Sound and Faulty Arguments Generated by Pre-Service Biology Teachers when Testing Hypotheses Involving Un-Observable Entities

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Abstract: A sample of preservice biology teachers (biology majors) enrolled in a teaching methods course formulated and attempted to test six hypotheses to answer a causal question about why water rose in a jar inverted over a burning candle placed in a pan of water. The students submitted a lab report in which arguments and evidence for testing each hypothesis were presented in an if/then/therefore hypothetico-predictive form. Analysis of written arguments revealed considerable success when students were able to manipulate observable hypothesized causes. However, when the hypothesized causes were unobservable, such that they could be only indirectly tested, performance dropped, as shown by use of three types of faulty arguments: (a) arguments that had missing or confused elements, (b) arguments whose predictions did not follow from hypotheses and planned tests, and (c) arguments that failed to consider alternative hypotheses. Science is an enterprise in which unobservable theoretical entities and processes (e.g., atoms, genes, osmosis, and photosynthesis) are often used to explain observable phenomena. Consequently, if it is assumed that effective teaching requires prior understanding, then it follows that these future teachers have yet to develop adequate hypothesis-testing skills and sufficient awareness of the nature of science to teach science in the inquiry mode advocated by reform guidelines. © 2002 Wiley Periodicals, Inc. J Res Sci Teach 39: 237-252, 2002