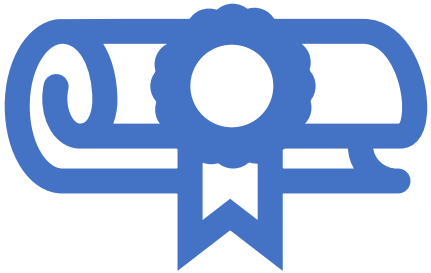
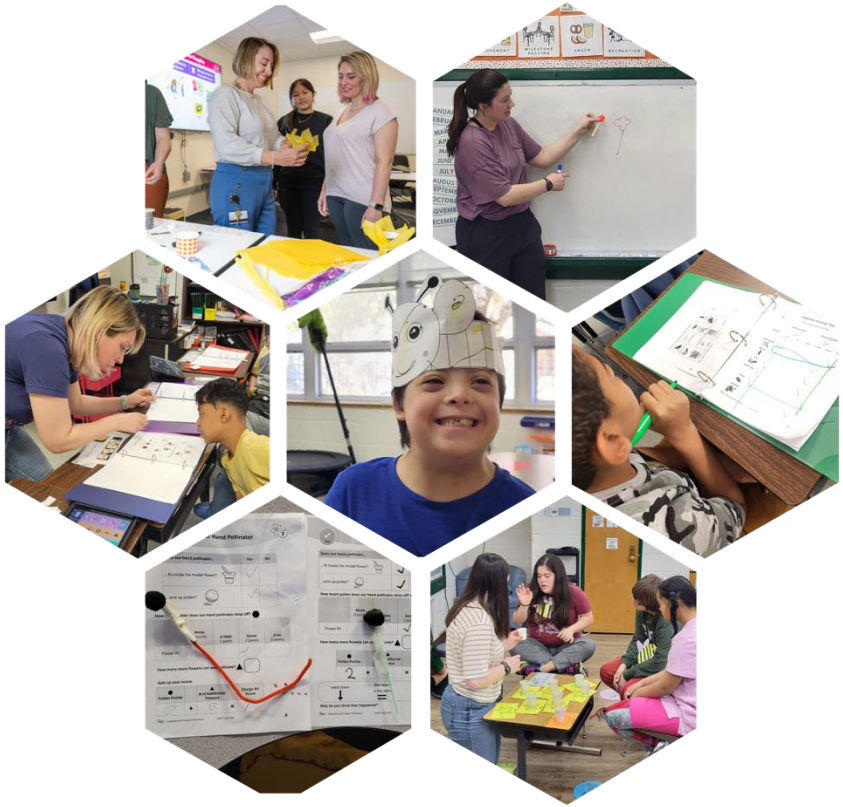


Conference Presentation

The following presentation was given at the 2025 American Society for Engineering Education (ASEE) Annual Conference and Exposition:

- Presentation Title: *Developing inclusive engineering education opportunities*
- Location: Montreal, Canada
- Date: June 23, 2025



Developing Inclusive Engineering Education Opportunities

Bree Jimenez, Baylor University

Ginevra Courtade, University of Louisville

Mary Rathmann, University of Louisville

Christine Cunningham, MOS- Boston

Project BEES

NSF-funded research (2021-2025) exploring effective scaffolding of engineering instruction for students with ID/ESN.

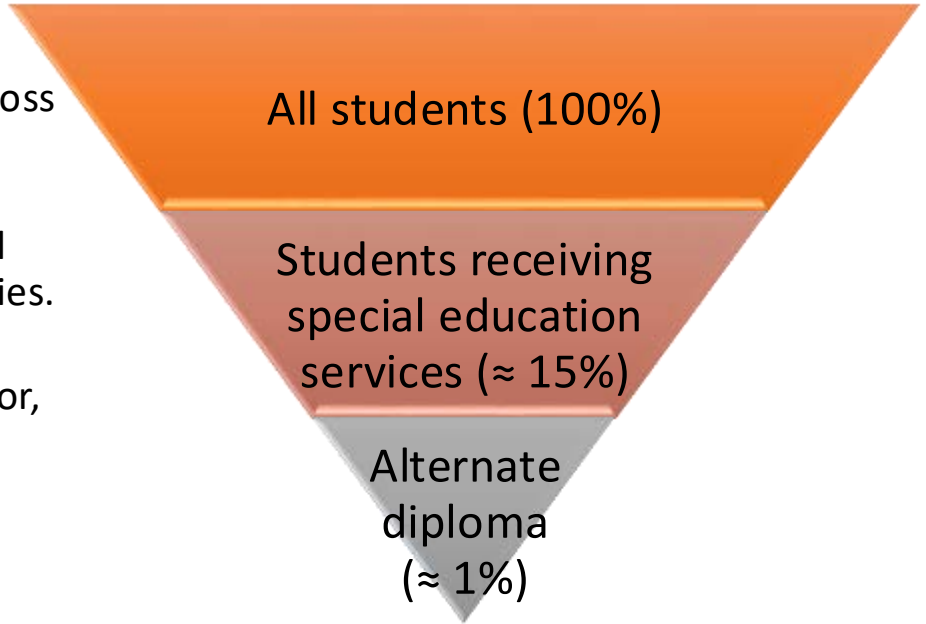
Objectives:

Investigate elementary special educators' knowledge and skills in teaching engineering to students with Intellectual Disability (ID) and Extensive Support Needs (ESN).

1. **Develop a framework** to support teacher instruction of engineering-focused behaviors and mindsets for students with ESN.
2. Use this framework to **design, assess, and disseminate** universally designed instructional materials.

Understanding ID and ESN

- Who are students with ID/ESN?
  - Students needing **extensive, ongoing support** across socio-communication, academics, adaptive skills, and behavior regulation.
  - This often includes students with ASD, intellectual disability, sensory disabilities, or multiple disabilities.
  - Typically, 3 standard deviations below in multiple areas (i.e., cognitive 55 or below, adaptive behavior, communication).
  - Alternate diploma track vs regular high school diploma



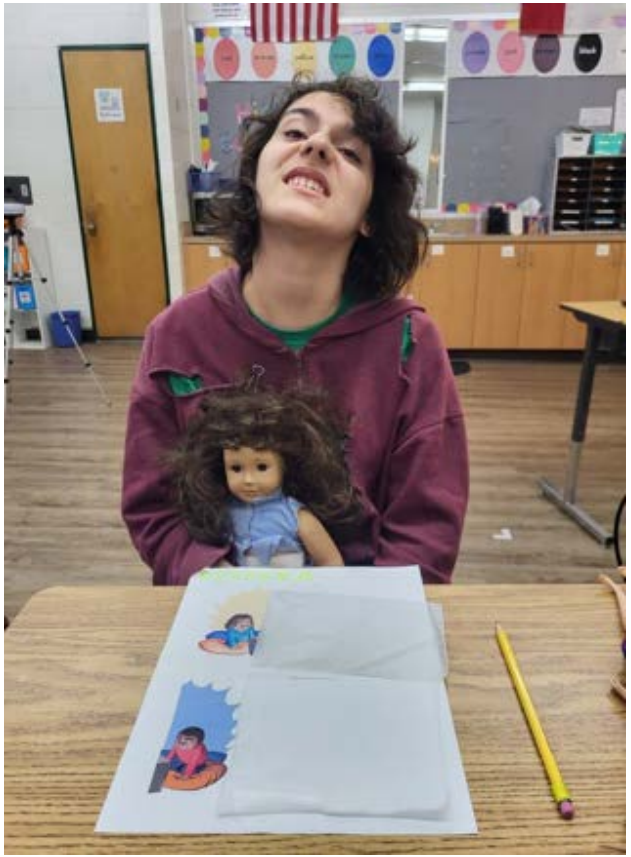
STEM Education for Students with ID/ESN

STEM's Importance for Students with ID/ESN

- 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

Current State of STEM for Students with ESN

- Historically, students with ID/ESN have been **largely excluded** from meaningful participation in STEM education.
- Despite federal laws ensuring access, students with ID/ESN often receive limited instruction in core STEM subjects due to **misconceptions about capability,** resulting in minimal exposure to complex scientific inquiry and engineering.



Current Research in STEM for Students with ID/ESN

Advancements

- Recent years have seen the development of accessible, grade-aligned strategies for teaching STEM, with most progress in mathematics.

Practices

- Practices like systematic instruction, technology-aided instruction, manipulatives, and graphic organizers are proven effective, though science and engineering underrepresented.

Engineering

- Few studies have examined engineering education for students with ID/ESN.
- Jimenez et al. (2021)

UDL

- Universally designed curricula and supports show promise in helping students develop engineering habits of mind and problem-solving skills.

Current Study

- Exploratory Study
- 5 elementary teachers for students with ID/ESN
- YES! Engineering Curriculum- Pumpkin Pollinators
  - Given as-is with teacher flexibility
- 4-part PD Program
  - Understanding engineering, effective practices for students with ESN, UDL strategies for accessibility
- Data collected through observations, interviews, focus groups, self-efficacy surveys

YES! 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

Teacher Perspectives

Results

Educator Challenges & Perspectives

1

Initial Reservations and Concerns

Skepticism:

- their students' ability to engage in engineering
- their own preparedness to teach

Challenges:

- Allowing their students to experience failure
- Encouraging perseverance
- Habits of Mind

2

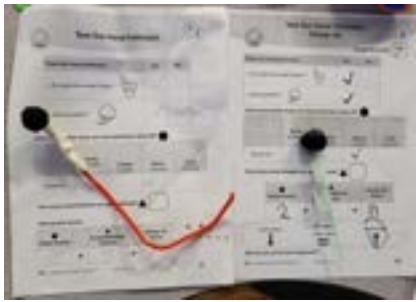
Shifting Beliefs and Confidence

Through PD and classroom experience:

- Observed unexpected student engagement and skill development.
- Surveys indicated increased teacher confidence in applying the UDL framework, differentiating instruction, and modifying content for accessibility.

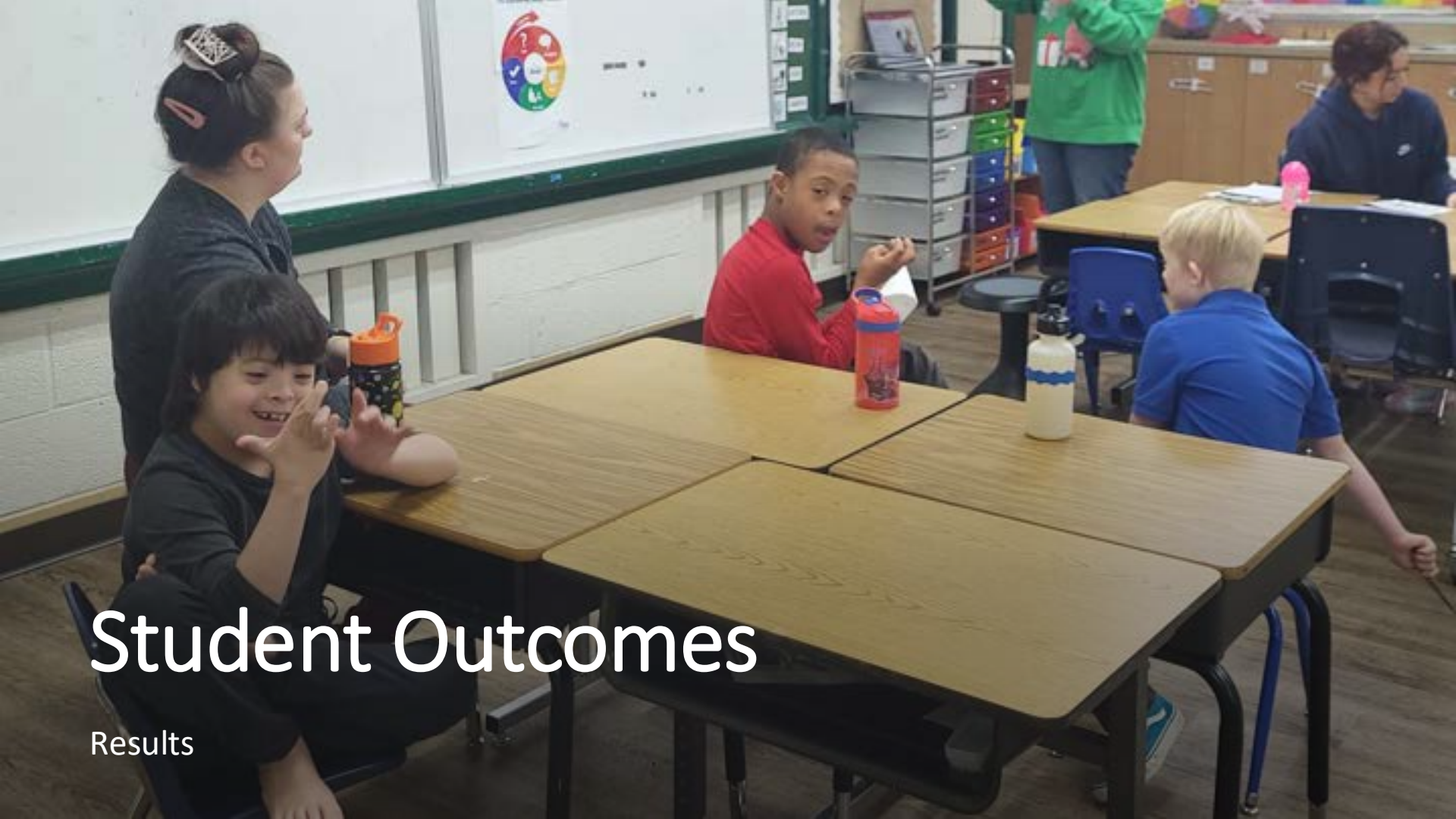
Rescue Reflex

- One teacher described having to “sit on her hands” to resist the urge to suggest adjustments
- “to be a good engineering teacher, you have to let the students be engineers… it’s important for their identity to do things on their own”



Sarah

“I was more surprised by what they were able to understand and grasp with some of the concepts and I just felt it gave me almost like a ***boost of energy that they can do hard things.*** *Like, sometimes I sell them short and I’m like, ‘I don’t think they can do this’ so it was a good experience.”*



Student Outcomes

Results

Student Engagement and Collaboration

- Demonstrated both **content knowledge** and **practices**
  - Identifying and using content vocabulary
  - Interacting purposely with materials
  - Solving problems
  - Iterating on their pollinator designs based on data
- **High levels of engagement**
  - Persisted through challenges
  - Increased on-task behavior
  - Increased communication, collaboration and enthusiasm
  - Generalization to other settings

Problem-Solving and Critical Thinking Skills

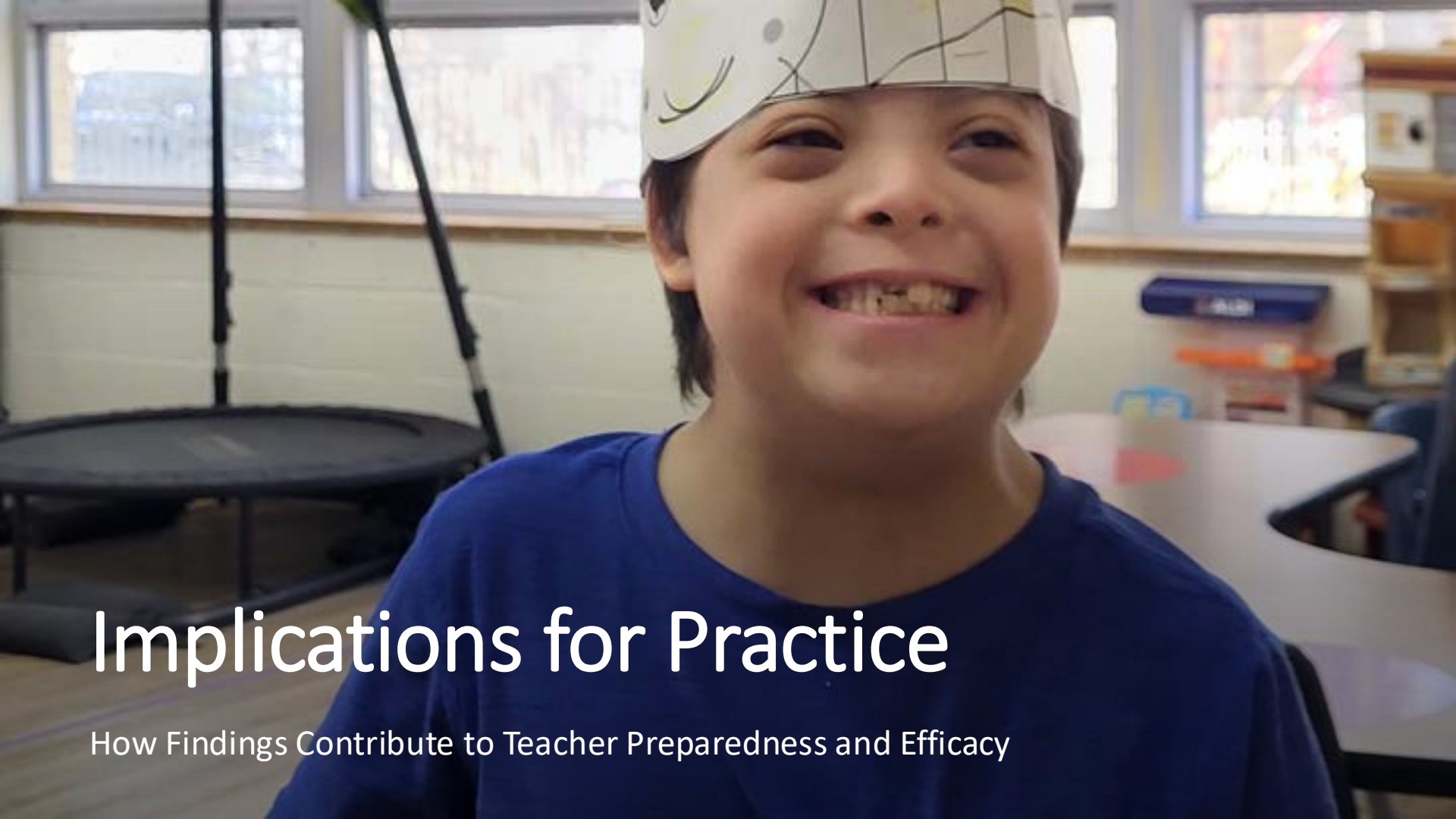
Early on, students would only glance at materials or minimally interact

- By end of the unit, students were actively engaging with the materials, touching/manipulating them, exploring how they worked, assembling
- Clear growth in curiosity and understanding

Creating pollinators:

- Redesigning instead of sticking to their initial designs

Applying results of testing to the problem (more flowers = more pumpkins).



Implications for Practice

How Findings Contribute to Teacher Preparedness and Efficacy

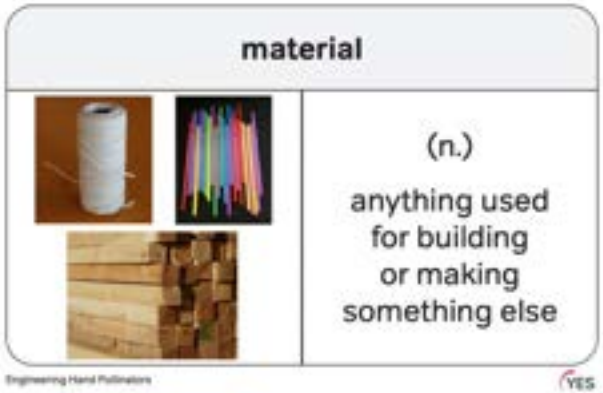
Communication and Material Needs

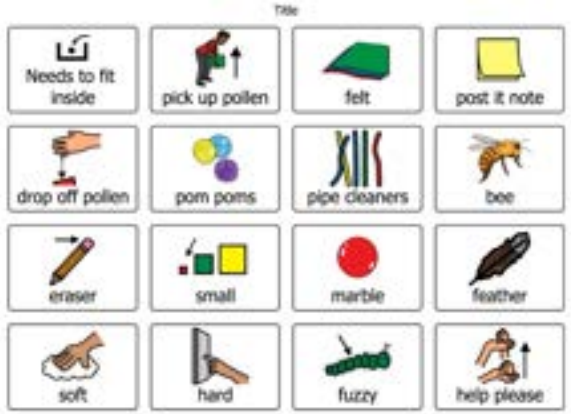
Communication

- 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

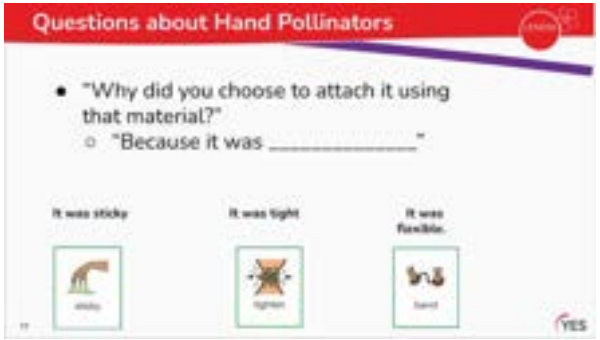


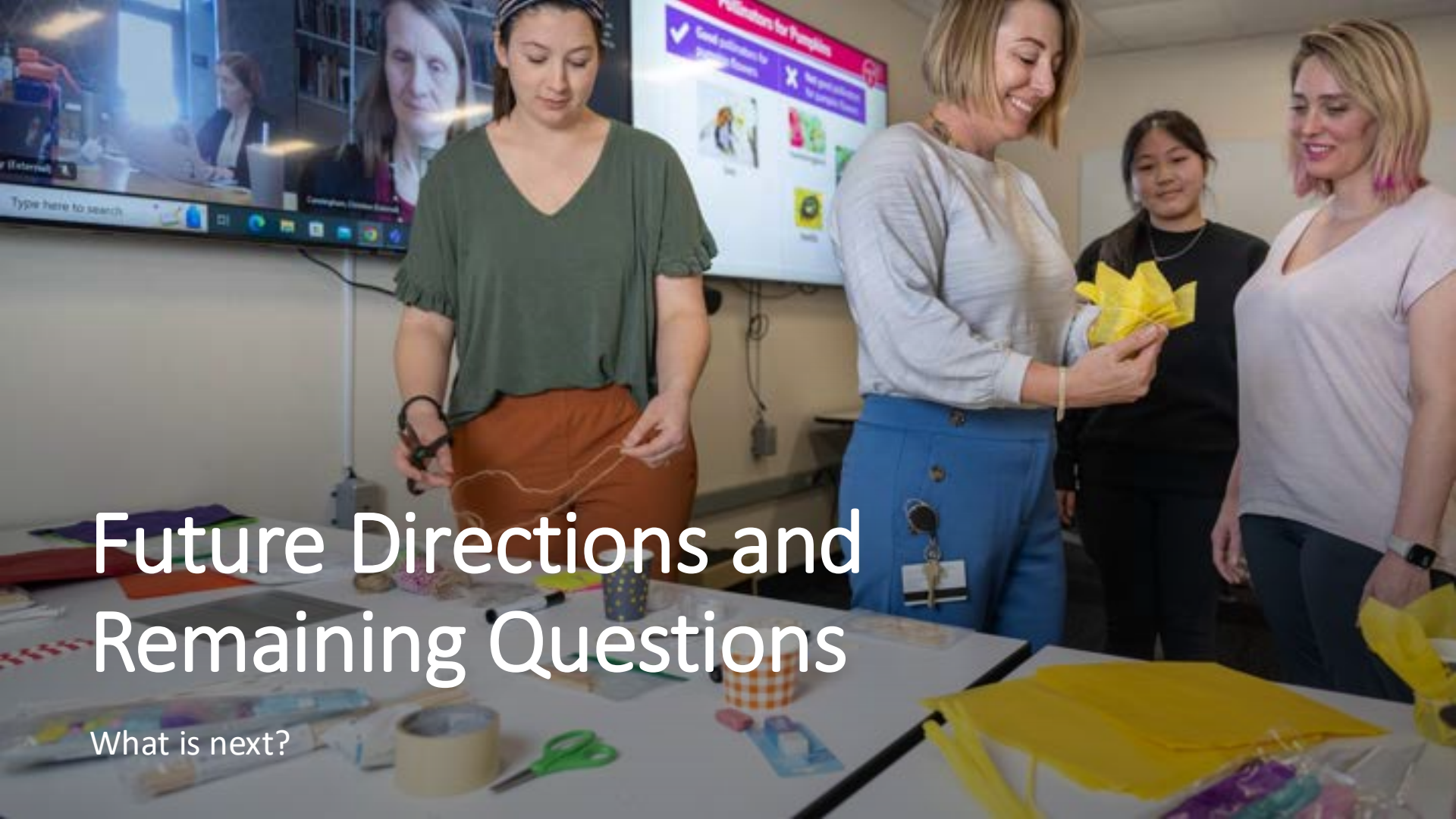


Integrating UDL

- 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





Future Directions and Remaining Questions

What is next?

1

Need for Ongoing PD

High-quality, ongoing professional development helps educators internalize inclusive, evidence-based STEM strategies, supporting sustained student engagement and achievement in engineering and other fields.

2

Sustaining Inclusive Practices

Further research is necessary to determine if teachers can consistently adapt engineering instruction and sustain the use of UDL strategies once external researcher support ends. The long-term impact on curriculum focus and individualized instruction remains an open question.

Questions or Comments?

Confidence & Beliefs Evolution

Increased Confidence
Overall mean scores on self-efficacy surveys increased across all areas, indicating increased teacher confidence in teaching engineering to students with ID/ESN.

Key Areas of Confidence Growth
Specific confidence growth was noted in using prompting, scaffolding, differentiation, modifying language, and identifying key elements in engineering activities.

Student & Teacher Capability
Teachers realized their students' capabilities and their own, with one stating, "I was more surprised by what they were able to understand and grasp...it gave me almost like a boost of energy that they can do hard things."