Fostering Reform in Undergraduate STEM Education: Levers for Systemic Change

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The Challenge

An array of reports provide evidence that undergraduate STEM education could be improved by using results from research on learning and teaching to inform pedagogical practice in the STEM fields.

Yet change in undergraduate education—and the practice of faculty members—does not occur easily.
Key Questions

- What factors contribute to reform in undergraduate STEM education?

- What are barriers and levers for change?

- What does a systems approach to organizational change suggest about how to encourage faculty to adopt evidence-based teaching practices?
Higher education institutions are complex organizations. Thus:

- **Multiple factors** simultaneously influence faculty members’ choices about teaching practice.

- **Linear, single lever approaches** to change are unlikely to be adequate.

- Change requires the **use of multiple levers** across multiple contexts.
Barriers to Reform in Instructional Practice in STEM Undergraduate Education

- Faculty members are situated in contexts that affect how they do their work, including teaching.

- Because many forces affect them, a single approach to encouraging change in practice is not enough.

- Fairweather (2008): “research evidence of instructional effectiveness is a necessary but not sufficient condition…” for faculty to change their teaching practice.
Systems Approach to Understanding Faculty Members’ Teaching-Related Decisions

External Context

Institution

College/Department

Faculty Member

Reward Systems

Professional Development

Work Allocation

Leadership Practices

Employers

Accrediting Organizations

Government

Scholarly Associations
Faculty as Individuals: Relevant Factors

- Beliefs, values, and experiences
- Doctoral socialization
- Discipline and career stage
- Nature of appointment
- Motivation
  - Knowledge, self-efficacy, perception of rewards
Contexts: Institutional Contexts

Different institutional types and missions

Institutional priorities affect faculty members’ decisions about time and energy devoted to teaching

Potential Barriers
- Ex: pressures to win grant money or do entrepreneurial work
Contexts: Departments

- Immediate context for faculty work
  - Work assignments are allocated
  - Initial context for evaluation

- Departmental characteristics that relate to faculty teaching behaviors
  - Priorities of department chairs
  - Curricular structures—sequencing, curricular content, gate-keeping role
  - Class size and physical arrangement
  - Decisions about teaching assignments/ TAs
Contexts: External

- Employers
- Government Organizations
- Accrediting agencies
  - Ex: ABET
- Scholarly associations
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Levers for Change
—or Potential Barriers

- Work Allocation
- Reward Systems
- Professional Development
- Leadership Practices
Lever or Barrier: Work Allocation

- Time to learn and implement can be a barrier for faculty (Henderson & Darcy, 2007)

- Faculty do not want to adopt methods that are more time consuming than traditional lectures

**Implication:**

- Strategies must be easy to use, adaptable, and faculty must have time to learn to use them

- Build time to learn and implement into teaching assignments, with accountability expectations
Lever or Barrier: Reward System

- Institutional messages can undermine emphasis on teaching
  - Pressure to do research is increasing
  - Publication productivity:
    - most impact factor in T&P
    - strongest predictor of salary
  - As time in class increases, salary level decreases
Lever or Barrier: Reward System

Impact on Faculty of institutional messages:

- Teaching becomes a less preferred option and faculty “suffice” in their teaching

- Fairweather (2008): Strong argument that faculty use of newer pedagogies will be more influenced by rewards and work allocation than by data-based evidence

- Implication: Faculty must not perceive time spent in developing new pedagogies as a negative factor in salary and advancement.
Lever or Barrier: Professional Development

Barriers:
- Faculty often don’t know research on learning and teaching and how to implement research-based teaching practices

Implications:
- Support for faculty learning is important
- Factors that relate to effective faculty development
  - Growth-oriented, not remedial
  - Tailored to individual circumstances
  - Accessible and time-effective
- Examples: Learning Communities
Lever or Barrier: Leadership Practices

Research emphasizes the important roles played by institutional leaders (provosts, dean, chairs) in change efforts:

- Communicate institutional goals
- Allocate resources
- Impact tenure and promotion processes
- Initiate campus conversations
- Create institutional teams
- Provide symbolic support
Implications for Improving Undergraduate STEM Education

Faculty work in complex systems in which many factors facilitate, impede, and influence their choices about teaching practices.

- Single-lever strategies are unlikely to result in widespread change in teaching.
- Successful efforts require mobilizing multiple levers for change.
Recommendation 1: Take a Systems Approach

- Recognize that multiple contexts affect faculty members’ decisions about their teaching behaviors.
- Recognize the “levers for change” that can be used to change the culture of undergraduate education.
Recommendation 2: Account for individual differences among faculty

A new faculty member may need basic information about the new role before she is sufficiently confident to try new teaching approaches.

A highly research-active senior faculty member may need support from TAs to find enough time.

Someone committed to evidence-based teaching may need assurance that time invested in this work is valued.
Recommendation 3: Reward Systems as a Lever of Change

- Current reward systems undermine interest in teaching

- Leaders can help…
  - Initiate campus-wide conversations about teaching innovation
  - Include teaching excellence more fully in evaluation and reward systems
  - Avoid penalizing those trying new approaches

- Professional societies can…
  - Continue national dialogues to encourage institutional efforts
Recommendation 4: Professional Development as a Lever of Change

- Make professional development widely attractive
  - Time-effective; various formats

- Promote easy and effective strategies
  - Emphasize easy active learning strategies

- Build networks

- Provide leadership support
Recommendation 5: Leadership Practices as a Lever for Change

- Institutions should offer ongoing professional development for deans and chairs
  - To encourage leadership skills that cultivate institutional cultures where teaching is valued and innovation is rewarded
Recommendation 6: Professional Societies and National Networks

Professional Societies can...

- Provide opportunities and safe space for reform-minded faculty to connect
- Provide symbolic leadership
- Initiate and frame national discussions
Recommendation 7: Preparation of Future Faculty as a Lever for Change

- Prepare future faculty
  - Who understand learning processes and evidence-based teaching practices and value effective teaching as part of their career aspirations

- Assess the messages sent to future faculty
A strategic, systems approach to change and reform considers:

- The multiple factors affecting faculty decisions about their teaching
- Characteristics and circumstances of individual faculty
- Use of reward structures to encourage change
- Easily accessible and useful professional development opportunities—including for future faculty
- Importance of leadership and the preparation of leaders with skills to cultivate change
Reforming Undergraduate Education requires...

- Recognition of the multiple factors affecting faculty work
- Analysis of the system in which teaching, research, and learning occur
- Use of multiple levers to encourage and support change
- Strategic and dedicated leaders
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