Engineering an Engineering Experience

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TRAEL

Tinkering, Reflection and Engineering Learning
Goals for Today

- Strategies
  - Designing activities
  - Training staff
- Impact
- Engineering museum experience

Making something  STEM Learning
You just tinkered!

Three Concepts

Tweet what you made!
#IA18
#CHICAGOCHILDRENSMUSEUM
1. Collaborative Learning

Raise your hand if you...

Worked with one or more colleagues

Watched what someone else was doing

Shared ideas or information

• Children’s Museums: places of mediated learning
1. Collaborative Learning

Family as Learning Unit: Caregiver Role

Design elements to support adult-child collaboration
Facilitation to support family interaction
2. Engineering Process

Raise your hand if you...
Set a goal.
Predicted what might happen.
Tested what you made.
Changed it after testing.
3. Reflection: Putting Words to Experience

Raise your hand if you...
Talked about what you tried.
Reviewed your process.
Still thinking about what you might change.
3. Reflection

Why is verbal reflection important?

Reflection

- Telling and sharing of experience with others.
- Can happen during and after an experience.
- Widely considered to be critical for learning

- Goes beyond learning from direct experience with objects
- Fosters understanding of specific scientific and engineering practices
- Consolidates experiences
- Offers a powerful tool for making learning visible
Tinkering Lab: Make it Roll

Do you think there's any chance it'll roll down the ramp?
Do you think there's any chance it'll roll down the ramp?
Tinkering Lab

Introduction to the space and staff
Tinkering Lab: Staffing model

• 1-2 facilitators (usually one)
• Rotate each hour
• Welcome, facilitate, manage entry, safeguard tool use, reset space and materials
• 30 to 40 facilitators --all eligible.
• On-going training
Designing Activities

7 Ways to Engineer an Engineering Experience
1. The Challenge
How open-ended or specific is the task?

Open ended
Make Something

Specific
Make Something that Does THIS (rolls, flies, etc.)

Make Something that Does Something
1. The Challenge

Make Something: Woodshop

“Welcome to Tinkering Lab. Today’s challenge is...!”
Make something that does something:
Make the monster move (fly, roll or sail)

“Today we’re helping monsters move. We have wind tunnels, fans and ramps....
1. The Challenge

Open ended

Specific

Make That Does THIS: Make it Roll

“Today we’re making something that rolls! You can test your vehicle on the ramps.”
Time Spent in Tinkering Lab

Avg. Minutes

Woodshop | Monster Playground | Make it Roll | Make it Fly

1. The Challenge
1. The Challenge

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Planning

Caregiver: So we have our four washers. We have our straws. What else do we need?

Child: I know. This [picks up a piece of cardboard].

Caregiver: Ohh. What do you think we could use that for?

Child: It’s cardboard.

Caregiver: Yeah, it’s cardboard. What can we use the cardboard for?

Child: The middle of the car.

Caregiver: Ohh, the middle part of the car. Okay.
Predicting

Caregiver: Do you think there’s any chance it’ll roll down the ramp?

Child: That’s not gonna roll.
2. Deliberately chosen materials and tools

General Materials

Wheels and Axles Provided
3. Testing opportunities
3. Testing Opportunities

Engineering Ways to Test
3. Testing Opportunities

Test on Big Ramp
3. Testing Opportunities

Test on Wind Table and Wind Tunnel
3. Testing Opportunities

**Percentage of Children Who Tested**

<table>
<thead>
<tr>
<th>Activity</th>
<th>% Children</th>
<th>n</th>
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<tr>
<td>Woodshop</td>
<td>100</td>
<td>31</td>
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<td>Make it Fly</td>
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<td>17</td>
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3. Testing Opportunities

What Happens After Testing?

Fixing
- Make It Roll
- Make It Fly

Repeat Testing
- Make It Roll
- Make It Fly
4. Challenge difficulty: What’s the sweet spot?

Make It Roll- build a vehicle to test

Make It Fly- Crumple paper to test
4. Challenge Difficulty

Make It Roll

• More altering, less starting over
• Testing parts: what spins?
• Didn’t test on ramp until the end

REVISIONS:

• More attractive table ramps
• Workable combinations of wheels and axles

Make It Fly

• Many new creations
• Less intentional
• More quick testing

REVISIONS:

• Added cork challenge
• Redesigned wind table
4. Challenge Difficulty

Number of Creations

Make It Roll
$n = 64$
- 1 creation: 97%
- 2 creations: 3%

Make It Fly
$n = 18$
- 1 creation: 17%
- 2 creations or more: 83%
5. Activating Knowledge

Facilitator questions and interactions:

• What do you know about cars?
• Have you been on a swing?

Advanced Organizer:
Facilitator interaction before entering
Example (also used for training)

**Facilitator:** So, when you spin this axle, what happens to the wheels?

**Child:** They spin with it.

**Facilitator:** Exactly, that’s what I was gonna say. They spin with the axle. Wheels actually spin together. Let’s test this one out, see how it rolls *[places creation on table ramp]*. Pretty good, huh?
Facilitator: Now let’s show you a different one. This one, the axles are taped down so are not supposed to be moving, but the wheels move around the axle. So, in this case, the axle stayed put and the wheels moved by themselves. Let’s test this one out [places creation on table ramp]. How did it work? Did it roll?

Child: Yeah, it rolled, but the axles didn’t move at all.

Facilitator: Exactly! So the wheels are spinning by themselves and it rolled just like that with the axle staying put....
Facilitator: So, what have we learned about wheels and axles? If something is to roll, either the wheels move by themselves, like this one, right? Or the wheels move with the axle.
5. Activating Prior Knowledge

Engineering the Advanced Organizer
6. On-going Staff Training

Initial TL training
- First Aid
- Introduction to space
- Tinkering philosophy
- Shadow a colleague

Repeated morning sessions:
tools, new information, review

Reflections and peer advice

“Make it Fly” Facilitator Tips:
Interacting w/ Visitors:
- When welcoming visitors try to encourage them to use multiple materials
- Always indulge a child’s questions and encourage them to ask more
- If it fails in the wind tunnel have them try the wind TABLE
6. Ongoing Staff Training

Interactive Workshops with Full Group
Self-Reflective Approach

From your experience...what’s working?
Role of Staff: Scaffolding for the Scaffolder

- Introduce the challenge
- Be a guide to the exhibit
- Activate (background) information
- Be an active and appreciative presence
- Offer support and expertise
- Promote Observation
- Boost the Engineering Process
- Support reflection
Exploring examples

• Transcripts, video and anecdotes (from their reflections)
• Value their expertise and experience
• Recognize the complexity of addressing situations
7. Opportunities for Reflection

- SNAP
- Facilitator questions
- Ipad Reflections
- Story Hub

So did it do any better? Or did it do anything differently?
7. Opportunities for Reflection

Reflection *During* Experience

I'm gonna go test it.
I'm gonna go test it.
7. Opportunities for Reflection

Reflection *After* Experience

Story Hub
Reflection After Experience

What we did today is I made this rolling thing
What we did today is I made this rolling thing
7. Opportunities for Reflection

Story Hub Reflections

![Graph showing frequency of Engineering Process Talk]

- Make It Roll
- Workshop Plus

*\[t(199) = 4.52, p < .001\]
Reflections After Experience

**Engineering Process Talk**

- **Project**: Frequency is higher compared to **No Project**.
- \( F(1, 177) = 4.37, p < .05 \)

**Associations to Prior Knowledge**

- **Project**: Significantly more associations compared to **No Project**.
- \( \chi^2 = 12.8, p < .001 \)

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7. Opportunities for Reflection
7. Opportunities for Reflection

Story Hub Reflections

Ratio of Child/Adult Statements

* $t(125) = 1.9$, $p = .05$
SNAP: Make It Roll

**Interviewer:** Did somebody help you?

**Child:** My mom.

**Interviewer:** Your mom? Okay and tell me how you worked together.

**Child:** Well [= worked well with mom] because when the first time that I put it in a test, it wasn’t working. It only was rolling a little and then we changed it to some wheels. It was rolling but it couldn’t go but then we tried again.
SNAP: Make It Roll

Interviewer: And what did you learn today?

Child: I learned that if you want something to roll, you need to have an axle...if you don’t have round wheels, it can’t roll.
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End of presentation!