Where do we go from here?
Natasha Holmes, Ido Roll, James Day & Doug Bonn
Context

• Invention Activities
  • Activities where students are asked to invent a method to solve a problem before being taught the domain
    • Least-squares fitting
    • Weighted Average
    • Weighted Least-squares fitting
    • Slope Uncertainty with fixed intercept
    • T-test

• Invention Support Environment
  • Computer-based learning environment built to support invention activities (Holmes, N. 2011)
ISE: Weighted Average

Invent a procedure to help each sous-chef calculate a single value to report as the diameter of their ostrich egg. Use the space to build a general formula for the index that can calculate a single value for each group. You may use the operators and symbols in the Equation Editor (below) as well as the keys on your computer keyboard.

Rules:
1. Each sous-chef can only report a single value as the diameter of the egg.
2. The exact same procedure must be used for each sous-chef’s dataset.
3. The equation must reflect the criteria described for the rankings above.

\[ \bar{x} = \frac{\sum x_i}{\sum \delta_i^2} \]

Please explain how your formula reflects the rankings made in Section 1.

divide each point by the uncertainty, then divide by the total weight to fix units.
## Experimental conditions

<table>
<thead>
<tr>
<th>Scaffolding stages*</th>
<th>Treatment Group</th>
<th>Control Group</th>
</tr>
</thead>
</table>
| Exploratory analysis | ▪ Pairwise Comparisons  
▪ Ranking  
▪ Self-explanation | | |
| Planning and design | ▪ Build Equation  
▪ Self-explanation | ▪ Build equation |
| Implementation | ▪ Apply equation  
▪ Ranking datasets | ▪ Apply equation |
| Evaluation | ▪ Self-explanation | | |

*Roll, Holmes, Day & Bonn (2012) Using metacognitive scaffolding to improve the inquiry process and its outcomes in guided invention activities*
Quality of Inventions

- Individual invention activities (Roll, et al. 2012)
  - Quality of inventions
  - Quality and quantity of self-explanations
- Slope Uncertainty/Fuel Consumption
  - Analyzed this activity in 2010, 2011
Domain Learning

- Pre- and post-study statistics test
  - 5 domains
  - 3 question types:
    - Conceptual
    - Evaluation
    - Transfer

- Previous found that metacognitive scaffolding improves performance on evaluation questions but has no effect on conceptual or procedural questions. *

Instruction Tasks

- **What matters**
  
  *Identify features from multiple choice list*

- **Drag and drop**
  
  *Connect features to mathematical representations*
Practice Tasks

• Procedural
  • Calculate the index for different data sets
  • Self-explanations

Here is another example of where a weighted average can be used. Three different liquids are combined into a container in different volumes, as in the table provided. How can you determine the density of the final liquid?

**Table**

<table>
<thead>
<tr>
<th>Liquid</th>
<th>Volume (mL)</th>
<th>Density (g/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>100</td>
<td>1.02</td>
</tr>
<tr>
<td>B</td>
<td>10</td>
<td>0.72</td>
</tr>
<tr>
<td>C</td>
<td>500</td>
<td>1.033</td>
</tr>
</tbody>
</table>

• Transfer
  • Evaluate a variation on the formula
  • Apply to a new situation
Transfer activities

- T-test invention activity
  - Both in low scaffolding
  - Quality of inventions
  - Quality of self-explanations

- Recall data and equation
  - Which of the following graphs were used last week?
  - What was the equation from last week?
  - What were the features?
Last week we asked you to use four graphs to invent a method for finding the uncertainty in the slope of an unweighted best-fitting line with a fixed intercept at the origin. Before we discuss slope uncertainty in a more general form, we would like to spend a minute recalling some of the information presented last week.

Given that the first graph (below) was one of the four given last week, which of the remaining graphs show the same data that was presented to you last week? Please check all that apply.

Without looking in your books, what was the formula for calculating the uncertainty in the slope of an unweighted best-fitting line with an intercept fixed at zero? Please use the equation editor below to recreate the equation to the best of your ability.

What were the three features involved in determining the uncertainty in the slope of an unweighted best-fitting line with an intercept fixed at zero?
Behaviours

- Log files of student actions throughout invention process
  - Where do they spend their time during invention activities?
  - How many solutions do they create?
  - How much evaluating are they doing?
  - Other questions I can’t even think of?
Next round of research questions?

- Motivation orientation
  - Does motivation correlate to invention performance?
  - How do invention activities affect motivation over the year?
- Case-studies
  - How do students use invention activities?
  - What self-regulated learning strategies are they using on their own?
  - What SRL strategies do we support?
  - What SRL strategies should we be supporting?