Students’ Performance on Similarity Rating and Case Reusability Tasks

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Motivation

Prior Research  Chi (1981)
• Novices categorize problems using surface features (i.e. facial similarities)
• Experts categorize problems using deep structure (i.e. principle similarities)

Our Goal
Investigate if a strategy that focuses explicitly on problem comparison can get students to recognize similarities/differences in deep structure rather than surface features
Research Questions

- To what extent do students focus on facial/principle, similarities and differences between problems?

- How does students’ focus on facial/principle, similarities and differences change with a treatment based on contrasting cases?
Methodology

• Participants: Algebra-based physics (N=10)

• Treatment: 8 weekly group learning interviews
  • Focused on compare, contrast and case re-use tasks
  • Protocol finalized only in Week 4.

• Assessment:
  • 2 Individual Interviews – 50 minutes each
    • 1st: BEFORE finalized Group Learn. Int. protocol
    • 2nd: AFTER Four Group Learn. Int. finalized protocol

• Tasks:
  • Similarity Rating Task
  • Case Reusability Tasks
Similarity Rating Task: Pairing Problems

4 Categories of Pairing

- **Facial Similarity (FS)**
- **Facial Difference (FD)**
- **Principle Similarity (PS)**
- **Principle Difference (PD)**

<table>
<thead>
<tr>
<th>FS</th>
<th>FD</th>
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<tbody>
<tr>
<td>A</td>
<td>B</td>
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<tr>
<td>PD</td>
<td>PD</td>
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<tr>
<td>C</td>
<td>D</td>
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Students are given 8 problem pairs in the order of:

A A B B C C D D

A: Pairs are **FS** and **PS**
B: Pairs are **FD** and **PS**
C: Pairs are **FS** and **PD**
D: Pairs are **FD** and **PD**
Type A

Facial Similarity (FS) & Principle Similarity (PS)

Facial Similarity (FS) : Both Roller Coasters.

Principle Similarity (PS) : Conservative system
Facial Difference (FD) & Principle Similarity (PS)

Facial Difference (FD): Roller Coaster vs. Gun
Principle Similarity (PS): Conservative system

An 800 kg roller coaster shown in the figure above is dragged up to point 1 where it is released from rest. Assuming the track is frictionless, calculate the speed at point 3.

A 0.10 kg bullet is loaded into a gun tilted upward at a 30° angle from the horizontal, compressing a spring (spring constant is 6400 N/m) a distance of 0.20 m. When the trigger is pulled, the spring is released, and the bullet leaves the spring at the spring’s relaxed length at a speed of 50.5 m/s. The bullet travels a distance of 0.60 m before exiting the barrel of the gun. What is the speed of the bullet as it leaves the gun?
Type C

Facial Similarity (FS) & Principle Difference (PD)

- Facial Similarity (FS) : Both Roller Coasters
- Principle Difference (PD) : Conservative vs. Non-Conservative

An 800 kg roller coaster shown in the figure above is dragged up to point 1 where it is released from rest. Assuming the track is frictionless; calculate the speed at point 3.

An 800 kg roller coaster shown in the figure above is dragged up to point 1 where it is released from rest. The work done by friction in going from point 1 to point 3 is 4800 J. Calculate the speed at point 3.
**Type D**

**Facial Difference (FS) & Principle Difference (PD)**

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**Facial Difference (FD):** Roller Coaster vs. Gun

**Principle Difference (PD):** Conservative vs. Non-Conservative

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An 800 kg roller coaster shown in the figure above is dragged up to point 1 where it is released from rest. Assuming the track is frictionless; calculate the speed at point 3.

A 0.10 kg bullet is loaded into a gun compressing a spring (spring constant is 6400 N/m) a distance of 0.20 m. When the trigger is pulled, the spring is released, and the bullet leaves the spring at the spring’s relaxed length. The bullet travels a distance of 0.60 m before exiting the barrel of the gun. The coefficient of kinetic friction between the bullet and the barrel is 0.10. What is the speed of the bullet as it leaves the gun?
Results

Interview 1 & 2 Ratings

Similarity Rating

Differences between B & C in Interview 2 negligible compared to Differences between B & C in Interview 1
Students’ end‐semester ratings for problem types A, B and D are similar to faculty ratings.
Summary

• To what extent do students focus on Facial Similarity and Facial Differences?
  • Students rate Facial Similarities higher overall for 1st Interview and 2nd Interview.
  • Students rate Facial Differences lower overall for 1st Interview and 2nd Interview.

• To what extent do students focus on Principle Similarity and Principle Differences?
  • Students seemingly unfocused on Principle Differences or Principle Similarities given problems with Facial Differences during 1st Interview.
  • Students begin to focus on Principle Differences or Principle Similarities given problems with Facial Differences during 2nd Interview.
Thank You