Effectiveness in Training, Workforce development, and Diversity

*The evolving evidence and opportunities for action*

FASEB TWD 2017
Erin Dolan, University of Georgia
Calls for change in undergraduate, graduate, and postdoctoral education

- Teach and mentor in ways consistent with how people learn and develop
- Recruit and prepare a larger, more diverse STEM workforce
- Prepare students to solve problems, communicate effectively, learn on their own, and work independently and collaboratively
- Prepare students to pursue various career paths
NIGMS Programs

SEPA    B2B    IMSD MARC RISE    PREP    B2D IMSD RISE    IRACDA

Pre-College    Undergraduate    Graduate    Postdoctoral

NRMN

And BUILD, IPERT, others...
Purpose:
• Increase the numbers of urban, rural and minority students considering research and medical careers

Partnerships:
• Scientists and clinicians partnering with educators, community organizations and science centers

Goals:
• Career opportunities for minority and underserved students
• Teacher professional development
• Student and teacher laboratory internships
• Mobile laboratories bring science to rural communities
• Public health literacy
NIH Science Education Partnership Award (SEPA)

- Type: R25 Research Education
- Budget: FY17 = $18.5M
- Awards: 5-Year, $1.3M
- Topics: Any area of NIH-funded research
- Participants: Pre-college students & teachers, community
- Receipt Date: November/December 2017 for FY18 awards

- NIGMS Home: Center for Research Capacity Building
- URL: www.nihsepa.org
- FOA: PAR-14-228
What we know from research in education and social sciences

Cognitive Development
- Conceptions and misconceptions
- Cognitive load
- Remembering and forgetting
- Expertise development
- Learning progressions

Affective Development
- Mindset
- Perseverance / Grit
- Values

Psychosocial Development
- Ownership
- Self-efficacy
- Sense of belonging
- Scientific identity

Career Pursuits
- Interests
- Expectations
- Choice points
- Pathways in, out, through
We dedicate a lot of time and energy to our students and programs.
We want to know that what we are doing works.

This is where evaluation and social science research can help.

Systematic collection and analysis of data to determine:

*Merit, Impact, Value, or Worth*

What works, how it works, for whom and in what contexts, how to improve what isn’t working.
Existing bodies of knowledge

- Skills & Practices
  - Source for what works – avoid reinventing the wheel
  - Theories that explain how people develop skills, interests, and career pursuits – inform program design and evaluation
- Careers
  - Methods and tools for systematic data collection and analysis
    - Validity and reliability evidence
    - Compare to results from other programs
    - Set the stage for meta-analyses
- Curriculum
What do we know already?

Skills & Practices

- Research
- Communication
- Quantitative & Computation
- Leadership
- Etc...

See work from Linn, Feldon & Timmerman, Sevian & Gonzalves, AAC&U VALUE, etc.

Careers

Curriculum
## Knowledge Integration
(Eylon & Linn, 1988; Linn, 2000; Linn et al., 2015)

<table>
<thead>
<tr>
<th>Develop practices</th>
<th>Elicit ideas</th>
<th>Add ideas</th>
<th>Distinguish ideas</th>
<th>Reflect</th>
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<tr>
<td>Identify or formulate a question in the context of the lab’s research goals</td>
<td>Conduct experiments, collect and organize data</td>
<td>Analyze and interpret data, evaluate evidence, critique conclusions</td>
<td>Make final conclusions and plan next steps</td>
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| Expand content knowledge | Articulate hypotheses and questions about the research topic | Read literature, attend seminars, discuss with research team | Consider quality of evidence and relevance to argument | Synthesize experimental results |

| Understand nature of science | Express expectations for science research experience | Attend lab meetings, experience experimental failure | Present progress reports and compare ideas in group setting | Consider how discoveries emerge from iterative processes |

| Develop identity in science | Share goals for the URE relative to personal and career aspirations | Participate in social network of research team | Experience how process of criticism contributes to research progress; share ideas as a team | Recognize strengths related to career aspirations |
What do we know already?

**Skills & Practices**
- Research
- Communication
- Quantitative & Computation
- Leadership
- Etc...

*See work from Linn, Feldon & Timmerman, Sevian & Gonzalves, AAC&U VALUE, etc.*

**Careers**
- Interests
- Motivations
- Values

*See work from Byars-Winston, Diekmann, Duckworth, Gibbs & Griffin, Estrada, Hernandez & Schultz, NRMN, etc.*
Social Cognitive Career Theory
Self-efficacy Theory
(Bandura, 1977, 2001; Usher & Pajares, 2008)

- Past performance
- Emotional arousal
- Social persuasion
- Vicarious learning
Expectancy Value Theory
(Eccles & Wigfield, 2002; Wigfield & Eccles, 2000)
Interest Development
(Hidi & Reninger, 2006)

- Situational trigger
- Situational maintenance
- Emerging individual interest
- Well-developed individual interest
What do we know already?

Skills & Practices
- Research
- Communication
- Quantitative & Computation
- Leadership
- Etc...

See work from Linn, Feldon & Timmerman, Sevian & Gonzalves, AAC&U VALUE, etc.

Careers
- Interests
- Motivations
- Values

See work from Byars-Winston, Diekmann, Duckworth, Gibbs & Griffin, Estrada, Hernandez & Schultz, etc.

Curriculum
- Backward design
- Learning cycles
- Cognitive load
- Practice
- Feedback
- Reflection and metacognition

See work from BSCS, Chi, Roediger, Wiggins & McTighe, etc.
5E Learning Cycle
(Biological Sciences Curriculum Study)
How many of you have…

Used one of these or other theories of learning or development to design your program?

In your program evaluation?

Doing some of this intuitively?
May need to think differently...

- Faculty
- Department
- Institution
- Discipline

See work from Borrego, Bowma-Gearhart, Henderson, Kezar, Rogers, PULSE Network
Opportunities to learn

- Design features
- Causal mechanism
- Individual and contextual factors

What it is

The Laboratory Course Assessment Survey: A Tool to Measure Three Dimensions of Research-Course Design
Lisa A. Corwin, Christopher Runyon, Aspen Robinson, and Erin L. Dolan

Integrating Theory and Practice to Increase Scientific Workforce Diversity: A Framework for Career Development in Graduate Research Training
Angela Byars-Winston, Belinda Gutierrez, Sharon Topp, and Molly Carnes
Opportunities to learn

Design features
Causal mechanism
Individual and contextual factors

Linguistic Analysis of Project Ownership for Undergraduate Research Experiences
D. I. Hanauer*, †, J. Frederick†, B. Fotinakes*, and S. A. Strobel§

How it works

Toward a Model of Social Influence that Explains Minority Student Integration into the Scientific Community
Mica Estrada-Hollenbeck, Anna Woodcock, Paul R. Hernandez, and P. Wesley Schultz
Opportunities to learn

- Design features
- Causal mechanism
- Individual and contextual factors

For whom and in what contexts?

**RESEARCH ARTICLE**

Biomedical Science Ph.D. Career Interest Patterns by Race/Ethnicity and Gender

Kenneth D. Gibbs Jr.¹,²*, John McGready³, Jessica C. Bennett⁴, Kimberly Griffin⁴*

Early Engagement in Course-Based Research Increases Graduation Rates and Completion of Science, Engineering, and Mathematics Degrees

Stacia E. Rodenbusch†, Paul R. Hernandez†, Sarah L. Simmons§, and Erin L. Dolan†,*

Cultural Context of Career Choice: Meta-Analysis of Race/Ethnicity Differences

Nadya A. Fouad, Angela M. Byars-Winston
Join forces to maximize progress and influence across education and career development stages

Resources within the life sciences

Collaboration beyond the life sciences

- Evaluators
- Psychologists
- Cognitive scientists
- Learning scientists

Discipline Based Education Researchers
Science Faculty with Education Specialties
Approaches to Biology Teaching and Learning

Displaying results 1-10 of 34

APPROACHES TO BIOLOGY TEACHING AND LEARNING:
Sarah Miller, and Kimberly D. Tanner
A Portal into Biology Education: An Annotated List of Commonly Encountered Terms
CBE Life Sci Educ 2015 14:fe2; doi:10.1187/cbe.15-03-0065
» Full Text  » Full Text (PDF)

APPROACHES TO BIOLOGY TEACHING AND LEARNING:
Jeffrey Schinske, and Kimberly Tanner
Teaching More by Grading Less (or Differently)
CBE Life Sci Educ 2014 13:159-166; doi:10.1187/cbe.CBE-14-03-0054
» Full Text  » Full Text (PDF)

APPROACHES TO BIOLOGY TEACHING AND LEARNING:
Gloriana Trujillo, and Kimberly D. Tanner
Considering the Role of Affect in Learning: Monitoring Students’ Self-Efficacy, Sense of Belonging, and Science Identity
» Full Text  » Full Text (PDF)
THANKS AND QUESTIONS?