Measuring Learning and Change in a Longitudinal Large-Scale Educational Assessment Program with Generalized Latent Variable Models

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A general latent variable modeling framework was used to specify multidimensional IRT (MIRT) models for longitudinal data with the following two variations: A model that handles repeated measurements as multiple, correlated variables over time (Andersen, 1985) as well as a model that assumes one common variable over time points, and additional orthogonal variables quantifying the change (Embretson, 1991). These two models were compared in the analyses presented in this paper. In addition, a model with a single two-dimensional ability distribution was compared to extensions of the Andersen and Embretson approaches assuming multiple populations, where the ability distributions of the MIRT models used were allowed to vary across subpopulations defined by school type. Moreover, a hierarchical mixture distribution variant of the (Andersen and Embretson) MIRT models was specified in the framework and compared to the above alternatives. These types of models are growth mixture models that allow for variation of the mixing proportions across clusters in a hierarchically organized sample. In order to illustrate the models presented in this paper, they were applied to the PISA-I-PLUS data for assessing learning and change across multiple subpopulations. PISA-I-PLUS is a longitudinal study conducted as a national addition to the Program for International Student Assessment (PISA). The results indicate that (1) the model with baseline ability and additional change variables (Embretson-type model) with multiple group assumptions provides better fit to the data than the other models investigated in this paper; and (2) that the higher performing group has larger improvement at time point 2 than the lower performing group.

Keywords:
HEM-Hierarchical & Multilevel Models, IRT-Item Response Theory, LVM-Latent Variable Modeling, MIX-Mixture Modeling