Outside-In: Drivers of Highly Effective After-School and Summer STEM Learning

Joan Bissell, CSU Chancellor’s Office
Jesse Lovejoy, 49ers Museum & STEM Education Center
Kathy Knutzen, CSU Bakersfield
Stephen Adams, CSULB & Don Rodriguez, LBB&G Club
Jeff Davis, California After School Network
John Keller, Cal Poly San Luis Obispo
Reactor: Chevron Representative
Outside-In Panel Presenters

- Joan Bissell, CSU Chancellor’s Office
- Jesse Lovejoy, 49ers Museum and STEM Education Center
- Kathy Knutzen, CSU Bakersfield
- Stephen Adams, CSULB and Don Rodriguez, Long Beach Boys & Girls Club
- Jeff Davis, California After School Network
- John Keller, Cal Poly, San Luis Obispo
- Reactor: Chevron Representative
Overview of Key Panel Themes

Joan Bissell
Director, Teacher Education and Public School Programs and Math and Science Teacher Initiative

jbissell@calstate.edu
http://teachingcommons.cdl.edu/ngss/
Focus of Panel and its Relevance to STEM Educational Excellence and Opportunity

- **Central Question**: What characteristics of STEM out-of-school learning excite students’ imagination and can be a part of STEM classroom learning?

- **Primary Goal**: To identify features of exceptional out-of-school STEM learning and examine how they can be used in school to transform STEM teaching and learning.

- **Key Outcome**: Develop a set of ideas for integrating features of outstanding after-school, summer, and informal STEM learning programs into K-12 classrooms.
What Are Some Cognitive Features of Effective After-School, Summer, and ISI STEM Learning?

- **Cross-disciplinary**: connect math and science, the various sciences, science and engineering, STEM and careers

- **College and Career Standards Focused**: utilize the standards of practice of the CCSS and NGSS

- **Challenging**: engage learners in complex, demanding activities

- **Cutting-edge**: make connections to the most current of knowledge in science and engineering globally
What Are Some Affective Features of Effective After-School, Summer, and ISI STEM Learning?

- **Affirming**: activities are structured to support and enhance achievement of students

- **Inviting**: activities build on the language, culture of the youth

- **Motivating**: programs reflect youth values (e.g., peer collaboration, team spirit, leadership)

- **Reinforcing**: learning itself is rewarding; success is recognized and celebrated by a range of caring others
Impacts of After-School and Summer STEM Opportunities On Future Teachers

- Working in the after-school program was an incredible experience in which I learned how to implement science activities in a fun and exciting manner.

- Without this Boys & Girls Club experience, I am not sure I would have considered working with middle school students. I now plan to. Working at the Club was a life-changing experience for me.

- The summer STEM Camp allowed me to share the power and excitement of science, and the numerous ways in which science can positively impact the lives of students.

- Because of the encouragement and inspiring approaches of our STEM camp leader and supervisor, I have decided not only to strive to be an amazing elementary teacher, but also to start a Saturday science camp.
Jesse Lovejoy
408-986-4827
Jesse.lovejoy@49ers.com
Levisstadium.com/Museum
49ERS MUSEUM EDUCATION - PROGRAM GOALS

- **Mission**
  - Illuminate the real-life relevancy and “cool factor” of STEM subjects through a lens of 49ers football & Levi’s Stadium
  - Light a fire for STEM in students that teachers, parents, mentors can feed

- **Execution**
  - **Field Trip Program**
    - Completely free, 5-hour program serving grades K-8; includes 60-90 minute, project-based STEM Lesson, Stadium Tour, Museum tour
  - **Family Learning Nights**
    - 2-hour experience including both parents and teachers that further integrates parents into their kids’ education around and interest in STEM and provides valuable family time

- **Year 1 Results**
  - More than 31,000 participants served
  - Nearly 50% Title 1 designation
  - More than 90% approval rating on all key metrics
Informal in name only; our curriculum rivals formal education in every sense

- Common Core and NGSS-aligned lessons

Key curriculum notes:
- Hands-on, project-based exploration
- Facilitate group work, exploration, experimentation, goal setting and reflection
- Use cutting-edge technology to speak to students in their language
- Vetted by exhaustive advisory council construction and review

The value of informal education
- Changes up the learning environment
- Better receptivity to smartly-designed content
- Moments of inspiration happen frequently when we combine learning with fun & real life
- Ideas that can be taken back to your classes! Curriculum, activities, etc.
49ERS MUSEUM EDUCATION: REAL-LIFE STEM LEARNING

- Engineer Your Gridiron Gear
  - Understanding the engineering design process through the evolution of football equipment
  - Hands-on opportunities to try on gear, examine what’s different
  - What would you change? How would you change it?

- Stadium Structural Challenge
  - Walk through Levi’s Stadium to understand structural engineering principles
    - Define the challenge – construct a venue that can bear a 5-lb load
  - Build together, test together

- LEEDing the Way
  - Understanding environmental sustainability & how it applies to the stadium
  - Solar bridges, green roof, the LEED design process

Find examples online at Levisstadium.com/Museum
Making STEM Relevant & Fun for Your Students

- Quick Discussion – What you don’t have a stadium or a football team?? How can you create the same learning environment

  - Know your strengths & key teaching points
  - Embrace the engineering design process – it can connect to virtually any standard or learning objective
  - Ask your students!
    - Not the normal questions …
    - … & have some suggestions ready
  - Don’t be afraid to fail
  - Raid your garage – what’s “old” is intriguing
  - Creativity is contagious & competition is healthy
Successful Summer STEM Program for Rural South Kern County

School of Social Sciences and Education

Kathleen M. Knutzen, Ph.D., Dean

www.csub.edu/sse    |    (661) 654-2219    |    sse@csusb.edu
Camp BLAST! Objectives

For both Pre-service & 4th-8th grade students

Engage students in STEM projects that connect the physical world with the digital

Promote teamwork, critical thinking, intrinsic motivation, and interdisciplinary content connections

Introduce the EDP (NGSS aligned Engineering Design Process) to help teach students methods of perseverance in problem solving
APPENDIX I – Engineering Design in the NGSS

Define
Specify criteria and constraints that a possible solution to a simple problem must meet

Optimize
Improve a solution based on results of simple tests, including failure points

Develop Solutions
Research and explore multiple possible solutions

https://www.youtube.com/watch?v=JEyh9-E2e1c&feature=youtu.be
## Curriculum Map

<table>
<thead>
<tr>
<th>Grades (incoming)</th>
<th>Week #1</th>
<th>Week #2</th>
<th>Week #3</th>
<th>Week #4</th>
</tr>
</thead>
<tbody>
<tr>
<td>4th-5th</td>
<td>Circuits &amp; Programming</td>
<td>Rockets &amp; Computer Art</td>
<td>Hybrid Robotics #1 &amp; #2</td>
<td>CSUB Culminating Week</td>
</tr>
<tr>
<td>6th-7th</td>
<td>Robotics #1</td>
<td>Robotics #2</td>
<td>Circuits &amp; Programming</td>
<td>CSUB Culminating Week</td>
</tr>
</tbody>
</table>

**Course Offerings:**
- Computer Programming
- Engineering Design Process
- Robotics
- Circuitry
- Water Bottle Rockets

**Institution:**
CSU Bakersfield
School of Social Sciences and Education
Water Rocket Challenge

Design Challenge:

Create the most functional version of a paper rocket launched from a straw.

A functional rocket will include a straight flight path, optimized distance of launch and rocket speed.

Center of Gravity

Try to balance your rocket across the width of your finger. Mark the spot where your rocket balances on your finger. This is called the center of gravity.
1. Teaching manipulatives
2. Designed equipment for summer camp projects
3. Nametags: Created from laser cutter and scissors were from the vinyl cutter in the CSU-FabLab
4. FabLab Associates
CreaSons were created from FabLab lessons, used outside of the Lab.
Engineering Education at the Boys & Girls Clubs of Long Beach

Don Rodriguez
CEO, Boys & Girls Clubs of Long Beach

Stephen Adams
Professor, CSU Long Beach
Model

Summer 2014, 2015

*Engineering Adventures* and *Engineering is Everywhere* units

Boys & Girls Club of Long Beach sites

Aligned with CSLUB STEM/Ed Tech course

Teams of 3-5 teachers in course worked with youth
Units from *Engineering is Elementary Series – 2015*

**Engineering Adventures:**
- Invasive Species
- Recycled Racers

**Engineering is Everywhere:**
- Engineering Helmets
- Engineering Ice Cream
“I Like Thinking of New & Better Ways of Doing Things” (p < .02)

Source of item: Gibbons, Hirsch, Kimmel, Rockland, & Bloom, 2004
“I think I know what scientists do for their jobs” (p < .04)

Source of item: Hirsch, Kimmel, Rockland, & Bloom, 2004
“We learn how to improve things, well like, if you get something wrong you can improve it, and work it out better.”

“Whenever we make something, each time we come back, we always make it better.”
Addressing Summer Learning Loss

- Project helped close the gap of academics in the summer
- Supports our enrichment component (STEM)
- Project-based learning reinforces academic enrichment and school engagement
Boys & Girls Club Youth

- **Fun.** Hands-on activities/lessons
- **Career Awareness.** Youth are aware of different types of professions in the fields of STEM
- **Confidence.** Youth are confident about getting results after each lesson and continue trying until the ultimate result
- **Teamwork.** Youth worked in groups. They learned how to communicate and listen to the rest of the groups input on the lesson
Boys & Girls Club Staff

- Students were engaged
- Fewer behavior issues
- Attendance increased
- Students learned new vocabulary
- Students expressed interest in being engineers when they grow up
- It gave staff an opportunity to learn how to implement fun & hands-on STEM activities
- Staff used this time as training workshops
Boys & Girls Club Parents

- During enrollment for summer, parents were asking if we were going to have STEM sessions
- Parents made sure students were at the club the day of the session
- Parent communication increased – parents were involved, asking questions about the child's academic sessions
- After the sessions, parents wanted to know if their child can be involved in those sessions the entire summer
We wish to acknowledge support from....
Approximately 5,000 publicly funded expanded learning programs

Serving nearly 500,000 of CA’s youth with the highest need

Such a rich infrastructure holds a lot of opportunity for leveraging and partnership for mutual benefit
The Expanded Learning Context: Quality Standards & Continuous Quality Improvement
Quality Matters: JumpStarting STEM Pilot Evaluation

- Regression analysis illustrated that those students who reported more positive experiences in the after school programs (a reflection of program quality)

- Demonstrated gains in the desired student outcomes. STEM outcomes are linked to overall program quality and the quality of relationships in the program.

- Achieving desired STEM outcomes cannot be separated from youth development principles of positive relationship building and general elements of program quality, specifically engaging and active learning experiences.
What works? Regular participation

Figure 4. After school Participation Narrows the Math Achievement Gap

Income differences in math achievement were eliminated for students who had consistent after school activities across K-5

Unstructured time in the after school hours is associated with
- Lower GPA
- More school absences
- Greater misconduct
- Reduction in work habits and self-efficacy

More time spent in after school is associated with
- Better work habits
- Improved academic performance
- Gains in self-efficacy
- Improved GPA
- Increased attendance, fewer school absences
What works? Intentionality

- Durlak and Weissberg (2010) found that when
  - Staff use sequenced step-by-step approach
  - Active forms of learning, and practicing new skills
  - Focused specific time and attention on skill development
  - Explicit about defining skills they were attempting to promote

- Associated with significant improvements in
  - Self perceptions
  - School bonding
  - Positive social behaviors
  - Significant reductions in drug use
  - Significant increases in achievement test scores, grades, and school attendance

Expandinglearning.org
What works? Partnership and Collaboration

EXAMINING LEVELS OF ALIGNMENT BETWEEN SCHOOL AND AFTERSCHOOL AND ASSOCIATIONS WITH STUDENT ACADEMIC ACHIEVEMENT

Research-Based Article
Tracy Bennett, Ph.D – University of California, Irvine (in partnership with THINK Together)

Afterschoolsciencestudy.sri.com
What works? Access to resources and Professional Development

- Participating staff had significant increases in professional development related to STEM, increased exposure to STEM-related material, as well as increased communication with teachers and parents regarding STEM learning.

- These features were associated with increased staff belief in the value of STEM learning, and increased confidence to facilitate STEM learning opportunities;

- which were associated with higher levels of challenge and student engagement in STEM, as well as relative gains in student self-reports of math efficacy.

Participating Program Directors report increased student engagement as a primary success of the project, and that participation in the Power of Discovery resulted in an increase in overall program quality.
Available Tools and Resources

Understand and focus on STEM quality

Utilize STEM Quality Elements & the Assessment and Planning Tool for STEM in Expanded Learning Programs

Regularly assess data related to goals / adapt plan as needed

Create relevant, realistic STEM goals and a STEM plan

• Utilize DoS (site-level) Program Planning Tool for activity planning.
• Utilize observation tools (see powerofdiscovery.org) for coaching.
• Access A Practical Guide for Developing Regional Communities of Practice to facilitate peer learning.

Assess

Support staff through planning, observation, and coaching, and peer learning

Access resources & professional development to support STEM Goals

Mentors in Out of School Time (MOST)
STEM Teacher and Researcher (STAR)

John Keller, Ph.D.
Associate Professor, Physics
Center for Excellence in STEM Education
Cal Poly, San Luis Obispo
Mentors in Out-of-School Time

• Partnership between Cal Poly and Lucia Mar Bright Futures Afterschool Program

• One quarter course for STEM & LS undergrads
  • Weekly 90-minute seminar
  • 4-6 hours per week in after-school setting
  • Grades K-5 and 6-8
  • Combination of tutoring and STEM enrichment
Mentors in Out-of-School Time

• Impacts
  • Early field experience for pre-service teachers
  • STEM enrichment for afterschool students
  • Professional development for afterschool staff
  • Opportunity to introduce NGSS and CCSS

• Summative Evaluation
  • Undergrad exposure to afterschool learning
  • Increased confidence in STEM teaching
  • Reinforced interest in teaching for 90%
  • STEM enrichment for afterschool students
STEM Teacher and Researcher Program (STAR)
States and Agencies Represented

Partner Labs Since 2007

<table>
<thead>
<tr>
<th>Agency</th>
<th>Total</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOE*</td>
<td>178</td>
<td>18</td>
</tr>
<tr>
<td>NASA*</td>
<td>128</td>
<td>12</td>
</tr>
<tr>
<td>CSU*</td>
<td>60</td>
<td>19</td>
</tr>
<tr>
<td>NOAA*</td>
<td>16</td>
<td>7</td>
</tr>
<tr>
<td>DOD</td>
<td>15</td>
<td>4</td>
</tr>
<tr>
<td>NSF*</td>
<td>13</td>
<td>4</td>
</tr>
<tr>
<td>Other</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>425</td>
<td>70</td>
</tr>
</tbody>
</table>

*100Kin10 Partner
Career Standing of All STAR Fellows
Upon Enrollment in STAR

- Undergraduate Student: 41%
- Early Career Teacher: 11%
- Graduate / Credential Student: 44%
- Other (4%)
Check out the >400 STAR projects
digitalcommons.calpoly.edu/star

- Heat transfer on super hydrophobic surfaces
- Inexpensive human pathogen detection
- Cryogen-free infrared stratospheric astronomy
- Mathematical models for earth orbit payloads
- Endangered species biology and conservation
- High-energy spectroscopy & chemical computing

Animal Traits and Survival
Brittany Daum
Romberg Tiburon Center

Lesson Plan Overview:
Elementary school students will discover how organisms acquire specific traits and how the environment influences them. Students will learn how variation of traits help certain individuals survive, find mates and reproduce at a higher rate than others. First, the teacher will show pictures of the European Green Crab from their STAR experience. The class will identify the crab’s physical characteristics and explain why these traits allow it to thrive in its specific habitat. After a brief introduction about how traits can be passed on and how the environment influences them, students will complete a worksheet on a specific animal. Students will share in groups all about the traits their animal has and how they help it survive. In the final part of this lesson, students will create their own “made up” animal in its unique habitat. Students will write what traits their animal has and why those specific traits help it survive, find mates, and/or reproduce at a higher rate than other individuals of the same species.

Research Project:
Habitat Preference of the Introduced Green Crab Carcinus maenas

Unique Research Connections:
My lesson plan utilizes my unique insight from my research experience because I have learned a lot about the European Green Crab (EGC) and what traits help them survive in different habitats. I plan to use my own photos of the EGC and the different habitats it can live in. With scaffolding, I will help my students determine what traits help the EGC in different environments. Based upon this we can talk about which habitat it may prefer. This will get my students thinking about traits animals possess and how they help them in everyday life.

NGSS and/or CCSS Standards Addressed:
- 3-5-2 Use evidence to support the explanation that traits can be influenced by the environment
- 3-5-4 Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing
- 3-5-1 Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms
Classroom Practices Associated with STAR

• Having students:
  – Design projects and carry them out
  – Use data (their own and citizen science data)
  – Collect data and analyze data
  – Communicate their results through reports and presentations to each other
  – Engage in open ended questions
  – Engage in group work/team work
  – Engage in real world applications and examples

• Fellows:
  – Use specific lesson developed during STAR
  – Share their research with students through their professional posters and stories