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.


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
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** (Clarity: 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)
   - **Blind Spot Concerns by Location**:
     - N.E. Aisle: 28%
     - S.E. Aisle: 26%
     - Center Aisle: 29%
     - Back Aisle: 18%
     - Non-Specific: 8%

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

3. **Set A Target** (Do What, By 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)
   - **Method:**
     - Restricted area
     - Must push racks
     - Crossing area not marked
   - **Manner:**
     - No communication
     - B/P Conv can't see us
   - **Effort:**
     - Lack of communication between Assy Conv & B/P Conv
     - Lack of awareness between parties
     - Uninformed of caution areas
     - Caution areas not identified

   - **Activity Plan**
     - What
     - Who
     - April
     - May
     - June
   - 1. Mark Parts Xing Zone
      - Heather
   - 2. Mark Tugger Xing Zone
      - Rich, Charlie
   - 3. Install Sign
      - Matt, Matt
   - 4. Install Caution Light
      - Matt, Matt

6. **Implement Countermeasure** (Collect Data, Check & Communicate Progress)
   - Initial observation found Assy Conv taggers only adhered to honking zone 30% of the time (3 out of 10 cycles), but adherence improved after more thorough communication.
   - Initially B/P Conv TMs were not cancelling the light consistently after crossing, but this also improved after further communicating impact to Assy Conv taggers.

7. **Confirm Result** (Compare Results to Target, Evaluate Process for Repetability)
   - Initial target of 13% by 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*

**Module 1**
- Classroom (lecture)
- Introduction to A3 approach
- Case study based on automotive supplier

**Module 2**
- Laboratory (hands-on, experiential)
- Warehouse case study
- First attempt at A3 development

**Module 3A**
- Laboratory (hands-on, experiential)
- Assembly Line case study
- Second attempt at A3 development

**Module 3B**
- Laboratory (hands-on, experiential)
- Assembly Line case study
- Third attempt at A3 development

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Pre Test (beginning of semester)  
Post Test (end of semester)  
Follow-up #1 (six months)  
Follow-up #2 (one year)
## Summary of Adaptations

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

Students in intervention group experienced a 14.6% improvement from PRE to POST

Short-Term Impact of Intervention
Students in intervention group experienced a 11.8% improvement from PRE to POST, and maintained this six months later.

Problem-Solving Assessment Evaluation:

Students in intervention group maintained consistently higher scores than students in control group.

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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