15th ANNUAL TEACHING & LEARNING SYMPOSIUM
Designing Classroom Assessment Ecologies for Universal Student Success

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Importance of Failure and Feedback in Engineering Education: A Trail Case

Center for Teaching and Learning Symposium
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“Can kids learn without grades?

Yes.

Can they learn without formative assessment and the feedback that comes with it?

Not at all.”

Rick Wormeli
Middle School Teacher and Author
Typical Engineering Course at UW

• Concept Delivery (3~4 hours)
• Unguided Practice (8~12 hours)
• Recitation (1 hour)
• Office Hours
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*Descriptive Feedback*
Flipped Classroom
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• Online content + Prep Quiz (3~4 hours)
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- In-class Q&A (30 minutes)
- Guided Practice (3½ hours)
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Descriptive Feedback
Online Content

liquid nitrogen
-196°C (cold!)

Initial state: $L_1 = 2L_0$, $T_1 = T_0$

final state: $L_2 = \alpha L_0$, $T_2 = ?$

$PE = -5.96$
<table>
<thead>
<tr>
<th>Question 10</th>
<th>Prep Quiz</th>
<th>1 pts</th>
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<tbody>
<tr>
<td><strong>Which analogy is most accurate from a molecular perspective?</strong></td>
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<td>☐ The elastic restoring force of a rubber band is like the elastic restoring force of a metal coil spring.</td>
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Which analogy is most accurate from a molecular perspective?

- The elastic restoring force of a rubber band is like the elastic restoring force of a metal coil spring.

\[ \hat{u} - \hat{u}_0 = \hat{C}_p (T - T_0) \]
\[ \hat{s} = \hat{s}_0 + \hat{C}_p \ln \left( \frac{T}{T_0} \right) - \frac{R}{2M} \left( \frac{L}{L_0} \right)^2 \frac{2L_0}{L} - 3 \]
\[ u - u_0 = C_v (T - T_0) \]
\[ s = s_0 + C_p \ln \left( \frac{T}{T_0} \right) - R \ln \left( \frac{1/\nu}{1/v_0} \right) \]
Which analogy is most accurate from a molecular perspective?

- The elastic restoring force of a rubber band is like the elastic restoring force of a metal coil spring.
- The temperature increase of a rubber band when stretched is like the increase in temperature of your hands when you rub them together vigorously.
- The elastic restoring force of a rubber band is like the pressure of an ideal gas.
- Stretching a rubber band is like expanding an ideal gas.
Guided Practice

- Failure is a key aspect of learning engineering.
• Failure is a key aspect of learning engineering.
• Feedback should be immediate & descriptive.
Guided Practice

- Failure is a key aspect of learning engineering.
- Feedback should be immediate & descriptive.
- Not all students need the same thing.
Guided Practice

CHECK YOURSELF

WORK IN: 972 kcal/min

Spent: 102.2 kcal/min

SYNOPSIS

EXTRACTION OF LIPIDS

LOST (HK): 5.1 kcal/min
LOST (PRV): 18.5 kcal/min
LOST (COMBINED): 53.0 kcal/min
LOST (COMBINED): 25.6 kcal/min

LOST (COMBINED): 102.2 kcal/min
An air spring contains air at 20.0°C and 1 atm. The air is compressed isothermally to a final pressure of 10.00 atm. *Calculate* the heat exported to the environment.
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• After completing a defined course of study
An air spring contains air at 20.0°C and 1 atm. The air is compressed isothermally to a final pressure of 10.00 atm. Calculate the heat exported to the environment.

• *After* completing a defined course of study
• No stakes
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- **After** completing a defined course of study
- No stakes
- Students work solo (25~30 minutes)
- Debrief + rubric-based **self** grading.
Test Yourself

All students need _____ to learn.
Test Yourself

All students need **feedback** to learn.
Test Yourself

All students need **feedback** to learn.
Students need a safe space to **____**.
Test Yourself

All students need **feedback** to learn. Students need a safe space to **fail**.
Test Yourself

All students need **feedback** to learn. Students need a safe space to **fail**.

The *main* objective of a flipped class is to:

- improve lectures
- reduce class prep time
- improve/increase student feedback
- become a Youtube star
Test Yourself

All students need feedback to learn. Students need a safe space to fail.
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