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Zoom available upon request to gradstudies@wsu.edu

Faculty, students and the general public are encouraged to attend

INVESTIGATION OF Q-MATRIX DESIGNS WITH HIERARCHICAL COGNITIVE ATTRIBUTES FOR LEARNING PROGRESSION OF LONGITUDINALDIAGNOSTIC CLASSIFICATION MODEL

Co-Chairs: Shenghai Dai and Brian French

This dissertation investigates the impact of Q-matrix designs on the performance of the Transitional Diagnostic Classification Model (TDCM), a longitudinal cognitive diagnostic model. The study systematically explores various attribute hierarchical structures (AHS), including linear, convergent, divergent, and unstructured configurations, in combination with different item-loading strategies (independent, adjacent, and reachability). By combining these AHS and item-loading approaches, eight unique Q-matrix designs are constructed: Linear-Independent (LI), Linear-Adjacent (LA), Linear-Reachability (LR), Divergent-Adjacent (DA), Divergent-Reachability (DR), Convergent-Adjacent (CA), Convergent-Reachability (CR), and Unstructured Adjacent (UA).

These Q-matrix designs align with the notion of learning progression, as conceptualized through Vygotsky's Zone of Proximal Development framework, which encompasses the Zone of Actual Development (ZAD), Zone of Proximal Development (ZPD), Accumulation of Knowledge (AK), and Cognitive Dissonance (CD). This theoretical lens guides the modeling of transformative learning trajectories across developmental stages.

Employing the TDCM, Study 1 examines how these diverse Q-matrix design approaches influence the accuracy of item parameter and attribute profile estimations under varying design factors, including sample size, growth rate, and Q-matrix design. Building upon Study 1, Study 2 extends the investigation by incorporating Q-matrix misspecification into the design, assessing the TDCM's performance and the robustness of the methods in the presence of misspecified Q-matrices.

Study 1 results showed that the Q-matrix design significantly impacted item parameter and attribute profile estimation accuracy. For item parameters, the Linear-Independent (LI) design outperformed others; larger samples ($N \geq 1000$) yielded smaller bias, and the LA, CA, DA, and UA Q-matrix designs performed similarly except for inconsistencies with LA and CA at $N=500$. Increasing sample size reduced RMSE for LI but yielded larger RMSEs across conditions with $N \geq 1000$). Regarding attribute profiles, the LI design demonstrated the highest classification accuracy, though accuracy declined over time across all designs. Attribute consistency (ACA) consistently outperformed pattern consistency (PCA).

Results of study 2 reveal similar patterns of the TDCM performance in the presence of Q-matrix misspecification, except that bias values increase with larger sample sizes and higher misspecification rates (MR) consistently but are more pronounced when MR reaches 20%. RMSEs revealed larger errors for most item parameter recovery, with fluctuations influenced by varying sample sizes and MR within different Q-matrix designs.