Evaluating STEM Programs in Public Institutions in Communities: Focusing on Equity

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Libraries in Networked Publics

The public sphere is changing, and libraries have, too,
Two Dimensions of Equity

• Opportunities to pursue interest-related learning across multiple settings
• Opportunities to participate in building knowledge about program implementation and effectiveness
Engagement in Disciplinary Practices

Obtaining, Evaluating, and Communicating Information

Science requires the ability to derive meaning from scientific texts (such as papers, the Internet, symposia, and lectures), to evaluate the scientific validity of the information thus acquired, and to integrate that information.
Students learn science best by engaging in the practices of science and engineering as they make sense of phenomena using conceptual ideas—both in and out of school. It helps them identify with science.
The Sci-Dentity Program

create, tell your story and read stories written by others

inspire, get inspired or share what inspires you

connect, customize your profile and keep in touch with your friends

June Ahn

Mega Subramaniam

Allison Druin

Ken Fleischmann
Mathematizing Children’s Literature

- Fair sharing in *The Doorbell Rang*
- Counting in *The Hungry Caterpillar*
- Arrays in the *Madeline* series

Allison Hintz

Elham Kazemi
Millvale (PA) Community Library Makeshop
Available at: www.nap.edu
How People Learn Across Encounters

Although it is important to understand the impact of informal environments, a more important question may be how science learning occurs across the range of formal and informal environments. The science learning literatures and fields are segmented in ways that are at odds with how people routinely traverse settings and can engage in learning activities across those settings. We need to better understand the extended learning processes and interactions associated with STEM literacy and workforce-related learning pathways.
Recommendations

• Build a map and bridge the gaps
• Connect young people to STEM learning opportunities
• Build an infrastructure that will last
• Provide professional development
• Support innovative evaluation approaches
• Research how STEM learning ecosystems work
Longitudinal Study of Connected Learning

http://connectedlearning.tv
Three Sources of Data

- Connected Learning Principles: A survey for measuring youth experiences of interest-related activities according to principles of connected learning.
- Program Experiences: A survey of youth’s experiences in programs designed to promote connected learning.
Construct-Centered Approach

• Begins with a clear definition of the focal constructs:
  – *Principles of Connected Learning*

• Identifies things people say or do to reveal these constructs, along with tasks to elicit these things:
  – *Asking youth to characterize their experiences of an interest-related pursuit*

• Develops and tests items to develop validity evidence for scales
  – Using construct mapping approach to characterize levels of depth of approach and measure variability in responses
## Defining the Principles

<table>
<thead>
<tr>
<th>Interest Powered</th>
<th>Production Centered</th>
<th>Shared Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Youth pursue their interests in a way that pervades their lives, and their pursuit deepens their knowledge and expands their horizons.</td>
<td>Youth ask for and iterate based on feedback on their designs, consistently applying a critical stance toward their own and others’ designs. They circulate designs to a broad audience whose thinking and action they seek to influence.</td>
<td>Youth participate in activities with a common purpose, equitable participation, and opportunities to lead and contribute.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Openly Networked</th>
<th>Peer Supported</th>
<th>Academically Oriented</th>
</tr>
</thead>
<tbody>
<tr>
<td>Youth have access all the time to needed digital tools and support for their use; pathways of participation across places to deepen interest are transparent and accessible.</td>
<td>Other people broker access to new opportunities and resources to deepen and pursue interests.</td>
<td>Youth pursue their interests in a way that pervades their lives, and their pursuit deepens their knowledge and expands their horizons.</td>
</tr>
</tbody>
</table>
Construct Map

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Other people broker access to new opportunities and resources to deepen and pursue interests.</td>
</tr>
<tr>
<td>3</td>
<td>Other people provide strong support through teaching and helping within the activity.</td>
</tr>
<tr>
<td>2</td>
<td>Other people provide modest support through teaching and helping within the activity.</td>
</tr>
<tr>
<td>1</td>
<td>Other people provide limited or no peer support for participation in the activity.</td>
</tr>
</tbody>
</table>

• Levels should clearly differentiate experiences in terms of quality
• Deeper levels are hypothesized to be linked to better outcomes
Puzzling Through How To Elicit Connected Learning Experience

• The second step in designing measures is naming things people might say or do to reveal these constructs, along with tasks

• Typical approaches
  – Give people a test (more appropriate for knowledge and skill development, not so appropriate in informal settings)
  – Ask about experiences in a single setting (not appropriate, given the construct)

• Our approach: Focus on the individual pursuit and elicit experiences related to that pursuit
Beginning with a Pursuit

• Think of an Activity:
  – What is something you did for at least three years during your second decade of life (age 10-20) that:
    • You enjoyed doing?
    • You got better at the more you did it? and
    • You looked for opportunities to do more of it, whenever you could?

• Talk to a Neighbor:
  – What was the activity?
  – When did you start and stop doing the activity (if you stopped)?
  – Who did the activity with you or encouraged you to do it (if anyone)?
  – Where did you take part in the activity?
Let’s hear about your experiences.
Our task revealed pursuits that spanned multiple settings.

<table>
<thead>
<tr>
<th>Number of Settings Youth Pursue Interest-Related Activity</th>
<th>Number of Youth (N=266) (Percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>77 (28.7%)</td>
</tr>
<tr>
<td>2</td>
<td>97 (36.2%)</td>
</tr>
<tr>
<td>3</td>
<td>58 (21.6%)</td>
</tr>
<tr>
<td>4</td>
<td>26 (9.7%)</td>
</tr>
<tr>
<td>5</td>
<td>7 (2.6%)</td>
</tr>
<tr>
<td>6</td>
<td>1 (0.4%)</td>
</tr>
</tbody>
</table>
Our approach enabled us to capture a variety of pursuits.

- New media arts
- Creating or performing art
- Sports
- Gaming
- Making and tinkering
- Youth leadership and civic engagement
- Traditional Schoolwork
- Research
- Hanging out
- Using technology
We get a sense of how and when learning is supported by a diverse range of adults and peers.

- They give me responsibilities, jobs, or tasks related to my interests.
- They let me teach them about what I know about my interests.
- They give me advice related to my interests.
- They buy or give me things I need to help me pursue my interests.
- They introduce me to people who know more about my interests.
- They sign me up for things that are related to my interests.
- They help me find information related to my interests.
- They work with me on a project.
- They teach me new things.
Peer Supported.

Youth provide encouragement, help, and feedback to each other as part of their participation in the activity.

- **New Media Arts**: 9 (60%)
- **Leadership & Civic Engagement**: 2 (13%)
- **Creating &/or Performing Art**: 4 (27%)

- **Peers provide little to no support with the activity.**
- **Peers provide modest support by teaching and helping with the activity.**
- **Peers provide strong support by teaching and helping with the activity.**
- **Peers provide access to new opportunities, which allow youth to pursue their interests in greater depth.**
The Next Steps

- We tested items in the field.
- We analyzed item responses to see whether they matched our expectations, based on our construct map.
- We revised items and repeated the process.
- We used the data to explore dimensions of equity in experience.
Program Experiences

A survey of youth’s experiences in programs designed to promote connected learning
## Guidance for Defining Constructs

<table>
<thead>
<tr>
<th>Common Core State Standards</th>
<th>Framework for K-12 Science Education</th>
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<tbody>
<tr>
<td>Make sense of problems and persevere in solving them.</td>
<td>Asking questions and defining problems</td>
</tr>
<tr>
<td>Reason abstractly and quantitatively.</td>
<td>Developing and using models</td>
</tr>
<tr>
<td>Construct viable arguments and critique the reasoning of others.</td>
<td>Planning and carrying out investigations</td>
</tr>
<tr>
<td>Model with mathematics.</td>
<td>Analyzing and interpreting data</td>
</tr>
<tr>
<td>Use appropriate tools strategically.</td>
<td>Using mathematics and computational thinking</td>
</tr>
<tr>
<td>Attend to precision.</td>
<td>Constructing explanations and designing solutions</td>
</tr>
<tr>
<td>Look for and make use of structure.</td>
<td>Engaging in argument from evidence</td>
</tr>
<tr>
<td>Look for and express regularity in repeated reasoning.</td>
<td>Obtaining, evaluating, and communicating information</td>
</tr>
</tbody>
</table>

Guidance for Defining Constructs

• Rich ethnographies of young people learning across settings and over time.
  LIFE Center: *Youth who construct or are provided with personally meaningful STEM learning experiences and agency for their learning develop a sense of themselves as capable STEM learners.*

• Input from parents and program leaders.

http://life-slc.org/
Guidance for Developing Constructs

• Frameworks developed collaboratively by researchers and practitioners

http://researchandpractice.org
Key Considerations in Eliciting Youth Experience

• Attend to equity in identifying opportunities
• Look for practices youth may not identify as “STEM-related”
• Programs are only one site where youth experience science, mathematics, and engineering practices
• Focus on unique site contributions:
  – At the setting
  – To roles that adults and peers play in brokering across settings
Thinking About Outcomes

Thinking in Levels
Individual level
Group level
System or community level

Modeling a Participatory Approach
Design charrettes with youth and program leaders
Individual Outcomes: Candidate Categories

- Further academic pursuits
- Workplace pathways
- Civic engagement
- Deeper play and fun
- Heightened interest in STEM
- Greater identification with STEM

Use *extreme caution* when using existing, traditional measures
What would youth say or do?

- Focus question: *What are the individual outcomes of connected learning?*
- Problem: Existing measures of youth development were a poor fit to program opportunities
- Approach: Design charrette, a tool of participatory design for developing survey items for outcomes of connected learning
Design Charrette for Outcome Measures

• Partners: HIVE Research Network, CU Boulder, SRI International

• Settings: HIVE New York, Denver network of arts-focused programs
Well, there's a lady named Sandra, and she has a big role in helping alumni, I don't know, helping them plan for their future, in a sense. So, I definitely seek some of those staff in the KAYSC. What they can do to help me is just being full of support, that being emotionally and mentally. Just being there for me and just being really honest and just, I don't know, helping me network and connect with people that they know can further, what do you call it, can help me figure out what I want to do, so, definitely that.

Support for college that doesn’t offer her desired major

I think that it definitely had to do with some of my teachers at my high school because they had kids who had already went to St. Kate’s. So they're like, "It's a great school you should definitely go there." Even then I had, even at the KYC, I had full support and everyone was like, "You should definitely go there." I mean, I had other choices for colleges, but St. Kate’s was like my final because I knew that it was right for me and I had full support from everyone else, so.

... after being enrolled in Saint Katherine’s and finding out they didn’t have my major, which was environmental law, and for that to be achieved, I had to major in environmental, in, what do you call it, political science and public, shoot, public relations and they didn't have that, so I had to take classes at St. Thomas. Right now, currently, that’s what I'm pursuing.
Deeper Fun/Fulfillment/Joy/Satisfaction
Ex: Talked about devoting more free or me time to a maker activity.

Success in Academics/Bonding to School
Ex: Says that classes seem more relevant now.

Advancing Career Goals/Goal Discovery
Ex: Followed up with a professional contact.

Deepening Civic Engagement
Ex: Developed a game with a social justice message.

[other outcomes]
http://tinyurl.com/mgtgkfx
System Level: Infrastructure

- **Infrastructure**
  - Developing institutional links for expanding pathways of movement across settings
  - *Analytic approach: Trace networks of ties that enable diverse youth to “level up” and “level out”*
  - *Analytic approach: Comparing search patterns to opportunities (using approaches for analyzing search patterns in UCAR’s digital libraries)*
System Level: Ecosystem Resilience

- Characterizing the opportunities available at the community or city level
- Dimension of *diversity*: How varied are opportunities in particular neighborhoods
- Dimension of *redundancy* of pathways: How many different ways are there to explore and develop an interest
Equity, Evaluation, and Stance

• Good measures can support accurate diagnosis of inequity

• Developing such measures requires participation of key stakeholders

• Measures need to be employed from a stance of continuous improvement, whereby a collective engages in purposeful efforts to use evidence to improve opportunities for all
Resources and Contact

Measures of Connected Learning
http://researchtools.dmlhub.net/

Research+Practice Collaboratory
http://researchandpractice.org

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