Preliminary Application of Cognitive Diagnostic Models (CDM) to Medical Education Assessment of Entrustment

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CONCEPTUAL FRAMEWORK

- The purpose of this proof-of-concept study was to apply a modern measurement model to student assessments to investigate the potential for the formative use of granular and categorical inferences into student entrustment. It is expected that when equipped with the more precise diagnostic information provided by a cognitive diagnostic model, faculty and administration may be able to provide a more effective and confidently identify strengths and areas of opportunity in guiding students to entrustment. This particular analysis included results from the preliminary empirical investigation into the construct internal structure using exploratory factor analysis (EFA).

- “A critical element of entrustment is the concept of trustworthiness for clinical work” (Kennedy, et al., 2008). Trustworthiness for clinical work consists of 4 dimensions:
  1) knowledge and skill; 
  2) discernment of limitations; 
  3) truthfulness; 
  4) conscientiousness.

Kennedy, Regh, Baker and Lingard (2008)

- VTCSOM Administration and Faculty experts mapped the VTCSOM Final Clerkship Assessment of M3 Student to ACGME Core Competencies and the Entrustable Professional Activities. This work was institutionally approved by the BIC2 and MCC committees.

- The concept map (above) showed an example of how assessment items will often theoretically and empirically measure more than one element, attribute, or dimension of latent constructs such as “trustworthiness.” Latent constructs are mental abstractions that can not be directly observed and must be measured using indicators. The map included above does not reflect all VTCSOM items, nor does it include the full text of any item. Assessment methodologies such as cognitive diagnostic models (CDM) (de la Torre, 2004) provide the ability to account for complex inter-item variance, and thus, they provide a more precise estimate of proficiency on each hypothesized dimension.

CONCLUSIONS

- The exploratory factor analysis with an oblique oblimin rotation yielded adequate assessment model fit results with a simple 4-factor loading structure solution. Although this commonly applied methodology provided valuable empirical information about the internal structure of the construct, its assumptions, and thus, its conclusions lacked the appropriate theoretical nuance expected in the measurement of a complex latent construct like entrustment.

- The information from this solution will be incorporated into the development of the diagnostic model, which is anticipated to prove more precise and useful in understanding the empirical nature of entrustment.

HYPOTHESIS

- Right: This figure is an example of the Q-Matrix Hypothesis (Tatsuoka, 1983). A Q-matrix depicts which skills/attributes contribute to the probability of a higher score on an item. By accounting for complex loadings, items can be assigned to multiple skills, and thus, the more skills assigned to an item, the more skills that affect the probability of a higher response on that item. Q-matrix indicator entries are binary in that a skill affects the probability of a more positive response or it does not. In this exploratory analysis, we are investigating the internal structure in order to inform the Q-matrix for this study.

PRELIMINARY RESULTS

- Results from steps 1-3 were displayed. Eigenvalues were plot, and a 4-factor solution was retained. The primary estimated rotated factor loadings were included below. Factor reliability (mean α=0.8) was assessed. Factor scores were calculated, standardized, plotted, and reviewed to better understand multidimensional relationships and inform Q-matrix construction for future model specification.

METHODOLOGY

- Step 1: Literature Review
- Step 2: Data Collection: Aggregate six years of clerkship data (n = 1681)
- Step 4: Expert input: Further develop hypotheses to explore and test complex factor loadings accounted for in Q-matrix hypothesis using CDM.
- Step 5: Model Specification and Fit: Determine model fit statistics and item parameters

LIMITATIONS AND FUTURE DIRECTION

- The research team also intends to investigate methods to account for the variance attributed to experiential differences to increase internal validity of the applied model. One important source of this variance occurs as a result of “clerkship order.” More specifically, students experience VTCSOM core clerkships in different orders than other students and thus scores must be horizontally equated across points in time. Sample sizes and conditions likely permit this calculation and so once this is further understood using appropriate methods, more precise solutions can be explored. Inter-rater reliability is another key source of variance to be further investigated.

- Using this information, several diagnostic models will be tested and compared to the results from the simple diagnostic structure and the compensatory reparameterized unified model.