The Role of Motivation in Supporting Preparation for Future Learning and Knowledge Transfer

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Goals

- Define knowledge transfer
- Discuss a type of instruction designed to support it
- Role of student achievement goals in transfer
- Pointers to related research
The magnitude of the initial angular velocity of a wheel rotating counterclockwise is $\pi$ rad/s. If the wheel is slowing down with an average angular acceleration of $\pi/6$ rad/s$^2$, how long does it take to stop?

- **Transfer**: the ability to use prior knowledge and experience to solve novel problems
The initial angular velocity of a wheel is \( \pi \text{ rad/s} \) in a clockwise direction. If the wheel is speeding up with a constant angular acceleration of \( \pi/4 \text{ rad/s}^2 \), what is the magnitude of the angular velocity of the wheel after 15 seconds?

The magnitude of the initial angular velocity of a wheel rotating counterclockwise is \( \pi \text{ rad/s} \). If the wheel is slowing down with an average angular acceleration of \( \pi/6 \text{ rad/s}^2 \), how long does it take to stop?
Transfer Scenario

Concepts, equations, solution procedures

- **target knowledge**
  - learning task
    - Lecture, text, or problem solving
  - transfer task
    - Test, term paper, or Design task
Barnett and Ceci’s 2002 Transfer Taxonomy

- Near: same room, same session, both academic, both individual, both written
- Intermediate: school vs. lab, weeks later, academic vs. tax forms, individual vs. small group, book vs. oral
- Far: school vs. beach, years later, academic vs. play, individual vs. society, lecture vs. wood carving

Learning task: physical, temporal, functional, social, modality contexts
Barnett and Ceci’s 2002 Transfer Taxonomy

- **Learning Task**
  - **Executing Procedures**
    - Near
  - **Adapting Procedures**
    - Intermediate
  - **Concepts and Principles**
    - Far

**Content**
Preparation for Future Learning

Bransford & Schwartz, 1999

knowledge

learning task

target knowledge

learning resource

transfer task
Goals

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Types of Instruction

- Traditional

The mean of this set is 36, which is calculated by adding up all of the elements and dividing by the number of data points in the set. That is, we add 26 + 27 + 28 + ... + 48, which equals 360. We then divide by 10, since there are 10 values in the data set. This gives us a mean of 36.

<table>
<thead>
<tr>
<th>x</th>
<th>Mean - x</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>10</td>
</tr>
<tr>
<td>27</td>
<td>9</td>
</tr>
<tr>
<td>28</td>
<td>8</td>
</tr>
<tr>
<td>29</td>
<td>7</td>
</tr>
<tr>
<td>36</td>
<td>0</td>
</tr>
<tr>
<td>45</td>
<td>9</td>
</tr>
<tr>
<td>47</td>
<td>11</td>
</tr>
<tr>
<td>48</td>
<td>12</td>
</tr>
</tbody>
</table>

To calculate the variability, you need to calculate how far each variable is from the mean. Because we do not want to end up with negative values, you should take only the absolute value of the difference of the data point from the mean. We can call this value the data point’s “deviation.” Doing so gives us the column of data shown to the right.

Now, you can find the mean of deviations. This will give you the average deviation, a measure of how variable the data is. In this case, the sum of all of the deviations (10 + 9 + 9 + ... + 12) equals 86. We divide this by 10 (since there are 10 values), and find that this data set has an average deviation of 8.6.
Types of Instruction

- Traditional

The mean of this set is 36, which is calculated by adding up all of the elements and dividing by the number of data points in the set. That is, we add 26 + 27 + 28 + ... + 48, which equals 360, then divide by 10, since there are 10 values in the data set. This gives us a mean of 36.

To calculate the variability, you need to calculate how far each variable is from the mean. Because we do not want to end up with negative values, you should take the absolute value of the difference of the data point from the mean. We can call this value the data point’s “deviation.” Doing so gives us the column of data shown on the right.

Now, you can find the mean of deviations. This will give you the average deviation, a measure of variable the data is. In this case, the sum of all the deviations (10 * 9 + 9 + ... + 12) equals 96. Divide this by 10 (since there are 10 values), and find that this data set has an average deviation...
Types of Instruction

- Traditional

- Structured inquiry invention
  - highlights features of the concept
  - range, number of observations, consistency
Prior PFL results

Schwartz & Martin, 2004
Relation to motivation

- Traditional

- Structured inquiry
  - Invention
  - Gives students authority
  - Grants students control
  - Challenging

Features associated with promoting mastery goals
Ames, 1992
Malone & Lepper, 1987
Goals

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Achievement Goals

Elliot, 1999

- **Mastery**
  - **Approach**: focus on attaining task-based or intra-personal competence
  - **Avoidance**: focus on avoiding task-based or intra-personal incompetence

- **Performance**
  - **Approach**: focus on attaining normative competence
  - **Avoidance**: focus on avoiding normative incompetence
Components of Goals

• Dispositional

Orientation - Achievement Goal Questionnaire (Elliot & McGregor, 2001)
In math classes, it is important for me to understand the content as thoroughly as possible.
In math classes, it is important for me to do better than other students.

• Dynamic

Task-based Mastery Goals Questionnaire (Belenky & Nokes-Malach, 2012)
I was concerned how well I understood the procedure I was using.
I tried to understand why the procedure I was using worked.
Results

Only 11% solved

- Traditional Tell-and-Practice
- Structured Inquiry
  - Goals
  - worked example
- transfer task
Results

Traditional Tell-and-Practice

Structured Inquiry

Goals

worked example

transfer task

50 % solved

Goals
Results

Traditional Mastery Approach Orientation

- Probability of Transfer

\begin{align*}
\text{Strongly Agree} & : \quad 1 \\
\text{Strongly Disagree} & : \quad 0
\end{align*}

Task Mastery

\begin{align*}
\text{Traditional} & : \quad 3 \\
\text{Structured Inquiry} & : \quad 5
\end{align*}
Results

![Graph showing accuracy for Tell-and-Practice and Structured Inquiry with Mastery-Approach Orientation]

- Traditional
- Structured Inquiry

Tell-and-Practice
- Low
- High

Structured Inquiry
- Low
- High

Mastery-Approach Orientation
Goals

- Define knowledge transfer
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Facilitating transfer

• Preparation for future learning instruction
  (Belenky & Nokes-Malach, 2012, 2013; Bransford & Schwartz, 1999;
  Schwartz, Bransford, & Sears, 2005; Roll et al., 2010, 2012;
  Schwartz & Martin, 2004; Schwartz et al., 2012)

• Other techniques:
  self-explanation, analogical comparison, worked example study, spaced practice, and testing effect
  (Reviews: Alfieri, Nokes-Malach, & Schunn, 2013; Dunlosky, et al., 2013;
  Pashler, et al., 2007; Richey & Nokes-Malach, 2015)
# Promoting Mastery Goals

<table>
<thead>
<tr>
<th>Structure</th>
<th>Instructional Strategies</th>
<th>Motivation Patterns</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Task</strong></td>
<td>Focus on meaningful aspects of learning</td>
<td>Focus on effort and learning</td>
</tr>
<tr>
<td></td>
<td>Design for novelty and student interest</td>
<td>High intrinsic interest</td>
</tr>
<tr>
<td></td>
<td>Design tasks that offer reasonable challenge</td>
<td>Attributions to effort</td>
</tr>
<tr>
<td></td>
<td>Establish short-term, self-referenced goals</td>
<td>Attributions to effort-based strategies</td>
</tr>
<tr>
<td></td>
<td>Support the use of effective learning strategies</td>
<td>Use of effective learning and other self-regulatory strategies</td>
</tr>
<tr>
<td><strong>Authority</strong></td>
<td>Help students participate in decision making</td>
<td>Active engagement</td>
</tr>
<tr>
<td></td>
<td>Provide choices where decisions are based on effort not ability</td>
<td>Positive affect</td>
</tr>
<tr>
<td></td>
<td>Support self-management and monitoring skills</td>
<td>Feelings of belongingness</td>
</tr>
<tr>
<td><strong>Evaluation/Recognition</strong></td>
<td>Focus on individual improvement, progress, and mastery</td>
<td>“Failure tolerance”</td>
</tr>
<tr>
<td></td>
<td>Make evaluation private, not public</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Recognize students’ effort</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Provide opportunities for improvement</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Encourage view of mistakes as a part of learning</td>
<td></td>
</tr>
</tbody>
</table>

Discussion

• Questions?