

Probabilistic Misconceptions: Middle and High School Students' Mechanisms for Judgments Under Uncertainty

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Abstract

This study explored middle and high school student probabilistic reasoning abilities. Students in grades 5, 7, 9 and 11 at a private school in New York City ($n = 173$) completed a Probability Inventory, which required students to answer and justify their responses to ten items. Supplemental clinical interviews were conducted with 33 of the students to provide further detail about their reasoning on these items. Analyses of student justifications to both correct and incorrect answers were conducted. Interviews revealed a perception among students that one question can have two distinct answers: a "math" answer and a "real world" answer.

Overall success rates on the ten individual items of the Probability Inventory ranged from 98% to 5% success; seven items were answered correctly by fewer than 50% of the sample. Only 31% of the students determined that the probability of one heads and one tails on two fair coins is 50% using a correct justification, and just 40% indicated that given sequences of results of coin tosses are equally likely using a correct justification. A 50/50 approach was more typical, especially among younger students, by which they over-generalized the probability of a single trial of a coin to a compound situation. A student using the 50/50 approach would indicate "correctly" that the probability of two coins resulting in one heads and one tails is 50% but also that the probability of any number of coins resulting in any outcome is 50%. The 50/50 approach was also used by students when comparing the likelihood of 7 tails on 10 tosses with 700 tails on 1000 tosses. 40% of the sample used a 50/50 approach on at least two items.

Results revealed stable performance across the 7th, 9th, and 11th grades, with an observable gap between the success rate of those age groups and the 5th grade. The compound of four events was the only item on which there was striking improvement across ages. Most of the common errors were stable across ages as well. Results also revealed stability in performance across ability levels.