When do diagrams enhance science learning?

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Many studies suggest that learning is enhanced when instruction includes relevant diagrams. However, diagrams do not always lead to improved outcomes, and relevance may be difficult to determine prior to assessment. We propose a framework consisting of three factors that influence the relevance of a diagram: the learning objective, the information included in the visual representation and the cognitive processing of the learner. In a randomized-design study conducted in a college chemistry class, we investigated whether diagrams that were created using the proposed framework would lead to enhanced learning. 171 students were randomly assigned to view an online lecture that either included diagrams (diagram condition) or did not include diagrams (traditional condition). Students watched short instructional videos and answered open-ended transfer questions related to the content on acid/base chemistry. Overall, there was a trend toward improved performance in the diagram condition ($M = 11.0$) compared to the traditional condition ($M = 9.7$), $F\,(1, 169) = 2.58$, $p = .11$. A planned comparison revealed that the low-performing students who viewed the diagram condition demonstrated enhanced learning ($M = 10.9$) compared to the low-performing students in the traditional condition ($M = 7.73$), $F(1,43) = 4.05$, $p = .05$. See Figure 1. The current study suggests that multimedia instruction that is designed to consider learning goals, learner abilities and the information made explicit in visual representations will likely enhance learning, particularly for low performing students.

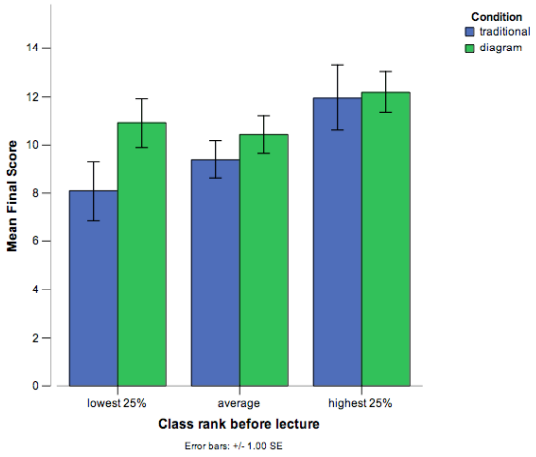

Figure 1: Diagrams increased learning for students in the lowest quartile of the class

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