Stony Brook University
The Graduate School

Doctoral Defense Announcement

Abstract

Measuring Student Understanding of Genetics: Psychometric, Cognitive, and Demographic Considerations

By

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Genetics is universally recognized as a core component of biological and scientific literacy. Consequently, educators and researchers have sought to develop measures of student understanding in this domain. Accurate measurement is essential for providing evidence-based insights into students' conceptual ecologies, guiding learning progression development, and evaluating the efficacy of educational interventions. Nevertheless, many science education assessment instruments lack: (1) alignment with professional standards and guidelines, (2) utilization of appropriate psychometric frameworks (such as Item Response Theory) and (3) grounding in contemporary cognitive frameworks. This thesis explores psychometric, cognitive, and demographic aspects of measurement in genetics education. Two domains were explored: genetic drift and Mendelian inheritance.

A genetic drift instrument (for which Rasch-based validity and reliability evidence was first established) was used to examine the degree to which vignette order impacted inferences about undergraduate student understanding. No evidence of item order bias was found when systematically rotating items among randomly assigned test forms. Rasch scores for person and item properties largely corroborated initial Classical Test Theory studies, but also identified areas in need of refinement. Raw scores from our sample aligned well with those from other studies, providing evidence of score generalizability across diverse populations.

A Mendelian inheritance instrument (for which Rasch-based validity and reliability evidence was first established) was used to test whether situational features or demographic factors biased performance in undergraduate biology majors. Contrary to work in other domains, parallel items featuring plant, animal, and human examples had no significant impact on measures of student understanding, and no significant associations were found in performance by gender or ethnicity. Significant associations were found between genetic problem types and item difficulty.

Overall, substantial evidence was generated about the measurement of genetics understanding and how it may be improved. The results serve as examples for the design and evaluation of genetics education instruments. The findings will be of interest to educators and researchers seeking to develop high-quality measures to inform educational decision making.

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