The Science of Learning: The Field and its Work

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Outline

• PART 1: The Learning Sciences
• PART 2: An Example
• PART 3: Enter Neuroscience
The Learning Sciences

Learning as:

• associations
• mental models
• social participation
• enculturation
What would a “good” science of learning look like?

• Learning in-situ
• Learning across scale (levels, time)
• Explanatory cum transformational
• Interdisciplinary
The Learning Sciences Lab @NIE/NTU

• established in 2005

• interventionist research agenda

• Worked with 100+ schools, 1000+ teachers, and 10,000+ students
Research Areas

Student-Generated Designs

Play-based Learning

The Science of Learning

Mobile / Seamless Learning

Embodied Cognition

New Media
PART 2: An Example
Learning from Productive Failure

If learning from failure is so intuitively compelling, why do we wait for it?

Why can’t we deliberately design for and test it?
Theoretical mechanisms

Cognitive
1. Activation
2. Noticing
3. Awareness of gaps
4. Sensitivity
5. Selection

Affective
1. Situational interest
2. Goal Orientation
3. Frustration
4. Persistence

Social
1. Explanation & elaboration
2. Shared representation
3. Multiple perspectives
4. Vicarious learning

Cultural
1. Failure as normative
2. Failure as positive
3. Effort and Growth
4. Disciplinarity: ways of thinking and being
What is Productive Failure?

Understand what students know about a **novel** concept that they have not been taught yet.

Afford opportunities to activate and differentiate prior and intuitive knowledge....to generate, explore, critique, and refine representations and solution methods (RSMs) for solving complex problems.

Invariably, such a process leads to failure (in relation to a desired goal)...

But, this may precisely be the locus of deep learning... provided some form of structure follows subsequently.
The Problem
(Grade 8/9 students)

Who’s the most consistent striker?

<table>
<thead>
<tr>
<th>Year</th>
<th>Mike Arwen</th>
<th>Dave Backhand</th>
<th>Ivan Right</th>
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<td>Mike Arwen: Mean = $\frac{280}{20}$</td>
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<td>2</td>
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<td>= 14 goals/year</td>
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<td>Mode = 14</td>
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</table>

| Dave Backhand: Mean = $\frac{280}{20}$ | 1 | 1 | 1 | 1 | 3 | 6 | 3 | 1 | 1 | 1 | 1 |
| = 14 goals/year | | | | | | | | | | | |
| Mode = 14 | | | | | | | | | | | |

| Ivan Right: Mean = $\frac{280}{20}$ | 1 | 5 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 5 | 1 |
| = 14 goals/year | | | | | | | | | | | |
| Mode = 18 and 10 | | | | | | | | | | | |

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**Mike Arwen**

- **Frequency:**
  - Year 9: 1
  - Year 10: 1
  - Year 11: 2
  - Year 12: 2
  - Year 13: 2
  - Year 14: 4
  - Year 15: 2
  - Year 16: 2
  - Year 17: 1
  - Year 18: 1
  - Year 19: 1

- **Graph:**

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**Dave Backhand**

- **Frequency:**
  - Year 9: 1
  - Year 10: 1
  - Year 11: 1
  - Year 12: 3
  - Year 13: 6
  - Year 14: 3
  - Year 15: 1
  - Year 16: 1
  - Year 17: 1
  - Year 18: 1
  - Year 19: 1

- **Graph:**

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**Ivan Right**

- **Frequency:**
  - Year 9: 1
  - Year 10: 5
  - Year 11: 1
  - Year 12: 1
  - Year 13: 2
  - Year 14: 1
  - Year 15: 1
  - Year 16: 5
  - Year 17: 1
  - Year 18: 1

- **Graph:**

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Students' Ideas

From Question paper: Average = \( \frac{280}{20} \)

Mike has 8 years < average
4 years = average
8 years > average

Dave has 7 years < average
6 years = average
7 years > average

Ivan has 9 years < average
2 years = average
9 years > average

Frequency of years above, below, and at average

Consistency = Ratio of years at average divided by away from average
Sum of deviations about the mean

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<th>Year</th>
<th>Avg</th>
<th>M.A</th>
<th>D.B</th>
<th>Z.R</th>
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Average of year-on-year absolute deviation

MIKE: \(= \frac{5 + 5 + 4 + 5 + 4 + 4 + 4 + 5 + 4 + 4 + 4 + 5 + 4 + 5 + 4 + 5 + 4 + 5 + 4}{20 - 1}\)

\[= \frac{84}{19} = 4.42\]

DAVE: \(= \frac{4 + 7 + 2 + 4 + 1 + 2 + 1 + 1 + 4 + 5 + 2 + 3 + 1 + 3 + 4 + 1 + 4 + 4 + 1}{19}\)

\[= \frac{54}{19} = 2.89\]

IVAN: \(= \frac{5 + 3 + 5 + 1 + 6 + 7 + 7 + 2 + 2 + 5 + 5 + 4 + 9 + 1 + 8 + 7 + 1 + 8 + 0}{19}\)

\[= 4.77\]
Idea 3: Measurement Graph Length

**MA**  \[ \frac{1}{2}x + \frac{1}{2}y + \frac{1}{2}z + \frac{1}{2}t + \frac{1}{2}p + \frac{1}{2}q + \frac{1}{2}r + \frac{1}{2}s + \frac{1}{2}u + \frac{1}{2}v + \frac{1}{2}w + \frac{1}{2}x + \frac{1}{2}y + \frac{1}{2}z + \frac{1}{2}t = 83.26 \]

**DB**  \[ \frac{1}{2}x + \frac{1}{2}y + \frac{1}{2}z + \frac{1}{2}t + \frac{1}{2}p + \frac{1}{2}q + \frac{1}{2}r + \frac{1}{2}s + \frac{1}{2}u + \frac{1}{2}v + \frac{1}{2}w + \frac{1}{2}x + \frac{1}{2}y + \frac{1}{2}z + \frac{1}{2}t = 56.54 \]

**IR**  \[ \frac{1}{2}x + \frac{1}{2}y + \frac{1}{2}z + \frac{1}{2}t + \frac{1}{2}p + \frac{1}{2}q + \frac{1}{2}r + \frac{1}{2}s + \frac{1}{2}u + \frac{1}{2}v + \frac{1}{2}w + \frac{1}{2}x + \frac{1}{2}y + \frac{1}{2}z + \frac{1}{2}t + \frac{1}{2}y + \frac{1}{2}z + \frac{1}{2}t = 94.54 \]

Dave Backford is the most consistent player as he has the shortest 'stretched-out' graph, showing consistency over time.

Azaaz Akeen
Key Findings

• Learning as knowledge gain
  • Better student learning
  • Better teacher learning

• Learning as social participation
  • Learning to collaborate vs. collaborating to learn
  • Learning to generate ideas vs. generating ideas to learn

• Learning as enculturation
  • Alignment of classroom norms and expectations
  • Designing for disciplinarity
  • Resistance from students and teachers
PART 3: Enter Neuroscience

Cultural

Social

Cognitive

Neural
What would a “good” science of learning look like?
Thank you

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