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A Multilevel Mixture Item Response Theory Model for Partial Engagement in Proficiency Tests

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Disengaged test-taking behavior is a problem in low-stakes assessments. To account for low engagement, popular approaches rely on item response times to classify responses as disengaged (rapid guessing) or inconspicuous (engaged). Although conceptually elegant, this binary classification has been found to miss a substantial proportion of disengaged responses. This paper introduces an extended classification of engagement that includes "partial (dis)engagement". To this end, a Multilevel Mixture Item Response Theory (MMIRT) model is proposed that classifies engagement at the item level. Partially engaged responses are specified to be associated with response times that fall between the very short response times of rapid guesses and the response times of engaged responses. Responses are classified on the basis of within-individual response time distributions, meaning that the model accounts for individual differences in habitual time expenditure. Disengaged responses are modeled as the result of a guessing process, while partially and fully engaged responses are both related to the proficiency variable via a three-parameter response model. The MMIRT model can be estimated using maximum likelihood techniques via the expectation maximization algorithm. The MMIRT model is illustrated with data from the TIMSS 2019 science assessment. Multiple-choice items presented at the beginning and end of the test in a rotated test design were analyzed. In the U.S. sample of eighth graders, test performance was lower on items presented at the end of the test. The lower performance could not be explained by models based on the binary classification of response engagement. In contrast, the proposed MMIRT model suggested that the decline in performance was due to an increase in partially disengaged responses.

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