The Effect of Explanation and Alternative Hypotheses on Information-Seeking Strategies: Implications for Science Literacy

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Recent assessments of science education emphasize science literacy—the ability to use scientific information in everyday life (National Research Council, 1995). To do this, students must exhibit self-reliance in seeking out new information. Brem and Rips (in press) showed that people use speculative explanations to fill gaps in their knowledge. Explanation improves comprehension and performance (e.g., Chi, deLeeuw, Chiu & LaVancher, 1994), but also leads to overconfidence (Koehler, 1991). Given that explaining has both positive and negative consequences, I examine how it affects students' testing of scientific claims.

First, explaining may affect student goals. I focus on two: Determining whether a relationship exists (Existence), and determining why the relationship exists (Mechanism). Suppose we test the claim: "Redwood harvesting is causing a decline in the hawk population." Existence questions address whether harvesting reliably causes a decline. Mechanism questions focus on how harvesting affects the hawks (e.g., destroying nesting sites). Because explanations focus on mechanisms, explaining should increase the number of Mechanism questions. This is a potentially undesirable shift—better to establish that there is a relationship before trying to determine how it works.

Second, explaining may affect the kind of information sought. Previous studies focused on the covariational (CV) and noncovariational (nonCV) distinction (e.g., Ahn, Kalish, Medin & Gelman, 1995). NonCV questions—"Do hawks nest in dwarf redwoods?"—can be made CV by explicitly addressing whether changes in cause result in changes in effect: "Do declines in dwarf redwoods coincide with declines in nesting sites?" Both CV and nonCV questions can serve Existence and Mechanism goals. What the distinction can tell us is how students approach a problem. CV questions specify explicit comparisons and measures; nonCV questions do not. Given the strong relationship between nonCV and mechanistic questions (Ahn et al., 1995), explaining should cause an undesirable shift to nonCV questions.

Given these opportunities for error, I consider a well-documented antidote for problems induced by explanation—considering alternative claims. Many studies show that considering alternatives reduces overconfidence (Koehler, 1991). However, do alternatives simply induce a lack of confidence, or do they encourage more rigorous testing? If alternatives have a positive effect, their presence should increase the number of Existence and CV questions.

Method

The design was a 2X2 between-participants factorial, varying Explanation (Explain vs. Don't Explain) and Alternate (Present vs. Absent). Participants read about 8 ecological problems and saw a primary claim as to the cause of each problem. In the Alternative Present condition, they also read an assertion regarding an alternative cause for each problem. Participants in the Explain condition speculated how the primary cause could lead to the problem, then generated three questions to ask an expert in assessing the validity of the primary claim. In the Don't Explain condition, participants posed questions without speculating.

The participants were 53 novice undergraduates.

Results

Participants' questions were coded by a blind rater as CV or nonCV, and as Existence or Mechanism. Only significant results are reported.

As predicted, with no alternatives present, the percentage of CV questions declined (47.9% vs. 27.8% ($t(7) = 2.75$, $p < 0.05$). With alternatives present, the drop is not significant (48.9% vs. 43.5%; $t(7) = 1.49$, $p > 0.10$). Again as predicted, most CV questions were of the Existence type (66%), and most nonCV questions were of the Mechanism type (79%). However, regardless of the presence of alternatives, explaining increased students' focus on mechanisms (52.5% vs. 30.9%; $t(7) = 3.02$, $p< 0.05$).

Discussion

The results do not recommend explaining as a gap-filling strategy. It produced less rigorous queries and assumptions regarding causal relationships. Although students still made assumptions, alternatives did encourage more specific tests. Using alternatives in concert with interventions to discourage unwarranted assumptions may help students achieve science literacy.

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