Now What? Creating an Institutional Framework for Undergraduate STEM Education

A Keck/PKAL project at AAC&U
Funded by the W.M. Keck Foundation

Project Meeting
April 26-27, 2012
Fullerton, California
Welcome!

Thursday, April 26
Dinner & Panel
Project Overview

This initiative aims to develop a comprehensive, institutional **STEM Education Effectiveness Framework** that will help campus leaders translate national recommendations and research for improving student learning and success in STEM into scalable and sustainable actions on particular campuses.
Why we are all here

1. Create a draft framework for articulating the dimensions, measures, and processes for improving undergraduate STEM student learning, achievement and success at the program and institutional level.

2. Bring participating campuses together to share and learn from one another regarding effective practices for improving STEM education.

3. Establish a process and timeline for further framework development by campus teams and project leaders.
Your Motivation for Participation
Why you are here ...

We would like to establish and compare a set of metrics with regard to infrastructure (majors, class size, lab size, FT faculty coverage, workload, budget per faculty/student, etc) to help us assess areas of concern.

We are interested in improving recruitment and retention of our STEM students, including those from under-represented groups.
We are seeking ways to: 1) improve the retention, persistence and graduation of mathematics and science majors, 2) improve the orientation of our students toward careers in their disciplines, 3) develop a college-based internship program that can offer capstone experiences in the students' majors, and 4) improve our program assessment strategies in both general education and individual degree programs.
Why you are here ...

We have self-identified ourselves as a STEM-infused University and are centrally located in a high-tech region of the state, so we recognize the significant STEM opportunities that are available for our graduates. Yet, a high proportion of our students lack adequate preparation and motivation to do well in STEM fields. Ideally, we would like to have students who are better prepared to succeed in STEM fields when they come to college. These students would have better quantitative and critical thinking skills.
What the framework helps accomplish?

• Articulate a vision or direction for change
• Audit or evaluate where you are now and where you want to go
• Chart a path for reaching the vision and goals
• Create a common language and vision around the change
• Pinpoint needed interventions and strategies
• Foster learning
What the framework helps accomplish?

• Serves as an accountability tool for maintaining momentum on the change
• A catalyst for priority setting
• Ensure collective leadership
• A way to garner resources (financial and human) for the vision
• A way to maintain focus and momentum over the long time period change often takes
Panel: National Perspectives

• Adrianna Kezar, Moderator
• Peggy Maki, Consultant
• Linda Slakey, Senior Fellow, PKAL/AAC&U
• Barbara Wright, Vice President, WASC
Framework Creation and Models

Friday, April 27
8:30 – 9:30 am
Engage to Excel: One Million Additional College Graduates with Degrees in STEM (PCAST Report)

• Widespread adoption of empirically validated teaching practices.
• Replace standard laboratory courses with discovery-based research courses.
• National experiment in postsecondary mathematics education.
• Diversity pathways to STEM careers.

Calls for development of metrics to evaluate STEM education, a “STEM certification”
A New Biology for the 21st Century: Interdisciplinarity

http://www.nap.edu/catalog.php?record_id=12764
“Scientific competency in medical practice includes the knowledge, skills and habits of mind needed to understand scientific concepts and discoveries, to integrate them into medical practice, and to communicate them effectively to patients.”
The STEM Pipeline

*Figure 2. Percentage of 2004 STEM Aspirants Who Completed STEM Degrees in Four and Five Years, by Race/Ethnicity*

http://www.heri.ucla.edu/nih/HERI_ResearchBrief OL_2010_STEM.pdf

Higher Education Research Institute (HERI) STEM Study
“The largest gain in learning productivity in STEM will come from convincing the large majority of STEM faculty that currently teaches by lecturing to use any form of active or collaborative instruction.”

-- James Fairweather (2009) Report to the National Academies Board on Science Education
Hoellwarth and Moelter, American Journal of Physics (2011)
Impact of Participation in High-Impact Practices on Percentage of Senior NSSE Respondents Graduating on Time, by Racial and Ethnic Background

Source: Does Participation in Multiple High Impact Practices Affect Student Success at Cal State Northridge? by Bettina Huber (unpublished paper, 2010).
Mathematics Preparation & Interest

Figure 1: Too few 12th grade students interested in STEM and proficient in math

## Draft STEM Education Framework

**Draft STEM Education Effectiveness Framework**  
Keck/PKAL Project Meeting: April 26-27, 2012

**Vision:**

The draft Framework below contains suggested categories of key dimensions of campus work as well as possible questions to guide campus work. EXAMPLE responses to the questions in Row 1 have been provided to prompt team discussions.

<table>
<thead>
<tr>
<th>Dimensions: In what key areas does the campus need to work to achieve this vision?</th>
<th>A. What does it look like?</th>
<th>B. What are the goals and measurable outcomes?</th>
<th>C. How will we know we are successful? What benchmarks will be used?</th>
<th>D. How are we doing? Where are the gaps? What are the challenges we face?</th>
<th>E. What interventions will we need to implement to reach our goals and vision?</th>
<th>F. How will we operate and learn as an organization?</th>
<th>G. How will we document our progress and success?</th>
</tr>
</thead>
</table>
| 1. Institution Learning and Leadership  
  a. mission and educational purpose  
  b. organizational learning  
  c. campus culture  
  d. policies and procedures, including faculty rewards and incentives | • | • | • | • | • | • | • |
| 2. Faculty work related to educational mission/objectives  
  a. quality of learning  
  b. assessment  
  c. program design  
  d. pedagogy  
  e. program culture  
  f. faculty development | • | • | • | • | • | • | • |
| 3. Student Success  
  a. measures of success  
  b. support programs  
  c. co/extra-curricular experiences | • | • | • | • | • | • | • |
| 4. External stakeholders and partners | • | • | • | • | • | • | • |
PCAST Report: Food for Thought

• **Barriers to change**
  – Lack of faculty knowledge
  – Lack of rewards
  – Multi-faceted approach required
  – Limited resources
  – Grading & workload
  – Institutional isolation
  – Challenge of change

• **Actions to induce change**
  – Create vision
  – Communicate vision & progress
  – Create community for transformation
  – Generate belief
  – Remove barriers
  – Reward change
  – Checklists to measure progress
  – Use diverse, concerted drivers to generate a tipping point
<table>
<thead>
<tr>
<th></th>
<th>Audit</th>
<th>Benchmarking</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aim</strong></td>
<td>Measures what is being done</td>
<td>Identifies problem areas and areas of excellence</td>
<td>Assesses the value of what is being done</td>
</tr>
<tr>
<td><strong>Process</strong></td>
<td>A cyclical series of reviews</td>
<td>An ongoing process</td>
<td>A series of individual assessments over time</td>
</tr>
<tr>
<td><strong>Data collection</strong></td>
<td>Collects routine data</td>
<td>Collects data for comparative purposes</td>
<td>Collects routine and complex data</td>
</tr>
<tr>
<td><strong>Methodology</strong></td>
<td>Review of what is actually being done</td>
<td>Review of best practice in the organisation or sector</td>
<td>Evaluative research methodology not necessarily for external comparison purposes</td>
</tr>
<tr>
<td><strong>Purpose</strong></td>
<td>Not possible to generalise from the findings</td>
<td>Possible to make comparisons across a process or sector</td>
<td>Often possible to generalise the findings</td>
</tr>
</tbody>
</table>

Table 1: Differences between audit, benchmarking and evaluation
(Adapted from the PDP Toolkit: see www.pdptoolkit.co.uk)
Dimensions of Engagement at Bristol

- **RESEARCH**
  - Applied
  - Theoretical
  - Community research

- **KNOWLEDGE EXCHANGE**
  - Business and Social Enterprise
  - Research dissemination
  - Business Links

- **EDUCATION**
  - Lifelong learning
  - Skills development
  - CPD

- **FLEXIBLE LEARNING**
  - Foundation degrees
  - Part-time degrees
  - Access & widening participation
  - Collaborative programmes

- **PUBLIC RELATIONS**
  - Media
  - Thematic events
  - Public lectures
  - Presentation of research

- **COMMUNITY BASED PROJECTS**
  - Student volunteering
  - Staff volunteering
  - Action research
  - Cultural and social partnerships

**ENGAGEMENT**
## WASC Educational Effectiveness Framework

<table>
<thead>
<tr>
<th>Key Descriptive Terms</th>
<th>ELEMENT &amp; DEFINITION</th>
<th>INITIAL</th>
<th>EMERGING</th>
<th>DEVELOPED</th>
<th>HIGHLY DEVELOPED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning: A. Standards established; communicated; in syllabi and publications; cited and used by faculty, student affairs, advisors, others (CFRs 2.2, 2.4)</td>
<td>For only a few programs and units; only vaguely if at all for GE; not communicated in syllabi, or publications such as catalogues, view books, guides to the major; only a few faculty know and use for designing curriculum, assignments, or assessment.</td>
<td>For many programs and units; most aspects of GE; beginning to be explicit in basic documents; beginning to be used by some faculty for design of curriculum, assignments, assessment.</td>
<td>For all units (academic and co-curricular); and for all aspects of GE; cited often but not in all appropriate places; most faculty cite; used in most programs for design of curriculum, assignments, and assessment.</td>
<td>For all units (academic and co-curricular), and for all aspects of GE; cited widely by faculty and advisors; used routinely by faculty, student affairs, other staff in design of curriculum, assignments, co-curriculum, and assessment.</td>
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</tr>
<tr>
<td>B. Expectations are established - for how well (i.e., proficiency or level) students achieve outcomes (CFRs 2.1, 2.4, 2.5)</td>
<td>Expectations for student learning: have not been set beyond course completion and GPA; level of learning expected relative to outcomes unclear.</td>
<td>Expectations for level of learning: explicit in a few programs; heavy reliance on course completion and GPA.</td>
<td>Expectations for student learning: explicit in most programs.</td>
<td>Expectations for student learning: explicit in all programs, widely known and embraced by faculty, staff, and students.</td>
<td></td>
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<tr>
<td>C. Assessment plans are in place; curricular and co-curricular outcomes are systematically assessed; improvements documented (CFRs 2.4, 2.7)</td>
<td>No comprehensive assessment plans; outcomes assessed occasionally using surveys and self-reports; seldom using direct assessment; rarely lead to revision of curriculum; pedagogy; co-curriculum; or other aspects of educational experience.</td>
<td>Some planning in place; outcomes assessed occasionally; principles using surveys; beginning to move toward some direct assessment; occasionally leads to improvements in educational experience; improvements sporadically documented, e.g., in units' annual reports.</td>
<td>Plans mostly in place; Assessment occurs periodically, using direct methods supplemented by indirect methods and descriptive data; educational experience is frequently improved based on evidence; and findings; improvements are routinely documented, e.g., in units' annual reports.</td>
<td>Assessment plans throughout institution; Assessment occurs on regular schedule using multiple strong reliance on direct methods; performance-based educational experience systematically reviewed and improved based on evidence and findings; documentation widespread and easy to locate.</td>
<td></td>
</tr>
<tr>
<td>D. Desired kind and level of learning is achieved (CFR 2.6)</td>
<td>Possible that learning is not up to expectations, and/or expectations set by institution are too low for degree(s) offered by the institution.</td>
<td>Most students appear to achieve all or above levels set by the institution, faculty and other educators beginning to discuss expectations and assessment.</td>
<td>Nearly all students achieve at or above levels set by institution; findings discussed periodically by most faculty and other campus educators.</td>
<td>All students achieve at or above levels set by institution; findings are discussed regularly and acted upon by all or nearly all faculty and other campus educators.</td>
<td></td>
</tr>
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</table>
Framework Dimensions

Friday, April 27
Lunch Discussion
“You’ve got to \textit{want} to connect the dots, Mr. Michaelson.”
Dimensions of Engagement at Bristol

- **RESEARCH**
  - Applied
  - Theoretical
  - Community research

- **KNOWLEDGE EXCHANGE**
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- **COMMUNITY BASED PROJECTS**
  - Student volunteering
  - Staff volunteering
  - Action research
  - Cultural and social partnerships
Framework Implementation

Friday, April 27
1:30 – 1:45 pm
Effective Framework Implementation

• Develop a team process – on-going meetings, schedule, and goals for accomplishing work

• Evaluate your team and whether you may need other members in order to effectively meet the vision you have developed

• Continue refining your vision and framework – obtain feedback from others on your campus

• Obtain needed data to begin exploring issues
Effective Framework Implementation

- Use data and information to refine understanding of the dimensions, to begin auditing your institution, and identify potential interventions and strategies
- Identify peers best practices, national models
- Use all this data to refine the framework in preparation for the next meeting where the revised frameworks will be shared
- As part of the project, get help you need along the way! (remember expertise in this room!)
Returning to Campus

• What dimensions has your team taken leadership for the entire project? What process will you use in order to develop this aspect of the framework more fully?

• What process will you use to review the vision of STEM reform and commit to a final vision? What groups do you need to meet with on campus?
Returning to Campus

• When and how will we develop a process for implementation?
• What data do we need to get access to in the short term and long-term?
• Is there any background or support that we need to attend to in order to move forward with our implementation?
This overall process takes 5-10 years.
Closing Panel

Friday, April 27
2:30 – 3:00 pm
Next Steps

Friday, April 27
3:00 – 3:30 pm
What you said about expertise needed