PROFESSIONAL DEVELOPMENT

The following presentation was given at the Jefferson County Public Schools (JCPS) 2025 Diverse Learners Institute:

- Title: *Engineering in action: Hands-on strategies for students with MSD*
- Location: Jefferson County Public Schools, Louisville, KY
- Date: July 15, 2025

Engineering in Action:

S T E M

Hands-on Strategies for Students with MSD

Who’s in the Room?

Works in an MSD setting?

Years Experience?

Teach elementary?

Experience with STEM?

Teach middle/high?

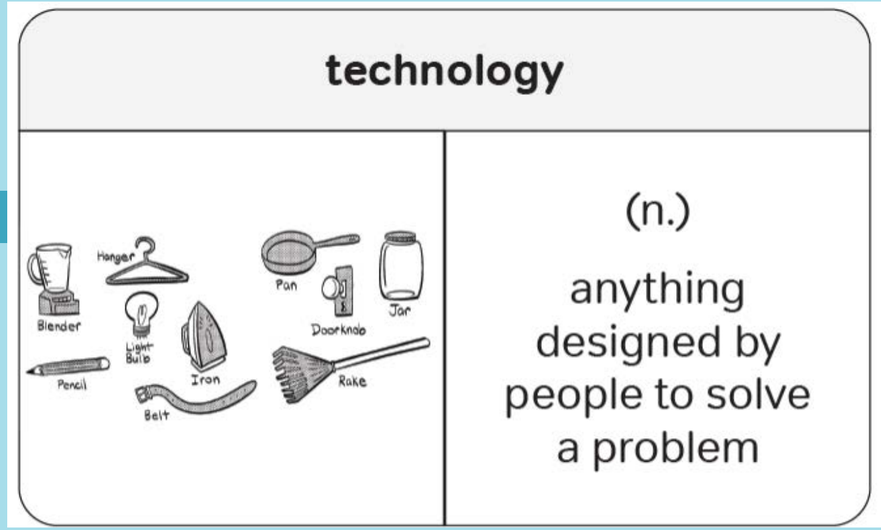
Came from Autism Helper Session??

Guiding Question

What comes to mind when you hear the word “technology?

Technology

Our definition of “technology?



Tool that makes life easier.

Examine an eraser

- What does the eraser do?
- What problem does it solve?
- What would happen if we did not have erasers?
- What other technologies could solve the same problem?

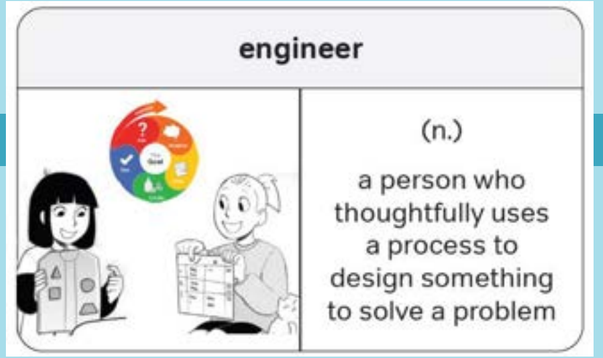
Teaching Students with MSD about Technology

- Students with MSD may have similar misconceptions about technology
- Focus instruction on how technology solves problems
  - More than one technology can solve the same problem
  - Explore features
  - Teach vocabulary!

Guiding Question

What do you think engineers do?

Engineers



What do you think engineers do?

Engineers create or design technology to solve problems.

Engineer or Scientist?

ENGINEERS

Definition 1

- Begin with problems that need to be solved.
- Ask questions, determine criteria for a successful solution, and identify constraints.

SCIENTISTS

Definition 2

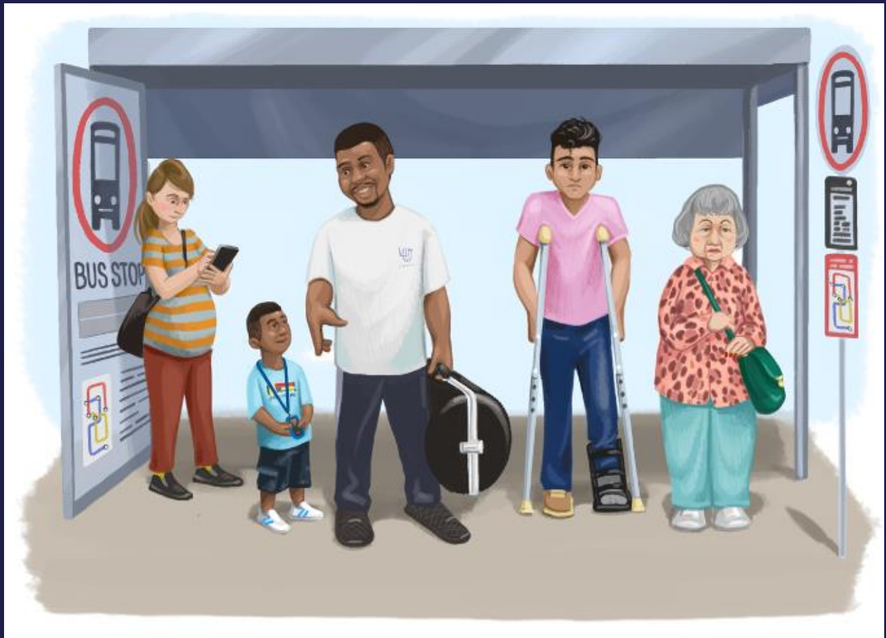
- Ask questions about a phenomenon,
- Establish what is already known and determine answers to questions.

EiE's Engineering Habits of Mind

Children who develop engineering habits of mind . . .

Develop and use processes to solve problems	Investigate properties and uses of materials
Consider problems in context	Construct models and prototypes
Envision multiple solutions	Make evidence-based decisions
Innovate processes, methods, and designs	Persist and learn from failure
Make tradeoffs between criteria and constraints	Assess the implications of solutions
Use systems thinking	Work effectively in teams
Apply math knowledge to problem solving	Communicate effectively
Apply science knowledge to problem solving	See themselves as engineers

What is the problem?



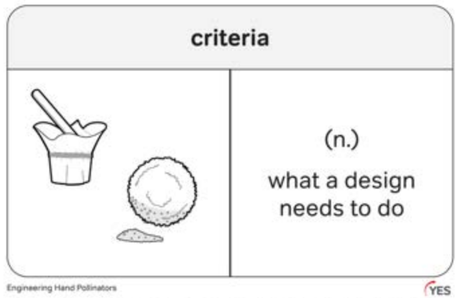
How much does the bench have to hold?

How big does it need to be?

What materials are available?

Is the bench covered or uncovered?

How to accommodate the person on crutches?



Everyday Engineering

Constraints:
Boundaries or limitations to the design

Communication Notebook Collection System

- Criteria:
  - Must hold 10 notebooks
  - Sturdy
  - Usable for students with fine motor deficits
- Constraints
  - Cost: Made from things you already have
  - Space: Small enough to fit on corner of desk

Keeping medications cold on field trip

- Criteria:
  - Temperature under 36°F for 3 hours
  - Portable
  - Not leak
- Constraints:
  - Work without electricity
  - Small and light

Pool Beverage Holder

- Criteria:
  - Float
  - Stay upright
  - Waterproof-ish

Constraints:

- Made with whatever you have around the house
- Not look fun so kids will want to play with it
- Can make within 5 minutes

The Engineering Design Process

Ask: Students define the problem, then identify the requirements for the design (criteria) and how their choices may be limited (constraints). This includes considering the needs of users and implications of the solution. They explore materials and consider which are best suited to the challenge.

Imagine: Students creatively brainstorm ways to solve the problem.

Plan: Students share and select their best ideas to generate one design. They sketch their plan and list the materials it uses.

Create: Students work in groups to make the solution they designed.

Test: Each group tests its solution against the performance criteria. Groups share and analyze data to determine where they can improve.

Improve Cycle: Groups improve their designs by going through another iteration of the process.

YES

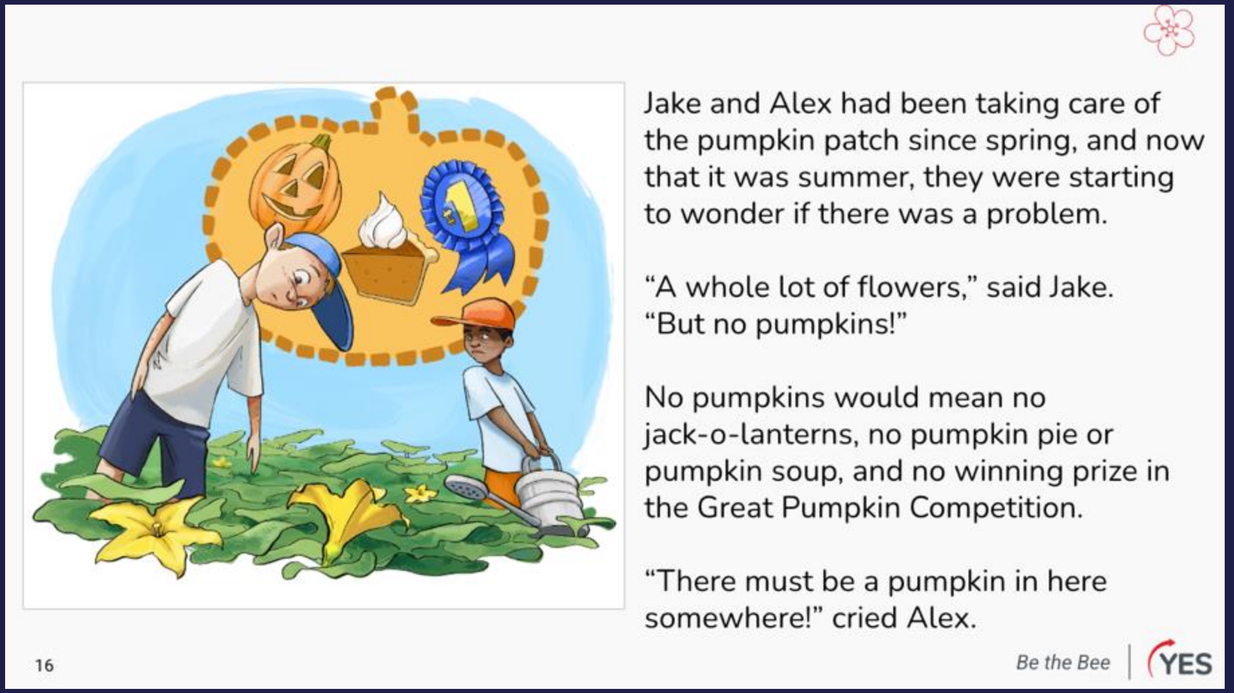
YES Engineering Curriculum

Unit Map

- Lesson 1: What Is Engineering?
- Lesson 2: What's the Problem
- Lesson 3: Experience the Problem
- Lesson 4: Investigate Pollinators
- Lesson 5: Investigate Materials
- Lesson 6: Imagine and Plan
- Lesson 7: Create and Test
- Lesson 8: Improve
- Lesson 9: Reflect and Share

Pumpkin Pollinator Unit: What is the problem?

Jake and Alex, second-graders, discover a problem in Jake's pumpkin patch: despite many flowers, there are no pumpkins. The issue is a lack of bees for pollination, resulting in fewer pumpkins. This poses a challenge for the community, especially with the upcoming Fall Festival, as people won't have pumpkins for the Great Pumpkin Competition or for consumption.



Bees in Slow Motion Pollinating Apple Blossoms

LESSON 3

Hand Pollinator Design Challenge

Problem

- The pumpkin flowers are not being pollinated

Goal

- Design a hand pollinator that can move pollen from one flower to another

Criteria (What does it need to do?)

- The hand pollinator needs to:
  - Fit inside the flowers
  - Pick up pollen from one flower
  - Drop off pollen at another flower

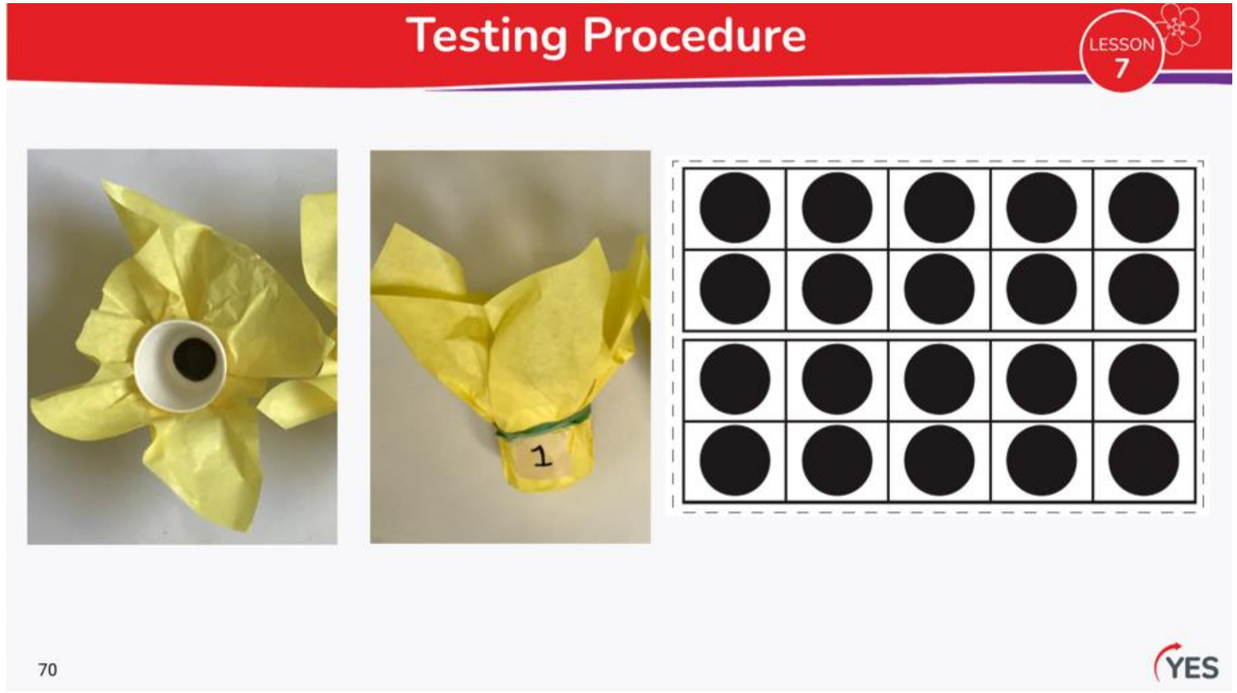
Constraints (Rules or guidelines)

- Only use the provided materials
- One handle, one tip, one connector
- 15 minutes

Test Your Hand Pollinator

LESSON 7

1. Gently collect pollen from the flower..
2. Touch your hand pollinator to the dots to drop off pollen.
    - How many more flowers can you pollinate?



yes.mos.org/pollinators-L7-example-pollinator

YES

Plan Our Hand Pollinator

Plan

Lesson 6

Draw your design.

Label your design.

Circle the materials you will need.

coffee stirrer	craft stick	eraser	feather	felt
pipe cleaner	pompom	sticky note	straw	string
tape	toothpick	twist tie		

Test Our Hand Pollinator

Test

Lesson 7

Does our hand pollinator...	Yes	No
... fit inside the model flower?		
... pick up pollen?		

How much pollen does our hand pollinator drop off? ⬢

	None 0 points	A little 1 point	Some 2 points	A lot 3 points
Flower #1				

How many more flowers can you pollinate? ▲ ☐

Add up your score:

⬢ Pollen Points		▲ # of Additional Flowers		Design #1 Score
	+		=	

Consider…..

What do you notice about the tip materials?

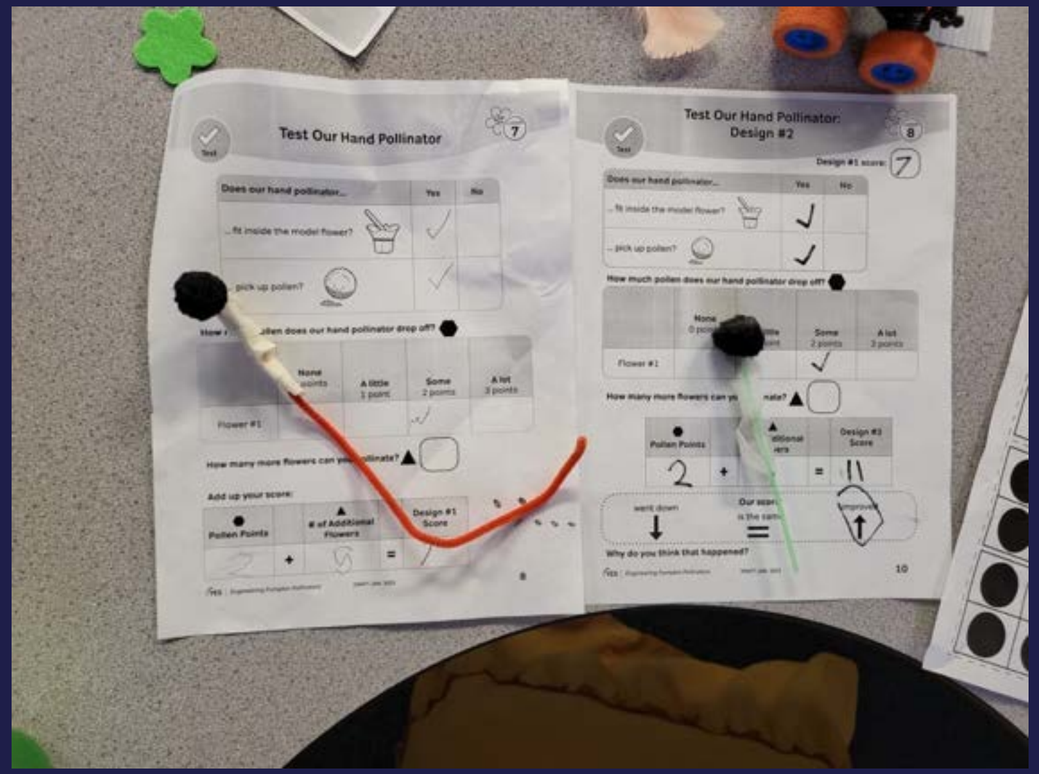
Which materials are better at picking up pollen? How do you know?

Which materials are worse at picking up pollen?

Do any of these materials meet the hand pollinator criteria? How do you know?

Discussion

- What happened when you tested your hand pollinator?
- Which parts of your hand pollinator **worked well**?
- How did your hand pollinator **fail**?



Student Needs?

UDL & Differentiation

The Universal Design for Learning Guidelines

The goal of UDL is **learner agency** that is purposeful & reflective, resourceful & authentic, strategic & action-oriented.

	Design Multiple Means of **Engagement**	Design Multiple Means of **Representation**	Design Multiple Means of **Action & Expression**
Access	Design Options for **Welcoming Interests & Identities** • Optimize choice and autonomy • Optimize relevance, value, and authenticity • Nurture joy and play • Address biases, threats, and distractions	Design Options for **Perception** • Support opportunities to customize the display of information • Support multiple ways to perceive information • Represent a diversity of perspectives and identities in authentic ways	Design Options for **Interaction** • Vary and honor the methods for response, navigation, and movement • Optimize access to accessible materials and assistive and accessible technologies and tools
Support	Design Options for **Sustaining Effort & Persistence** • Clarify the meaning and purpose of goals • Optimize challenge and support • Foster collaboration, interdependence, and collective learning • Foster belonging and community • Offer action-oriented feedback	Design Options for **Language & Symbols** • Clarify vocabulary, symbols, and language structures • Support decoding of text, mathematical notation, and symbols • Cultivate understanding and respect across languages and dialects • Address biases in the use of language and symbols • Illustrate through multiple media	Design Options for **Expression & Communication** • Use multiple media for communication • Use multiple tools for construction, composition, and creativity • Build fluencies with graduated support for practice and performance • Address biases related to modes of expression and communication
Executive Function	Design Options for **Emotional Capacity** • Recognize expectations, beliefs, and motivations • Develop awareness of self and others • Promote individual and collective reflection • Cultivate empathy and restorative practices	Design Options for **Building Knowledge** • Connect prior knowledge to new learning • Highlight and explore patterns, critical features, big ideas, and relationships • Cultivate multiple ways of knowing and making meaning • Maximize transfer and generalization	Design Options for **Strategy Development** • Set meaningful goals • Anticipate and plan for challenges • Organize information and resources • Enhance capacity for monitoring progress • Challenge exclusionary practices

CAST | Until learning has no limits®

Universal Design for Learning (UDL)

An example of the planning process used to ensure we were using UDL as a framework for our Engineering units.

	Provide multiple means of **Engagement** *The WHY of learning*	Provide multiple means of **Representation** *The WHAT of learning*	Provide multiple means of **Action & Expression** *The HOW of learning*
Access	• Task analysis (order of lesson) • Real life examples – engineering jobs, hands on materials	• Adapted texts (teacher to read) • Pictures to illustrate book ideas	• Basic sign language/ Key Word Signs • Yes/no response cards • iPad response boards • Choral responding
Build	• Differentiated activities based on reading/writing ability	• Key vocabulary cards • Visual representation of Habits of Mind and Engineering Design Process	• Key vocabulary cards • Response boards • Prompting hierarchy (Least intrusive prompting) • Sentence starters • Think alouds
Internalise	• Modelled and guided questioning using prompts such as *I noticed... I wonder...* • Self-assessment using criteria	• Big ideas • Repeated storylines • Chapter summaries	• Graphic organisers • Criteria and reflection • Habits of Mind (choral responding; visual)

Developed based on CAST (2018). Universal design for learning guidelines version 2.2. Wakefield, MA

For more information about UDL visit http://www.cast.org/our-work/about-udl.html#.W82IoRMzbow

To reference this document, please use: *Engineering for All Interpretation of UDL (October, 2018). Mater Dei School, Camden, NSW, Australia*

Needs Identified in Current Research

Rescue Reflex

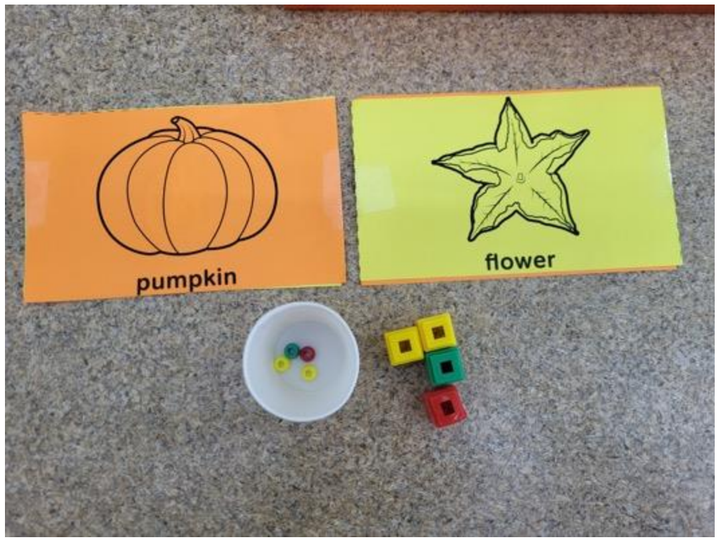
- Teachers struggled watching their students fail and try again

Communication

- Content-specific communication tools for students with limited vocal communication
- Open-ended questioning- Admitted feeling like “talking to a wall”
- Met with silence or confusion at first

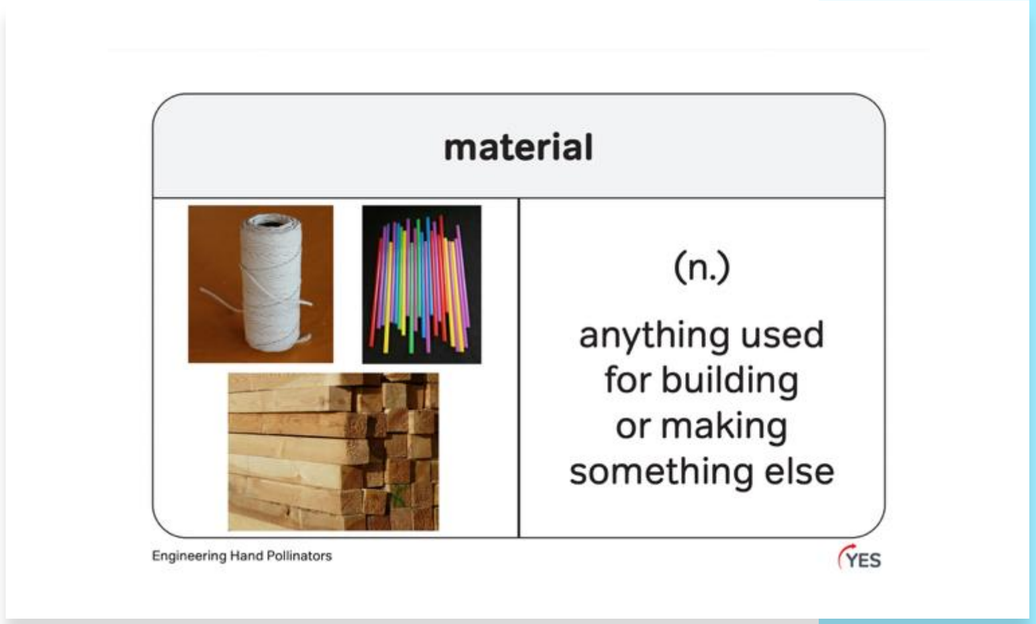
Material Needs

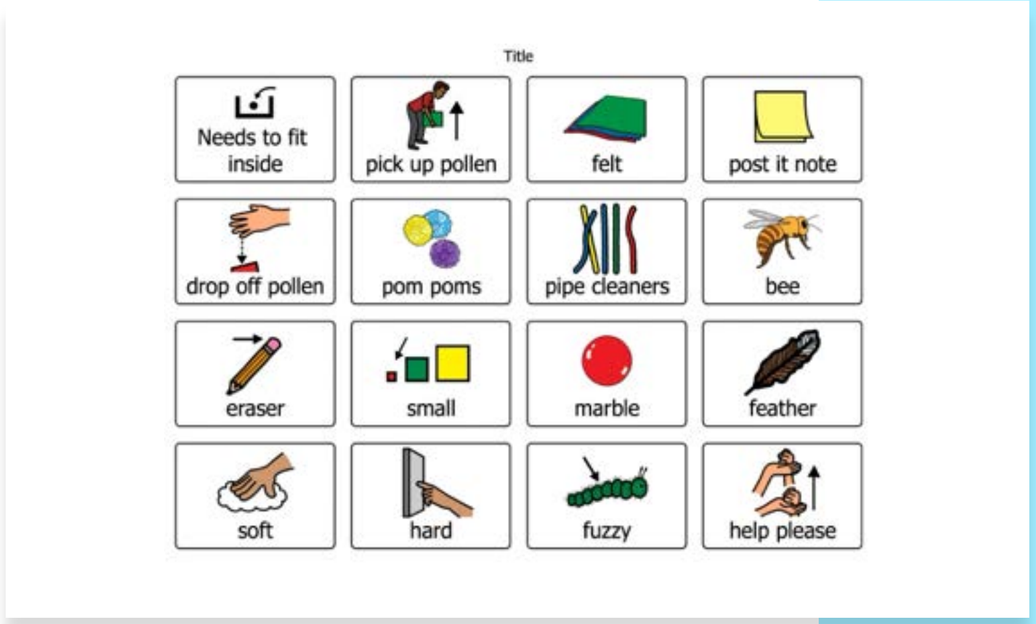
- Fine motor barriers
- Need for visuals



Integrating UDL

- Lesson core boards to support communication and questioning
- Visuals embedded throughout vocabulary, story, and worksheets
- Adapted activity materials (stacking rings vs beads, thicker handle materials to allow independent grasp)
- Prompting procedures for engagement vs. correct answer





UDL to Support Open-Ended Questioning

Reading Reflection

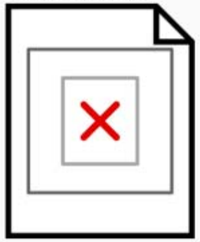
LESSON 8

- How did Jake and Alex improve their hand pollinator?

They used a different material for the handle.

They made it less sticky so the pollen would fall off.

They did not change anything.



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YES

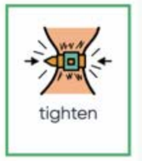
Questions about Hand Pollinators

LESSON

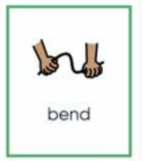
- "Why did you choose to attach it using that material?"
  - "Because it was _____"

It was sticky

It was tight



It was flexible.



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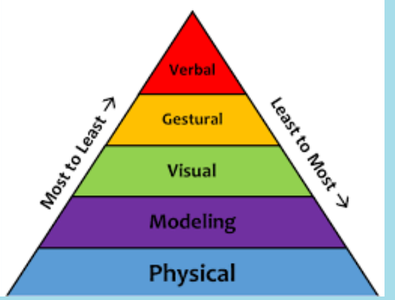
Promoting Engagement Using the Prompt Hierarchy



Independent

- Student explores materials and builds independently

Gesture

- Gesture toward materials to encourage engagement- avoid pointing toward "right" option

Verbal

- "Let's pick a handle."
- "Your turn"

Modeling

- Model interacting with materials vs choosing specific materials

Physical

- Provide physical support in picking up materials, touching, exploring. Consider adaptations if overly supporting

MSD Recommendations

- Pre-teach Vocabulary
- Support open-ended questioning vs skipping
- Teach the Engineering Design Process routine
- Try before you change!
- SLP for Engagement vs Accuracy
- Allow your students to persevere

STEM Education for Students with MSD

- Emphasizes inquiry**, problem-solving**, and critical thinking
- Fundamental skills for *all* students, including those with ID/ESN
- Fosters self-determination
- Informed decisions, meaningful participation in their communities
- Improves quality of life

Resources!

- Yes! Engineering Curriculum https://yes.mos.org/
- CAST UDL https://udlguidelines.cast.org/
- YES! Curriculum Youtube Channel https://www.youtube.com/@EieOrg