Students’ Responses to Curricular Activities as Indicator of Coherence in Project-Based Science

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Project-based Learning: The Promise
Project-Based Learning: The Reality

Why are we doing this activity?
A Measurement and Design Challenge

• How can we study students’ day-by-day experiences of units?
• How can we use data from students’ varied experiences of unit coherence to inform design?
Coherence: A Definition

• Lessons organized so that:
  • Each builds a piece of knowledge that is needed to explain a science phenomenon or solve an engineering design challenge.
  • Each generates new student questions that are addressed in subsequent lessons through student engagement in science and engineering practices.
Assumptions

• Coherence is only partly a function of the design of the unit; it is also a function of:
  • Teacher implementation
  • Student sensemaking

• Sustained engagement is supported by strong perceptions of relevance (Polman, 2012).
Initial Conjectures (1 of 2)

Student experience will differ, depending on less on type

THE REAL WORLD
- Ask Questions
- Observe
- Experiment
- Measure

COLLECT DATA
TEST SOLUTIONS

Investigating

ARGUE CRITIQUE ANALYZE

THEORIES AND MODELS
- Imagine
- Reason
- Calculate
- Predict

FORMULATE HYPOTHESES
PROPOSE SOLUTIONS

Developing Explanations
and Solutions

FIGURE 3-1 The three spheres of activity for scientists and engineers.
Initial Conjectures (2 of 2)

Tools and Materials: Different Lesson Types

Discursive Practices: Connecting Lessons to Challenge

Participant Structures: Engagement in Science and Engineering Practices

Emotional Experience

Experience of Coherence

Perceptions of Relevance
“Practical” Measurement Approach

• Relies on a handful of items
• Collected weekly from all students
• Aggregated and analyzed quickly for patterns to inform iterative design and implementation guidance to teachers
Project-Based Unit: Ecosystems

What species of tree should we plant and where, in order to benefit human beings and other organisms in the city?
Participants

• **592** students of **11** teachers from **8** schools in a large urban school district

• The majority of students in the district are Hispanic and **69%** participate in the free/reduced lunch program.

• Our data sample consists of **1,223** surveys submitted by participating students from August 25 through October 28, 2015.
Data Sources

• Emotional experience in class (Morozov et al., 2014)
  • “Today in class, I felt....”

• Perceived coherence of lesson
  • “We learned about something today that connects to the challenge.”

• Relevance to self, class, and community

Measure is available online: http://tinyurl.com/ihubpm
Approach to Analysis

• Hierarchical linear models fit to the data
  • Unconditional models to analyze teacher and student variance first

• Outcomes
  • Emotional experience in class
  • Coherence

• Predictor
  • Lesson type: Investigative or discursive
## Findings: Excitement and Boredom

Table 2: Model of *excited* emotion with lesson connected to the challenge.

<table>
<thead>
<tr>
<th>Outcome - Model</th>
<th>Predictor</th>
<th>Coefficient in log odds (se)</th>
<th>Coefficient in probability</th>
<th>% of Variance at the Teacher Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excited</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connected to challenge</td>
<td></td>
<td>0.84* (0.37)</td>
<td>0.70</td>
<td>40.1%</td>
</tr>
</tbody>
</table>

Table 3: Model of *bored* emotion with lesson connected to the challenge.

<table>
<thead>
<tr>
<th>Outcome - Model</th>
<th>Predictor</th>
<th>Coefficient in log odds (se)</th>
<th>Coefficient in probability</th>
<th>% of Variance at the Teacher Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bored</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connected to challenge</td>
<td></td>
<td>-0.79 (0.48)</td>
<td>0.31</td>
<td>40.6%</td>
</tr>
</tbody>
</table>
### Findings: Coherence

Table 1: Model of lesson connected to the challenge with type of challenge as predictors.

<table>
<thead>
<tr>
<th>Outcome - Model</th>
<th>Predictor</th>
<th>Coefficient in Log Odds (se)</th>
<th>Coefficient in Probability</th>
<th>% Variance at Teacher Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connected to Challenge Unconditional Model</td>
<td></td>
<td></td>
<td></td>
<td>30.5%</td>
</tr>
<tr>
<td>Connected to Challenge Type of Lesson</td>
<td>Investigation-focused</td>
<td>-0.28 (0.33)</td>
<td>0.43</td>
<td>34.7%</td>
</tr>
<tr>
<td></td>
<td>Discursive-focused</td>
<td>-0.37 (0.20)</td>
<td>0.32</td>
<td></td>
</tr>
</tbody>
</table>
Additional Findings

• We found a significant correlation between perceptions of relevance and perceptions of coherence

• Perceived relevance, like coherence, has a high percent of teacher variance (37%)
  • Lesson type was not associated with perceived relevance.
Revised Conjectures

We need clearer guidance and deeper investigation of teacher moves to promote coherence.

Discursive Practices: Connecting Lessons to Challenge

Participant Structures: Engagement in Science and Engineering Practices

Emotional Experience

Experience of Coherence

Perceptions of Relevance
Informing Iterative Design

• Evidence presented to teachers for why challenge is important for student engagement.

• Developing additional guidance in the form of:
  • Lesson plan templates that engage students in reflection on coherence.
  • Heuristics for teachers to use when making adjustments to planned sequence of lessons.
Conclusions

• Curriculum design is important, but not enough to ensure coherence.

• With moderately coherent curriculum, student experience can still vary widely.

• There is value in using small surveys that elicit student experience in coherence for informing design.
Thank you.

Presentation is available at:
http://learndbir.org/talks-and-papers

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