Critical Science Dispositions and Skills That Evolve in the Middle School Years

American Educational Research Association
Washington D.C. • April, 2016
Context for our Work

- The Activation Lab: A multi-institutional collaborative
  - Lawrence Hall of Science; University of California, Berkeley
  - Learning Research & Development Center; University of Pittsburgh
  - SRI International \textit{(during first phase of work)}
  - Originally funded by The Gordon and Betty Moore Foundation
  - Now also has funding from the National Science Foundation (EHR CORE & PRIME), and other organization.

- This studies we are discussing done as part of a larger research agenda.
Frameworks
Guiding Questions

What positions youth for success in science/STEM?

How can we *activate* children’s interest and curious minds in ways that ignite persistent engagement in science/STEM learning and inquiry?
Began with Focus

...on science and its overlap with other areas of STEM
Began with Focus

within and across STEM learning settings
Science (STEM) learning activation = A composition of *dispositions, skills, and knowledge* that enables success in proximal science (STEM) learning experiences.
Activation Framework

Activation
- Fascination
- Values
- Competency Beliefs
- Scientific Sensemaking
- Other ...

Success
- Choice
- Engagement
- Perceived Success
- Learning
Science Activation Dimensions

- **Fascination** with natural and physical phenomena. A person’s emotional and cognitive attachment with science topics and tasks.

- **Values science.** The degree to which a person values science, including the knowledge learned in science, the ways of reasoning used in science, and the role that science plays in families and communities.

- **Competency Beliefs.** The extent to which a person believes that s/he is good at science.

- **Scientific Sensemaking.** The degree to which a person engages with science learning as a sensemaking activity. Sub-dimensions include: questions, experiment, evidence, explanation, and nature of science.
Possible STEM Activation

- **Innovation Stance.** Enthusiasm for new ideas and try new ways of doing things.

- **Problem Solving.** The process that one uses when confronted with unfamiliar problems or tasks.

- **Creative Thinking.** The thought process involved in generating new ideas within or across domains of knowledge (new configurations or ideas, new possibilities for something that already exists, discovering/imagining something new).

- **Computational Thinking.** The thought processes involved in formulating problems and their solutions so that the solutions are represented in a form that can be effectively carried out by an information-processing agent.
Success Dimensions

- **Choice.** Choosing to participate in the next science learning opportunity (e.g. camp, museum visit, watching a science program).

- **Engagement.** Includes affective, behavioral, and cognitive components (e.g. excited about materials, doing the science activities at hand, and thinking about science ideas).

- **Perceived Success.** Feeling successful in completing science learning tasks in absolute and relative terms.

- **Learning.** Achieving the learning goals for a particular science experience.
Related Projects Underway

Studies of Activation framework & measures
- Act App (NSF Prime)
- Malleable Factors (NSF CORE)

Projects using Activation framework & measures
- Pathways towards STEM Careers (NSF ITEST)
- EPICC (NSF ITEST)
- Multiple evaluation studies
- Pending projects
  - New measure development of other STEM dimensions
  - Additional studies in proposal stage
# Malleable Factors (ALES 2014)

## 2014-2015

<table>
<thead>
<tr>
<th>6th + 8th grade</th>
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<tbody>
<tr>
<td>Fall</td>
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<table>
<thead>
<tr>
<th>Fidelity / Activity Logs</th>
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<tbody>
<tr>
<td>Activation</td>
<td>Begin</td>
<td>Mid</td>
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<tr>
<td>Family Background</td>
<td>Begin</td>
<td></td>
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<tr>
<td>Prior/Recent Experiences</td>
<td>Begin</td>
<td>Mid</td>
</tr>
<tr>
<td>*Content knowledge</td>
<td></td>
<td>Pre</td>
</tr>
<tr>
<td>Engagement</td>
<td>~3 times</td>
<td>~3 times</td>
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<tr>
<td>Choice Preferences</td>
<td>Begin</td>
<td></td>
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<tr>
<td>Career Likelihood</td>
<td>Begin</td>
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## Malleable Factors (ALES 2014)

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<tr>
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<th>2014-2015</th>
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<tbody>
<tr>
<td>Grades</td>
<td>6&lt;sup&gt;th&lt;/sup&gt; &amp; 8&lt;sup&gt;th&lt;/sup&gt; grades</td>
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<tr>
<td>Students</td>
<td>2,938</td>
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<tr>
<td>Location</td>
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<tr>
<td></td>
<td>SF Bay Area California</td>
</tr>
<tr>
<td>Gender</td>
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<tr>
<td></td>
<td>Male—50%</td>
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<tr>
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<tr>
<td></td>
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<tr>
<td></td>
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<tr>
<td></td>
<td>Asian—10%</td>
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<tr>
<td></td>
<td>Native American/Pacific Islander—7%</td>
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<tr>
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<td>East Indian/Middle Eastern—6%</td>
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Today’s Session

- **Five Papers**
  - When I Grow Up: The Relationship of Science Learning Activation to Career Affinity & Goals (Rena Dorph)
  - Scientific Sensemaking: Intellectual Resources that Predict Content Learning (Mac Cannady)
  - The Increasingly Important Role of Science Competency Beliefs for Science Learning in Girls (Paulette Vincent-Ruz)
  - What is the Nature of Powerful Science Learning Experiences?: Influences of Engagement and Perceived Success on Science Motivation and Content Learning (Meghan Bathgate)
  - The Dimensions and Impact of Informal Science Learning Experiences on Middle Schoolers’ Attitudes and Abilities in Science (Chris Schunn)

- **Two Discussants**
  - Jonathan F. Osborne, Stanford University
  - Adam V. Maltese, Indiana University