## Background

Worked examples (WEs)—step-by-step solutions to a problem—are popular in classrooms and online (Chegg, PhotoMath, Slader) despite drawbacks for learning, transfer, and metacognition. WEs are often used in conjunction with problem-solving (PS) and self-explanation (SE); each have strengths and limitations.

<table>
<thead>
<tr>
<th>Access to accurate information</th>
<th>✓</th>
<th>✗</th>
<th>✓</th>
<th>✓</th>
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<tbody>
<tr>
<td>Generation</td>
<td></td>
<td>✗</td>
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</tr>
<tr>
<td>Attention directed to deep structural explanations</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
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<tr>
<td>Metacognitive accuracy&lt;sup&gt;3&lt;/sup&gt;</td>
<td>✗</td>
<td>✗</td>
<td>✓</td>
<td>?</td>
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</table>

Poor metacognition → impaired self-regulation and learning.<sup>4</sup>

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## Procedure

### Practice Problem: A given problem about illnesses.

**4 Types of Transfer Test Problems:**

- **Superficially similar**
  - Given problem about illness
  - Experts: Focus on conceptual structure & implicit features for transfer<sup>1,4</sup>
- **Structurally similar**
  - Given problem about illness
  - Novices: Focus on surface or explicit features of problems
- **Superficially different**
  - Given problem about machines in a factory
- **Structurally different**
  - And problem about illness
  - Experts: Focus on conceptual structure & implicit features for transfer<sup>1,4</sup>

**Real-world transfer:**

**Maria tested for a disease and received a positive result.** About 1 in 2000 people have the disease, whereas the false positive rate is 5%. She is certain she has the disease and awaits further testing. How concerned should she be about the result?

**Sample answer #1:** She should not be too concerned, since the percentage of people with the disease is much lower than the false positive rate. It is likely she does not actually have the disease, and that the test is mistaken.

**Sample answer #2:** Maria should be concerned but should get more testing because 100 people who do not have the disease are told they have it.

### Help us construct a scoring scheme for test problems!

<table>
<thead>
<tr>
<th>Problem work</th>
<th>Correct answer</th>
<th>Type of error</th>
<th>Score</th>
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</thead>
<tbody>
<tr>
<td>P(S</td>
<td>B) = P(S</td>
<td>B)/P(S) = (1/4)/(1/3) = 1/2</td>
<td>N/A</td>
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<tr>
<td></td>
<td></td>
<td>Incorrect division order</td>
<td>N/A</td>
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<tr>
<td></td>
<td></td>
<td>Incorrect operation</td>
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</tr>
<tr>
<td></td>
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<td>Calculation error</td>
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## Expected Results

1. **WEs exacerbate the learning and metacognition gap between experts and novices**
2. **SEs encourage novices to activate prior knowledge, identify misconceptions, and generate arguments more than WE**
3. **SEs best reduces gap:** novice learners focus on deep principles, make connections to prior knowledge, generate information, and have their subjective experiences of difficulty reflect their actual understanding.<sup>6</sup>

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## References

Abstract

In STEM, experts focus on the conceptual structure of problems, whereas novices focus on superficial, irrelevant, features. I aimed to improve college students’ statistics learning. Participants watched a lesson on conditional probability, practiced problems through one of three methods, predicted their test performance, and took a transfer test. Worked example (WE) practice entailed studying problems’ step-by-step solutions. Self-explanation (SE) involved explanations of each WE solution. Structured SE (SSE) practice required explanations about key WE solution steps. I predict that SSE practice will lead to the highest test performance and most accurate test predictions by shifting attention to deep problem structure.