The Effects of Diagram Use in Probability Instruction and Problem Solving

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Abstract

Instructing students to use diagrams as problem-solving aids is commonly expected to improve comprehension and achievement, especially with particularly complex or counterintuitive topics such as probability. This study addressed the effects of such an approach compared to a more algebraic, formula-based problem-solving method. Undergraduate participants were tested for prior knowledge and then instructed to solve a particular type of probability task using either a diagram or a purely algebraic procedure. Immediate and delayed posttests were administered to measure the effects of using diagrams on participants’ levels of achievement. Results indicate that the use of diagrams does not always improve student problem-solving performance.

Previous Experiments

In three previous experiments we investigated the effect of different types of diagrams on problem-solving performance for word problems involving total and joint probability. All treatment groups were given instructional material that explained 1) basic probability concepts, 2) how to solve total- and joint-probability problems, and 3) practice problems.

Results: Undergraduates who used equations alone performed more accurately on the posttest than their peers who used diagrams to solve the same word problems. The effect sizes ranged from $d = .58$ to $.70$, always favoring the no-diagram treatment.

Students in the diagram condition of these experiments reported higher levels of cognitive load than students in the procedural condition.

For example, here are the results from Beitzel, Staley, and DuBois (2011, Experiment 2):

![Diagram vs. No Diagram](chart)

**Conclusions**

- Participants trained to use diagrams did not have a stronger conceptual grasp of either joint- or total-probability problems than participants who were trained to use equations alone.
- For both types of problems, using a diagram increased self-reported cognitive load during the training phase, relative to training that used equations alone.
- This increased mental effort required for using diagrams did not pay off in higher success in either Experiment 1 or Experiment 2.
- In fact, the use of a diagram lowered performance success by 45% on near-transfer problems in Experiment 2.