribed in advance?

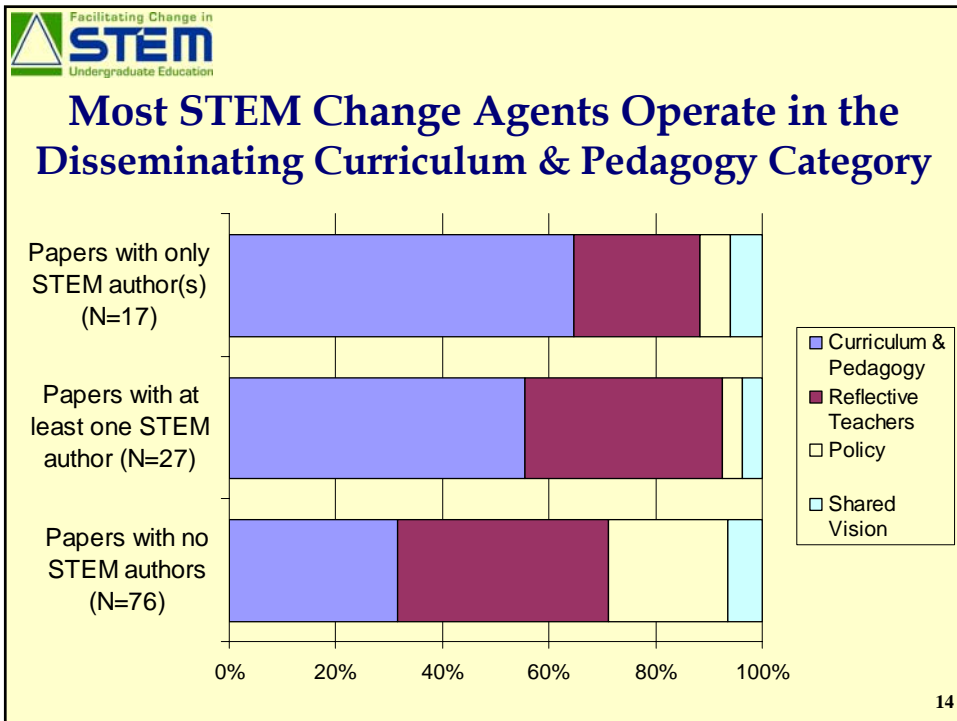
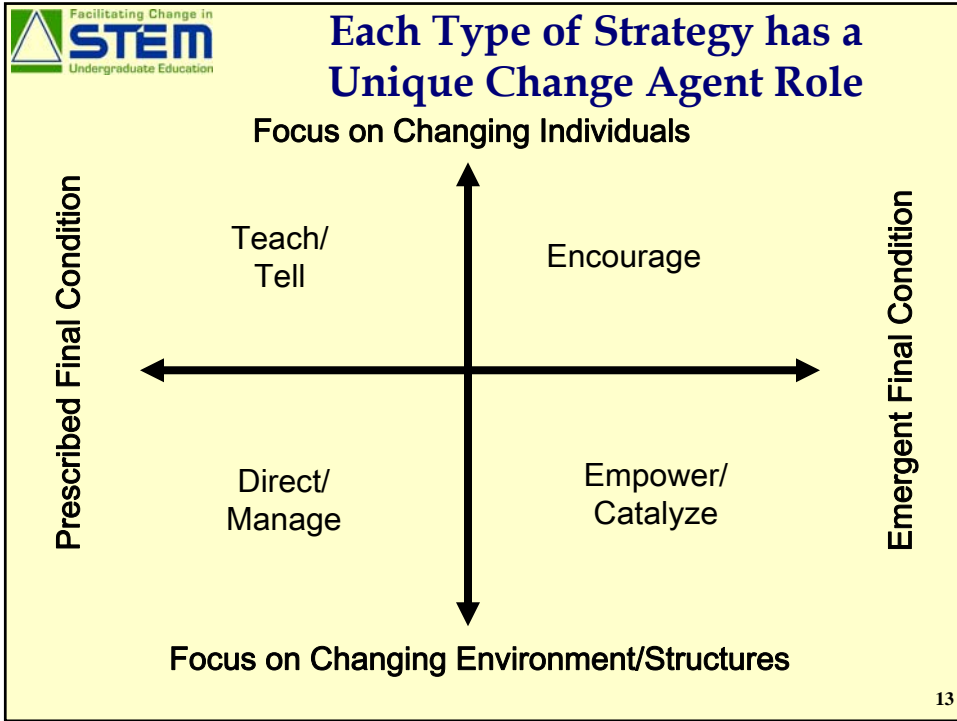
Prescribed Final State	Emergent Final State
The desired final state for the individual or environment is known at the beginning of the change process.	The desired final state for the individual or environment is developed as part of the change process.

Four Categories of Change Strategies



Each Type of Strategy has a Unique Emphasis





Relationship to Change Literature

Many articles made no connection with any change literature (despite a very liberal definition of “change literature”)

Articles Making A Connection to Change Literature	
Articles with at least one STEM author	5/12 = 42%
Articles without a STEM author	16/31 = 52%

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Evidence of Success*

Many articles present little or no evidence of the success (or failure) of the change strategy implemented.

Articles that Present at Least Moderate Evidence of the Success (or failure) of the change strategy	
Articles with at least one STEM author	2/7 = 29%
Articles without a STEM author	10/23 = 43%

*13/43 articles did not present a specific change strategy and are not included in the counts on this slide.

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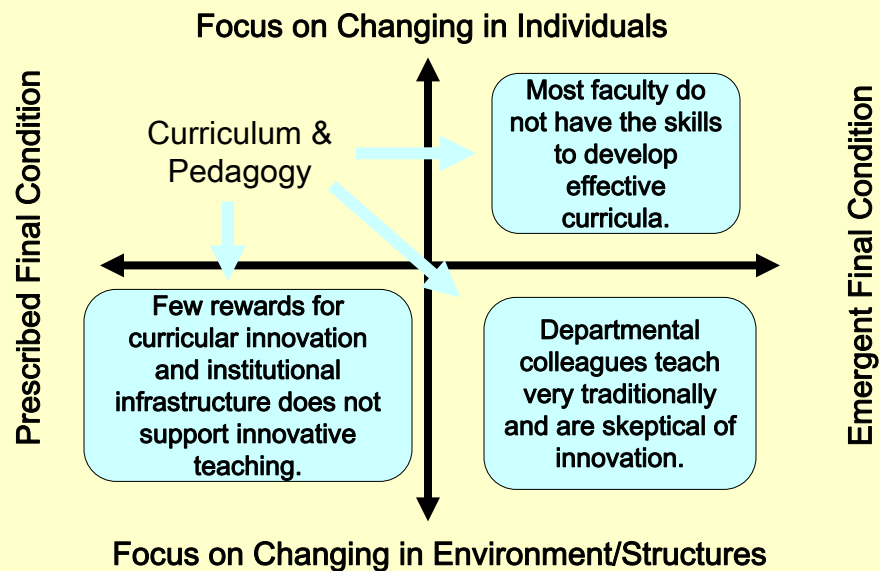
Three Isolated Research Communities

Each has a different and important perspective.

There is little interaction between groups and minimal interaction within groups

(Based on a citation analysis within the complete set of articles.)

Each change strategy sees areas of influence of other strategies as outside of their control



Summary

- **STEM change agents frequently:**
 - **operate within the change category of disseminating curriculum and pedagogy.**
 - **do not attempt to test the effectiveness of their change strategies.**
 - **do not build their change strategies on the work of other STEM change agents or on knowledge of change strategies/models from other disciplines.**

Recommendations

STEM Change Agents Should:

- **Develop change strategies/models that span categories by drawing from other research communities.**
- **Collect and use data to test and improve change strategies/models.**
- **Publish the results of the above.**