Exploratory Activities in the Classroom
A Cognitive Science Perspective

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Digit Span Activity
• How did your thinking change between the first task and the second?
Digit Span Activity

1\textsuperscript{st} task measures short-term memory
- Storage & passive rehearsal

2\textsuperscript{nd} task measures working memory
- Storage & active manipulation
Exploratory Learning Activity

• Characteristics?
Exploratory Activities in the Classroom

• What are they?
• Why do they work?
• Important characteristics
• For whom are they most helpful?
Exploratory Activities in the Classroom

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Exploratory Learning

Constructivism
Active learning
Inquiry
Student-centered

Direct Instruction

Instructivism
Passive Learning
Authority
Teacher-centered
Exploratory Learning

- Increases motivation, active engagement
- Encourages hypothesis testing
- Discover underlying patterns, causality

(Bonawitz et al., 2011; Piaget, 1973, Wise & O’Neill, 2009)

Direct Instruction

- Lessens burden on cognitive resources
- Supports development of accurate knowledge
- Allows more coverage of content

(Kirschner et al., 1996)
“Pure” discovery learning does not increase learning outcomes as much as direct instruction

(Alfieri et al., 2011)

(Bonawitz et al., 2011; Piaget, 1973, Wise & O’Neill, 2009)

(Kirschner et al., 1996)
Exploratory Learning & Direct Instruction

Combining aspects of both approaches is even better.

(Alfieri et al., 2011)

(Bonawitz et al., 2011; Piaget, 1973, Wise & O’Neill, 2009)

(Kirschner et al., 1996)
Exploring Variance

- 9th grade boys in Singapore
- Previous experience with central tendency (mean, median, mode)

Exploring Variance

(Kapur, 2012)
Exploration Condition

Which of these 3 potential players has been the most consistent (and should be hired)?

Please come up with a formula for consistency and show which player is the most consistent striker.

Later told canonical solution and practiced

Table 4  Number of goals scored by three strikers in the premier league

<table>
<thead>
<tr>
<th>Year</th>
<th>Mike Arwen</th>
<th>Dave Backhand</th>
<th>Ivan Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988</td>
<td>14</td>
<td>13</td>
<td>13</td>
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<td>1989</td>
<td>9</td>
<td>9</td>
<td>18</td>
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<td>1990</td>
<td>14</td>
<td>16</td>
<td>15</td>
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</tr>
<tr>
<td>1994</td>
<td>15</td>
<td>13</td>
<td>17</td>
</tr>
</tbody>
</table>
Exploration Condition

Example Problem Approaches

- Mike Arwen: \[ \text{Mean} = \frac{280}{20} \]
  \[= 14 \text{ goals/year}\]
  \[\text{Mode} = 14\]

- Dave Backhand: \[ \text{Mean} = \frac{280}{20} \]
  \[= 14 \text{ goals/year}\]
  \[\text{Mode} = 14\]

- Ivan Right: \[ \text{Mean} = \frac{280}{20} \]
  \[= 14 \text{ goals/year}\]
  \[\text{Mode} = 18\text{ and }10\]

Exploring Variance

(Kapur, 2012)
Exploration Condition

Example Problem Approaches

graphing to examine patterns

Exploring Variance
(Kapur, 2012)
Exploration Condition

Example Problem Approaches

summing deviations from the mean

Exploring Variance
(Kapur, 2012)
Direct Instruction Condition

First told canonical solution
Practiced
Completed same problems as exploration condition, plus extra (to equate time)
Exploring Variance
(Kapur, 2012)
• Cognitive psychology (Schwartz & Bransford, 1998)
• Economics (Capon & Kuhn, 2004)
• Early algebra learning (DeCaro & Rittle-Johnson, 2012)
• Descriptive statistics (Schwartz & Martin, 2004)
• Density (Schwartz et al., 2012)
Exploratory Activities in the Classroom

- What are they?
- **Why do they work?**
- Important characteristics
- For whom are they most helpful?
Preparation for future learning

- Creates a “need to know” (Hiebert & Groews, 2007; Wise & O’Neill, 2009)
- Dispels illusions of understanding (Bjork, 1994)
- Activates (or creates) relevant prior knowledge (Kapur, 2012; Schwartz & Bransford, 1998)
- Helps learners notice features they might otherwise overlook (Schwartz & Bransford, 1998)
Exploratory Activities in the Classroom

• What are they?
• Why do they work?
• **Important characteristics**
• For whom are they most helpful?
General Features

• Set up a problem to be solved or a phenomenon to explain
• Require explanation and elaboration ("why?")
• Challenge, but do not frustrate

(Kapur, 2012)
Inventing Procedures

Otherwise, will focus on the procedure, rather than what makes it useful

Exploring Variance (Kapur, 2012)

(Schwartz, Lindgren, & Lewis, 2009)
Compare/Contrast

Highlight important features by using contrasts (but not too many contrasts)

(DeCaro & Rittle-Johnson, 2012; Fyfe, DeCaro, & Rittle-Johnson, under review; Schwartz, Lindgren, & Lewis, 2009)
Schema Induction

An experiential activity (e.g., video, demonstration) given before instruction can introduce learners to basic features and questions.
Exploratory Activities in the Classroom

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Prior Knowledge

- An important benefit of exploration is to develop prior knowledge → seek answers
- Sufficient prior knowledge → already have questions and seek answers

(Schwartz & Bransford, 1998; Schwartz, Lindgren, & Lewis, 2009)
Response to Challenge

Students approach learning with different goals and conceptions of “ideal” performance (Hidi & Renninger, 2006)

(Diener & Dweck, 1980)
Response to Challenge

Higher Mastery-Orientation

- Desire personal growth
- View challenge (confusion, difficulty) as an opportunity to learn
- Respond to setbacks with increased effort and persistence

Higher Performance-Orientation

- Desire to demonstrate ability
- View challenge (confusion, difficulty) as a sign of incompetence
- Respond to setbacks by withdrawing

(Diener & Dweck, 1980)
Response to Challenge

Higher Mastery-Orientation

- Desire **personal growth**
- View challenge (confusion, difficulty) as **an opportunity to learn**
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Higher Performance-Orientation

- Desire to **demonstrate ability**
- View challenge (confusion, difficulty) as **a sign of incompetence**
- Respond to setbacks by withdrawing

**Benefit most from exploratory activities**

(DeCaro, DeCaro, & Rittle-Johnson, in prep.)

(Diener & Dweck, 1980)
Response to Challenge

Encouraging Mastery-Oriented Orientation

“Many people make mistakes in the beginning but get better as they go along. Try to see this activity as a challenge you can learn from.”

(adapted from Graham & Golan, 1991)
• Concept you typically “tell” then “practice”?
• How could you “flip” this to create an exploratory activity?

Your Ideas
Final Thoughts

Exploratory activities can:

• Take more class time, but students can learn more from less material
• Result in equal ability to use procedures, but promote a deeper level of conceptual understanding
• Require more planning, but can also simply require switching the order of activities
• Be less helpful in some situations, such as when learners already have a rich knowledge base
• Frustrate some students, but encouraging mastery-orientation should help