# Integration of Experiential Learning to Develop Problem Solving Skills in Deaf and Hard of Hearing STEM Students


Wendy Dannels

Rochester Institute of Technology/ National Technical Institute for the Deaf

Matthew Marshall

Rochester Institute of Technology/ Kate Gleason College of Engineering

Andres Carrano

Auburn University



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# Introduction

Rochester Institute of Technology

- KGCOE: The Toyota Production Systems Laboratory
- NTID: National Technical Institute for the Deaf

# Objective

*The objective of this work was to develop and evaluate a novel, experiential-based approach to teaching problem-solving skills to DHH students in STEM fields of study.*

# + Motivation

- Some students who are deaf or hard of hearing (DHH) have been shown to struggle in the development of problem solving skills (Marschark and Everhart, 1999; Luckner and McNeill, 1994)
- This can limit some students' success in pursuing post-secondary STEM degrees and careers.
- Often, DHH students do not possess the same level of conceptual knowledge as their hearing peers (Marschark et al, 2008).
- This limits the experience base that some DHH students may use as they solve complex and unfamiliar problems.

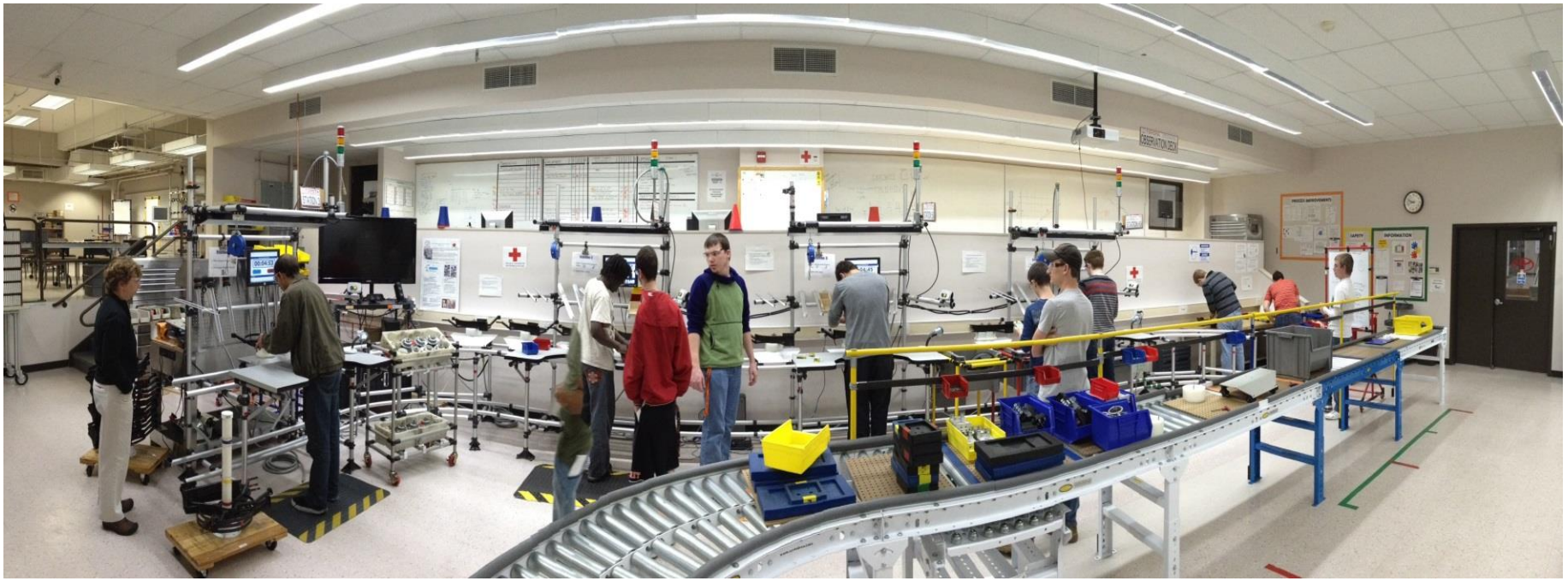
Marschark, M. and Everhart, V.S. (1999). Problem-solving by deaf and hearing students: Twenty questions. *Deafness and Education International*, 1(2), 65-82.

Luckner, J.L. and McNeill, J.H. (1994). Performance of a group of deaf and hard-of-hearing students and a comparison group of hearing students on a series of problem-solving tasks. *American Annals of the Deaf*, 139, 371-377.

Marschark, M., Sapere, P., Convertino, C.M. & Pelz, J. (2008). Learning via direct and mediated instruction by deaf students. *Journal of Deaf Studies and Deaf Education*, 13, 446-461.

# + Background:

## The Toyota Production Systems Lab



***Mission: to provide hands-on education in state-of-the art production systems***

## Roots:

- Targeted skills and context

- Problem Solving
- Continuous improvement
- Technical communication
- Teamwork

# Background

# A3 Problem Solving

## PROBLEM SOLVING GUIDE

**Theme:**
Reduce Blind Spots in Plastics

**Area:** Plastics
**Start Date:** 2/05
**End Date:** 7/05

**Members:** Matt B. (Captain)
Charlie M, Kelly H, Stacey M,
Elizabeth C, Heather M

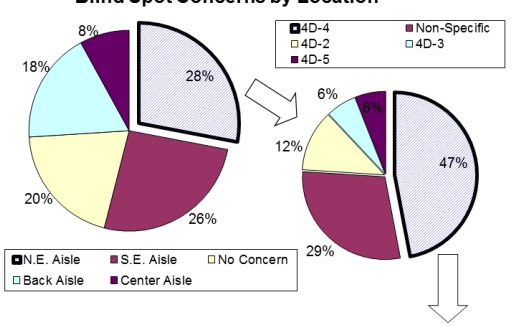
### 1. Identify The Problem *(Clarify Ideal & Current Situations, Visualize the Gap)*

**Ideal:** 100% TMs feel safe when entering conveyance aisle.

***Gap:* 80% of TMs have a blind spot safety concern.**

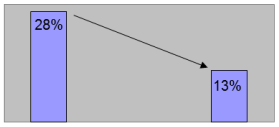
**Current:** 16 out of 20 TMs have a concern with blind spots when entering conveyance aisle (20% feel safe).

### 2. Grasp The Current Situation *(Break Down, Narrow Focus, Go & See, Contain)*



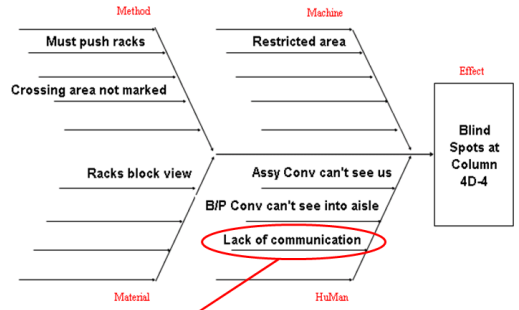

***Problem to Engage:* Blind Spots at Column 4D-4**

### 3. Set A Target *(Do What by How Much by When?)*




**Reduce Blind Spots at N.E. Aisle to 13% by 5/31/05.**

### 4. Determine The Root Cause *(Brainstorm Causes, Verify as Fact by Asking Why)*




**Lack of communication between Assy Conv. & B/P Conv.** ***Why?***

**Lack of awareness between parties** ***Why?***

**Uninformed of caution areas** ***Why?***

**Caution areas not identified** ***Why?***

***Root Cause to countermeasure:* Caution areas not identified**

### 5. Develop A Countermeasure Plan *(Address R/C, Consensus & Action Plan)*

**Activity Plan**

| What | Who | April | May | June |
|---|---|---|---|---|
| 1. Mark Parts X'ing Zone | Heather Stacey | → | | |
| 2. Mark Tugger Honking Zone | Elizabeth Kelly, Charlie | → | | |
| 3. Install Mirror | Matt, Maint. | → | → | |
| 4. Install Caution Light | Matt, Maint. | | → | |

### 6. Implement Countermeasure *(Collect Data, Check & Communicate Progress)*

1.

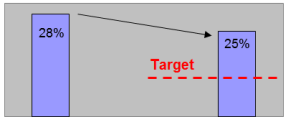

2.


Initial observation found Assy Conv tuggers only adhered to honking zone 30% of the time (3 out of 10 cycles), but adherence improved after more thorough communication.

3 & 4.


Initially B/P Conv T/Ms were not cancelling the light consistently after crossing, but this also improved after further communicating impact to Assy Conv tuggers.

### 7. Confirm Result *(Compare Results to Target, Evaluate Process for Repeatability)*




- Did not achieve target of 13%
- 4D-4 concerns dropped, but other NE Aisle concerns increased due to heightened awareness through this activity.

### 8. Standardize / Control *(Prevent Recurrence, Sustain, Yokoten, Start Again)*

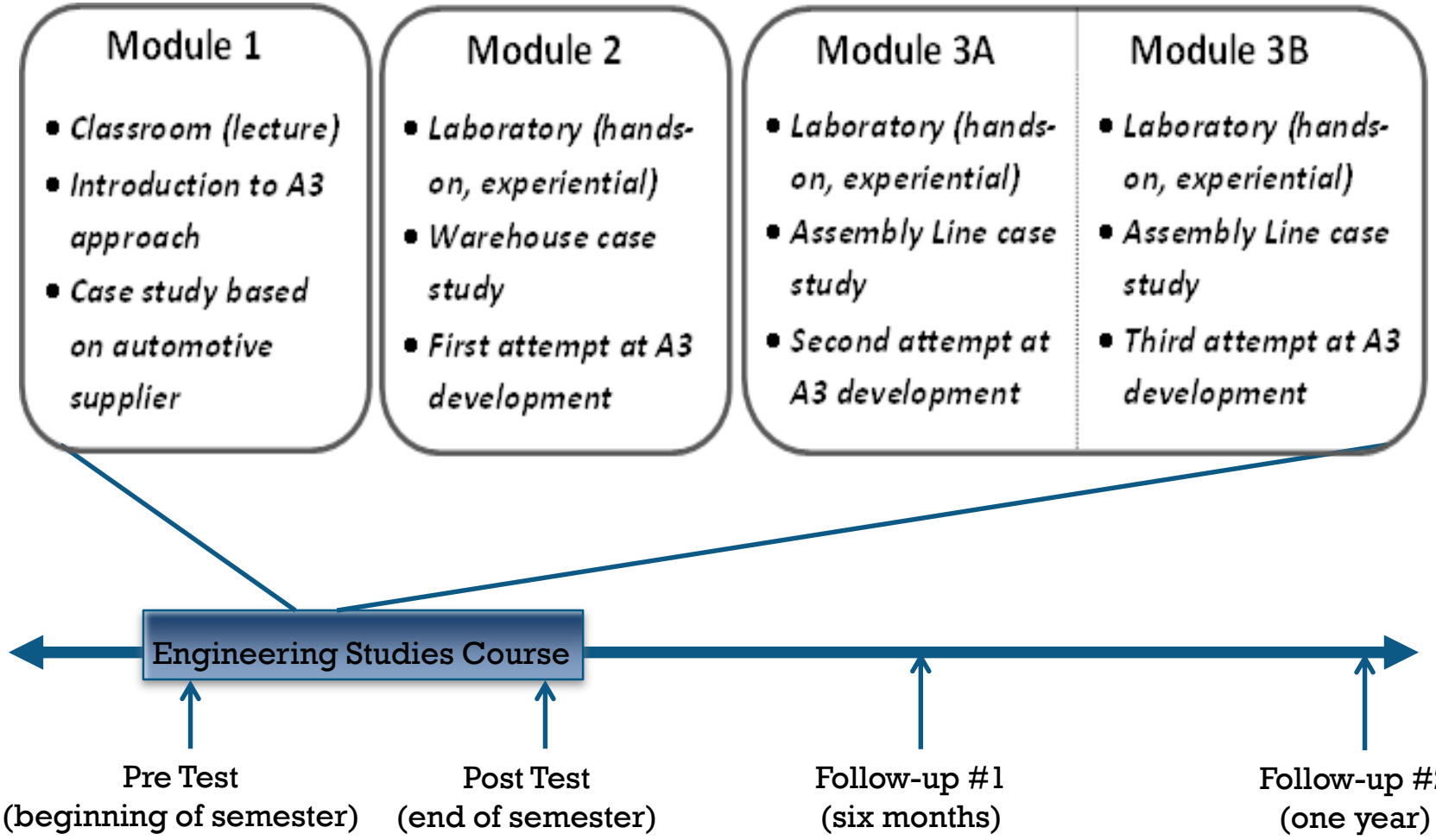
- B/P Conv. Std Work updated 7/05.
- Assy Conv. Std Work updated 7/05.
- C/M yokoten to columns 4D-3 & 4D-5 planned for 8/05.

# Our Approach

- Develop a set of laboratory experiences in which DHH students utilize an adapted A3 approach to solve “real world” problems presented in the TPS Lab
- Develop supporting material that is fully accessible to DHH students
- Implement this intervention in first-year NTID engineering studies classes over a two-year period
- Use a series of case studies to assess baseline and improvement in problem-solving skill using a case/control approach

# Timeline

*Intervention – occurs within semester*



# + Summary of Adaptations

| Best Practice | Adaptation |
|---|---|
| Teacher as skilled communicator | Native ASL communicator as instructor |
| Instruction through primary language | Instruction in ASL before competence is assessed in English |
| Active learning | Laboratory-based (hands-on) instruction; A3 problem-solving requires synthesis and analysis |
| Visual organizers | Lab-based instruction and A3 process are highly visual; text-based materials presented on captioned/signed video |
| Authentic, problem-based instruction | Majority of instruction in industry-like laboratory environment; use of real-world case studies; group discussion |
| Use of technology | Tablet provides interactive, real time information access; fully captioned/signed videos |
| Specialized content vocabulary | Video-based glossary in both captioned English and ASL accessed through tablet; pre-teaching of specific vocabulary |
| Critical thinking | Provide step-by-step problem solving, gradually giving way to independent work and experimentation |
| Mediating textbooks | Scaffolding techniques to accommodate variability in reading levels (lower level reading materials, ASL/captioned video) |

Easterbrooks, S.R. and Stephenson, B. (2006). An examination of twenty literacy, science, and mathematics practices used to educate students who are deaf or hard of hearing. *American Annals of the Deaf*, 151, 385-397.

# Intervention:

- Students participated in the TPS laboratory modules provided with instructional intervention using the A3.
- Students work in small groups, utilizing a tablet-based application of the Plan-Do-Check-Act cycle to solve problems

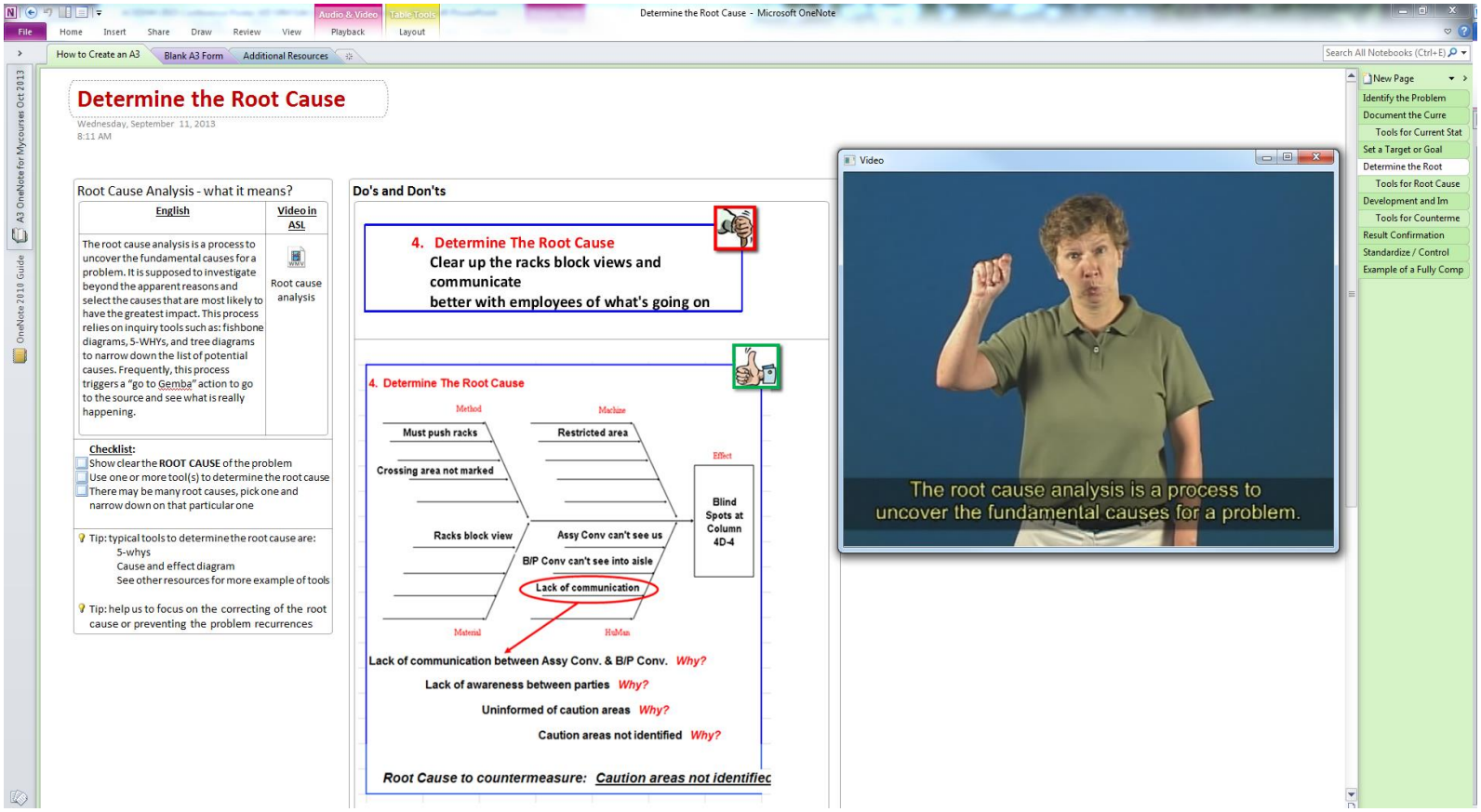
# Intervention:

- Students pose as “workers” in one of several manufacturing/warehousing scenarios and are presented with problems to solve as a team

- By being part of the system, students quickly develop the content knowledge needed to address problems introduced as part of the lab activity.

# Intervention:

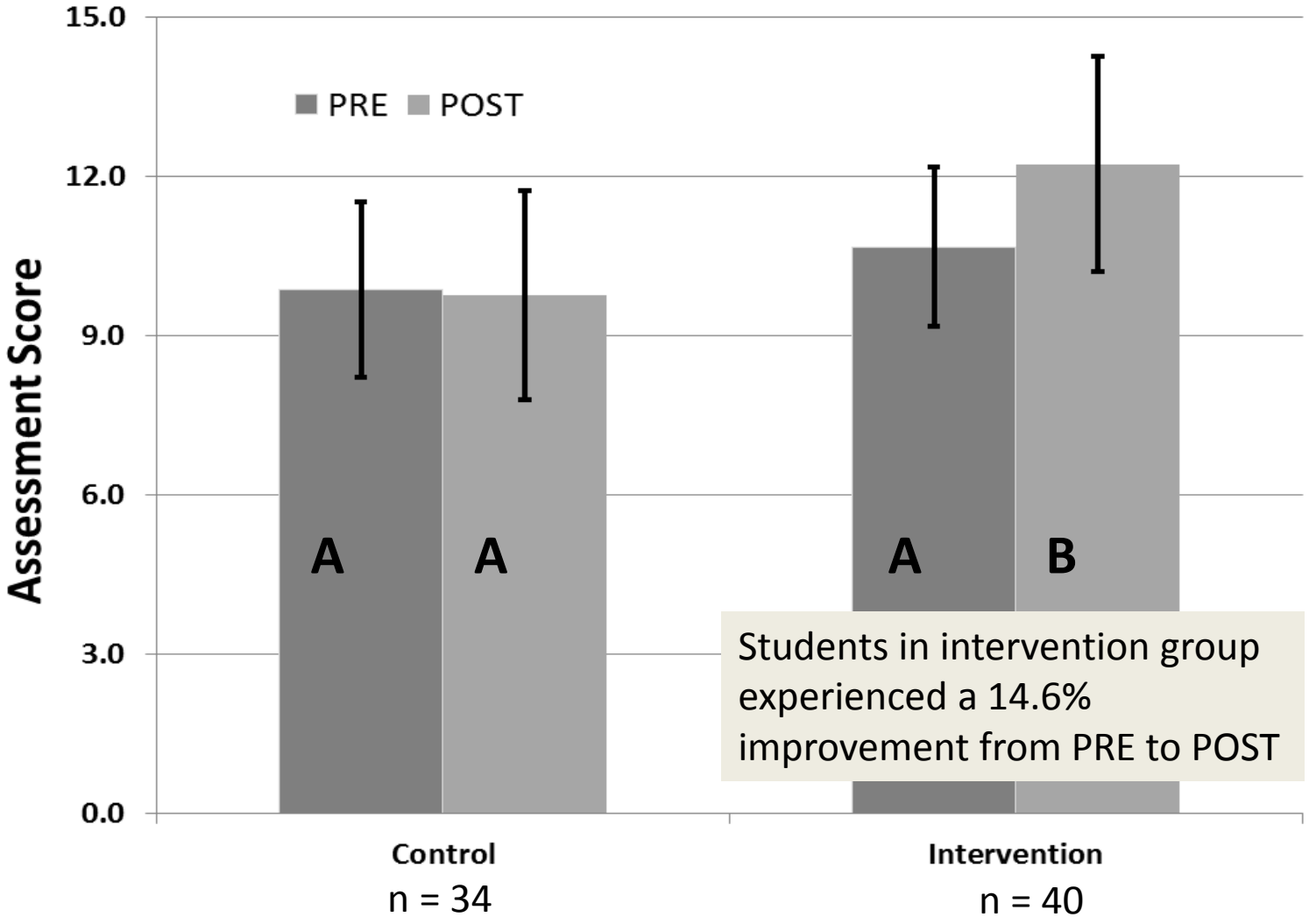
- Screen shot of OneNote tutorial that students use as they are guided step-by-step through the problem-solving process



# Evaluation:

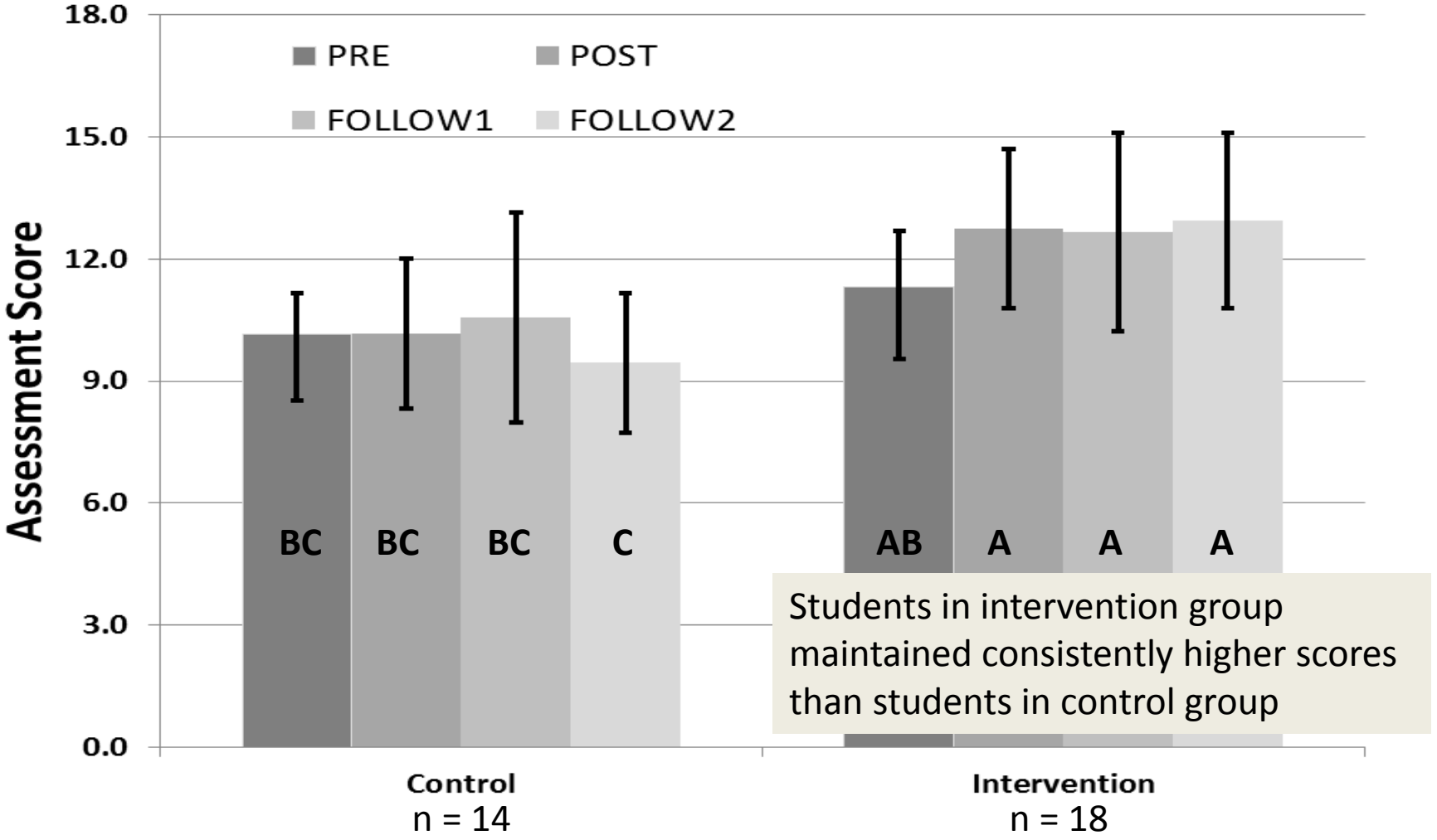
- Four case studies were developed that presented a situation where several problems were described and enough information was provided to develop a root-cause analysis.
- For each case, students in groups of two or three answered questions in which they were required to demonstrate their approach to problem solving.
- A team of three faculty blindly evaluated each student work using a custom rubric.
- Data were analyzed by an independent research group at NTID, Center for Education Research Partnerships (CERP)
- The case studies were used as pre, post and follow-up instruments for assessment. Two control cohorts and two intervention cohorts were established in the experiment.

# Problem-Solving Assessment Evaluation:




## Short-Term Impact of Intervention

# Problem-Solving Assessment Evaluation:




## Long -Term Impact of Intervention

# Key Findings and Conclusions

- Experiencing intervention was associated with short-term and long-term improvement in problem solving
- Approach may be adapted to other experiential activities in which student is immersed – not limited to specialized Toyota Production Systems Lab (e.g., legos, paper airplanes)
- Problem-solving materials will be made available online for other STEM educators to use/adapt

# Questions?

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