Findings from The Power of Discovery: STEM² Afterschool Learning Initiative 2015 Study

University of California, Irvine
Deborah Lowe Vandell
Rahila Simzar
Pilar O’Cadiz
Valerie Hall

With support from
Noyce Foundation
Samueli Foundation
California Department of Education
The Power of Discovery: STEM² 2014-2015

Logic Model

POWER OF DISCOVERY: STEM² INITIATIVE

REGIONAL INNOVATION SUPPORT PROVIDERS
Technical Assistance & Support

PROFESSIONAL DEVELOPMENT
Training, Mentoring & Support Systems

CURRICULA INNOVATIONS & PRACTICES
Quality STEM Activities & Career Orientation

STAFF BELIEFS
Beliefs about the Importance of STEM & Confidence for Implementing STEM Activities

PROGRAM OFFERINGS
Quality & Quantity of STEM Activities
Engaging, Challenging, Overall

STUDENT OUTCOMES
Confidence in ability to do Math & Science, Science Interest, STEM Career Aspirations
Regional Innovation Support Providers (RISPs)

- Professional development
- Curriculum resources
- Communities of practice
- Inter-agency networks of support
Time Line

2012-13 Start up of Power of Discovery Initiative
- 5 RISPs statewide recruited 625 Programs in their regions to participate in PoD Initiative
  - Northern California
  - Southern California

2013-14 First Year of Full Implementation
- PoD Initiative fully implemented at 601 sites (121 sites)

2014-2015 Implementation and Expansion of PoD to enlist new programs
Measures

1. Staff Survey—demographic characteristics and educational background of afterschool program staff (Noam & Sneider, et al., 2010)

2. Professional Development Documentation Forms—quantity and quality of professional developments attended by staff in 2015 (Vandell, Simzar, & O’Cadiz, 2014)

3. STEM Activity Documentation Forms—quantity and quality of STEM activities implemented with students attending afterschool programs (Vandell, Simzar, & O’Cadiz, 2014)


5. Student Survey—students’ beliefs and attitudes about STEM (Noam & Sneider, et al., 2010, Tyler-Wood, Knezek, & Christensen, 2010), skill development, academic outcomes, and positive behavior
Observation Study Aims

- Document ways that afterschool programs implement learning activities focused on promoting STEM learning in diverse afterschool program settings.

- Identify effective STEM learning practices in afterschool program settings.
Observation Study

- **16 sites** in the observation study sample
  - 8 sites in the PoD Initiative
  - 8 non-PoD sites
  - Two visits per site (March through May 2015)
  - Two researchers observing same activity

- **52 observed activities**
  - 40 activities with STEM-related content and learning goals
Promising Practice Ratings System*

Seven dimensions:

1. Supportive relations with adults
2. Supportive relations with peers
3. Student engagement in activities
4. Development of higher level thinking
5. Skill building (mastery orientation)
6. Materials
7. Structure

*(Adapted from , Vandell et al., 2005, 2014)
Promising Practice Ratings System

Research-based measure

- Assesses processes viewed as quality indicators that research has found to be linked to social and academic outcomes for both children* and adolescents.**

*(Pierce et al., 1999; Vandell, Shumow, & Posner, 2005)

** (Eccles & Gootman, 2002)
The PPRS uses a **4-point scale** to measure program processes:

1 = **highly uncharacteristic** (little or no evidence of the process is observed)

2 = **somewhat uncharacteristic** (the process is not characteristic of the program but exemplars might be observed infrequently)

3 = **somewhat characteristic** (good evidence of the process but it is not pervasive)

4 = **highly characteristic** (the process construct is highly evident)
PPRS Observation Tool

Allows observers to...

- Document information on the context of activity being observed
- Rate quality of the activity on multiple dimensions following a rubric of indicators for each domain aligned to a four-point rating scale

[See rubric excerpt handout].
PPRS Certification Process

- View video exemplars of the seven PPRS dimensions
- Ratings compared to an established mean rating
- Two practice observations at an actual afterschool site with a trainer
- Alignment of observer ratings for live observations
Observation Study
Findings
Observations of STEM Learning Activities

- Two UCI researchers trained to use the **Promising Practice Rating System**

- Each rated program processes using PPRS 4-point rubric along each of 7 **dimensions**
  [4=highly characteristic; 1=no evidence]

- Detailed **field notes** of instructional practices and students’ learning experiences used to create vignettes illustrative of STEM Learning in diverse afterschool settings
Observations

- **2 observation visits** at **16 study sites**
  (8 PoD; 8 non-PoD)

- Total of **32 observation visits** conducted between March 19, 2015 and June 2, 2015

- **52** learning activities observed

- Duration of observations: **20 to 60 minutes**
Observation Ratings

- Most highly rated dimensions across all 52 activity observations (PoD and Non-PoD sites):
  - Positive Relations with Adult Staff ($M = 3.44$)
  - Positive Relations with Peers ($M = 3.52$)
  - Engagement ($M = 3.54$)
  - Materials ($M = 3.56$)
  - Structure ($M = 3.02$)

- Lowest mean ratings were obtained for the areas most related to STEM learning:
  - Higher Level Thinking ($M = 2.44$)
  - Skill Building and Mastery Orientation ($M = 2.79$)
Diving Deeper into STEM Activities

- 40 activities observed with STEM-related content and learning goals in the following areas:
  - Health and Nutrition
  - Earth and Environmental Sciences
  - Aerodynamics
  - Chemistry
  - Physics
  - Engineering and Construction
  - Robotics and Coding
  - Computer Literacy and Keyboarding
  - Math Games and Puzzles
  - Scientific Inquiry Methods
## Mean PPRS Ratings of all STEM Activities

<table>
<thead>
<tr>
<th>PPRS Construct</th>
<th>N</th>
<th>M</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supportive Relationships with Adults</td>
<td>40</td>
<td>3.35</td>
<td>0.74</td>
<td>2-4</td>
</tr>
<tr>
<td>Supportive Relationships with Peers</td>
<td>40</td>
<td>3.43</td>
<td>0.75</td>
<td>1-4</td>
</tr>
<tr>
<td>Engagement</td>
<td>40</td>
<td>3.55</td>
<td>0.71</td>
<td>2-4</td>
</tr>
<tr>
<td>Higher Level Thinking</td>
<td>40</td>
<td>2.60</td>
<td>0.84</td>
<td>1-4</td>
</tr>
<tr>
<td>Skill Building Mastery Orientation</td>
<td>40</td>
<td>2.68</td>
<td>0.86</td>
<td>1-4</td>
</tr>
<tr>
<td>Materials</td>
<td>40</td>
<td>3.53</td>
<td>0.72</td>
<td>1-4</td>
</tr>
<tr>
<td>Appropriate Structure</td>
<td>40</td>
<td>2.88</td>
<td>1.02</td>
<td>1-4</td>
</tr>
</tbody>
</table>
An Area for Improvement: Higher Level Thinking

Higher Level Thinking considers the extent to which staff:

- facilitated scientific inquiry practices, asking “why, how and what if” questions
- Held students to the expectation that they explain their reasoning behind their answers and choices they made in a project
- Listened to students, took their input seriously and probed for deeper critical thinking
Ratings of Higher Level Thinking

- Opportunities for students to engage in Higher Level Thinking was characteristic of less than half of the 52 activities observed
  - 29 activities rated of 2 or 1 in this dimension
  - 6 received a 4 rating
  - 17 sites received a 3 rating
A Second Area for Improvement: Skill Development

Skill development considers if...

- Students exercise their intellectual and creative capacities while applying and learning new skills
- Staff encourage **mastery** through modeling, explanatory and coaching processes that serve to scaffold student skill development
Ratings of Skill Development

- **Skill Development** opportunities were more frequently observed:
  - 23 activities received a 3 rating
  - 11 activities a 4 rating.
  - One third of the activities were rated a 2 or 1 (n=18)
Characteristics of Highly Rated STEM Activities

- Student-driven hands-on project with a high level of student engagement
- Students work collaboratively to create a model to test specific STEM concepts and principles
- Students engage in group reflection with supportive adult facilitation
- Staff encouraged mastery through modeling, explanatory and coaching processes that served to scaffold student skill development
- Activities are well structured and organized around materials that were age appropriate and matched the activity learning goals
PPRS ACTIVITY
1. Exemplary video: Higher Level Thinking (high)

[INSERT VIDEO]
2. Exemplary video: Skill Development (high)

[INSERT VIDEO]
Read, Reflect and Rate Activity

CASE STUDY:
ENGINEERING & CONSTRUCTION

- Tallest Foil Tower
- Strongest Newspaper Tower
- Straw Tower Challenge
Five Sets of Case Studies Are Available

- Engineering and Construction
- Physics, Aeronautics, and Kinetic Energy
- Biology, Forensic & Nutrition Science
- Technology—Computer Literacy and Robotics
- Math Skill Development
Read, Reflect & Rate Activity

1. **Read** Vignette

2. **Discuss practices** related to **Higher Level Thinking** and **Skill Development** dimensions of Promising Practice Rating System (PPRS) [see handout]

3. **Rate** activity using PPRS Rubric below for both dimensions
## Consensus Ratings

<table>
<thead>
<tr>
<th>Support of STEM Learning</th>
<th>Supportive Relations with Adults</th>
<th>Supportive Relations with Peers</th>
<th>Engagement</th>
<th>Higher Level Thinking</th>
<th>Skill Building (Mastery)</th>
<th>Materials</th>
<th>Structure</th>
<th>Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tallest Tower</strong></td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td><strong>3.8</strong></td>
</tr>
<tr>
<td><strong>Supportive</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Strongest Tower</strong></td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td><strong>3.1</strong></td>
</tr>
<tr>
<td><strong>Somewhat supportive</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Straw Tower</strong></td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td><strong>2.3</strong></td>
</tr>
<tr>
<td><strong>Not Supportive</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Higher Level Thinking
Justifications—Foil Tower Vignette

- Students’ were...
  - Challenged to design and construct in collaborative groups
  - Engaged in experimentation developing prototypes and making modifications as they test their designs
  - Generated their own questions and asked them of each other

- Adults facilitated reflection of their design, construction and results

- Specific physics content about what makes a structure stand was lacking
Skill Development: Mastery
Justifications—Foil Tower Vignette

- Each group successfully completed their project
- Students honed their cooperative problem solving skills strategizing, planning and analyzing together
- Students discussed the rationale behind their team’s approach and identified the challenges and what they might have done differently
- Adults circulated, posing in-depth questions to students about their design and construction process scaffolding their learning
Summary

Observational data indicate need for...

- **Professional development** opportunities for staff to increase competencies in inquiry based activity facilitation

- More challenging and sequentially structured **curricula** with defined STEM-related knowledge and skill development goals
Summary

Areas of challenge for staff:

- Making explicit connections between STEM concepts introduced and the experiential activity that they guided students in doing

- Guided reflection processes that deepen student understanding of the concepts addressed.