

Challenges for Measuring Human Connections: Views from Psychometric Sciences

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Domains of Human Connection

- Relational Intelligence (RQ)
 - Dynamic (vs. Static)
 - Multidimensional
 - Context-sensitive
 - Interactional
- Moving target but we need to evoke the targeted capabilities

Psychometric Challenges

- Construct representation
- Multidimensional latent structures
- Longitudinal change
- Contextual dependence
- Process data integration
- Validity

Psychometric approaches

- Behaviors
- Observation
- Technology-generated evidence
- Requires **computational psychometric methods** utilizing digital data

Assessments

- Virtual performance-based assessments

(Andrews-Todd, Mislevy, Lamar, & de Klerk, 2021)

- Environments for test takers to interact with systems via
 - Interactive simulations
 - Games
 - Branching scenarios
 - Collaboration among students communicating through digital chats

Assessments

- Overview of the VPBA on the discussions of
 - Sociocognitive psychological perspective
 - Assessment argumentation
 - Psychometric principles of validity, reliability, generalizability, comparability, and fairness
- What of VPBA ~ Providing an (digital) environment for test takers
- Why of VPBA ~ The evidence they can provide about aspects of capability
- How is twofold
 - Analytic procedures for modeling data from educational and psychological assessments
 - **Encompassing the issues of design, purpose, theory, context, and content**

Assessments

- Categories of VPBAs
 - Scenario-based assessments
 - Simulation-based assessments
 - Game-based assessments
 - Assessments involving collaboration

- Resulting feature of the argument structure

(Fig. 4.1 in Andrews-Todd, Mislevy, Lamar, & de Klerk, 2021)

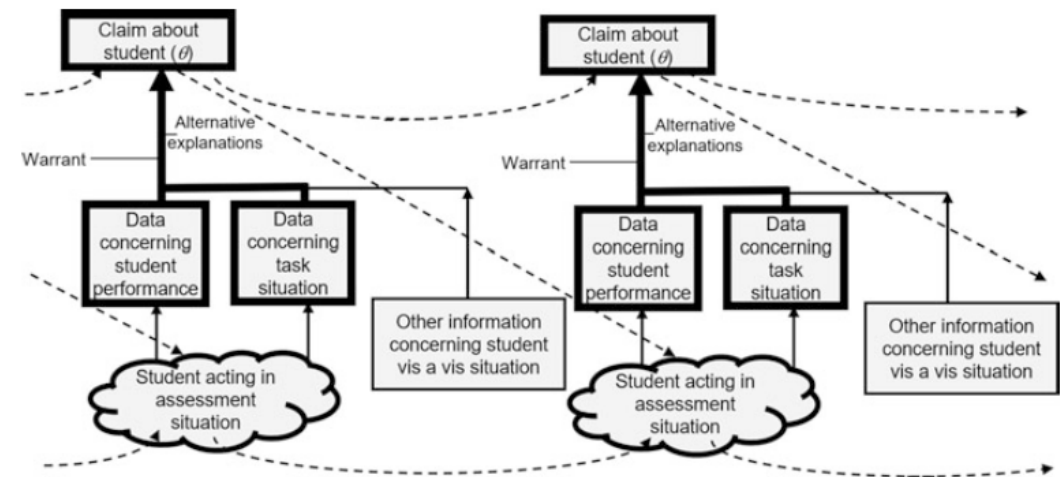


Fig. 4.1 Simplified design/interpretation argument in interactive task performances. Bold lines indicate the main elements that enter as variables in measurement models. Dashed lines indicate potential dependence over time, which may be to evidence-identification from performances and to inferences about students

Virtual Performance-Based Assessment

- Scenario-Based Assessments
 - A narrow context for a student's experience, to add a layer of meaning to motivations,



- Challenge to psychometrics
 - **Conditional dependence**
 - **Generalizability concern**
 - **Hard to aggregate evidence together in a principled psychometric inference**

Fig. 4.2 Screenshot of the weather task
7/22/2026

Virtual Performance-Based Assessment

- Simulation-Based Assessments

- The goal is to create a particular situation that resembles the real-world context to provide opportunities to assess individuals' capabilities in such a situation
- **What is new is technology for authentic interaction and automated scoring**

- Challenges

- **Costly to develop**
- **Time-consuming to deliver**



Resource:
<https://www.hsu.ac.uk/course/simulation-based-education-and-assessment-for-health-science-practice/>

Virtual Performance-Based Assessment

- Game-Based Assessments

- Incorporate principles of game design in addition to assessment design to measure individuals' knowledge, skills, and abilities
 - Game elements
 - Assessment elements

- Challenges

- All of the challenges of scenario-based and simulation-based assessments
- **Framing the assessment as a game**
- **Treats to validity such as construct irrelevant variance**
- **Potential individual differences with respect to things such as enjoyment of and desire to achieve a "top score"**

TABLE 2 Game descriptions, duration, and example screens.

Game	Duration	Description	Example
Numerosity	3 min	Mental arithmetic task where players are presented with a set of numbers and are asked to identify a combination that when summed, subtracted, multiplied or divided, yields a target result.	

Table 2 in
Leutner,
Codreanu, Brink
& Bitsakis,
2022

Virtual Performance-Based Assessment

- Collaborative Assessments
 - Designed to create opportunities for individuals to demonstrate their proficiency in working or communicating effectively with others
- Challenges for measurement of individuals' performance
 - **Identify the contributions of individuals**
 - **Evidence identification**
 - After identification, a psychometric model that incorporates the dynamic interaction among team members will be required
 - **Multidimensional structure in collaborative skills**

Psychometric Methods in VPBA

- Address the challenges

- **Evidence Model**

- Evidence model within the conceptual assessment framework layer of the ECD framework (Mislevy et al., 2003)
 - Student provide evidence about their knowledge, skills, and abilities as they move through tasks in a VPBA

- Evidence identification and evidentiary elements (Fig 10 in Levy, 2013)

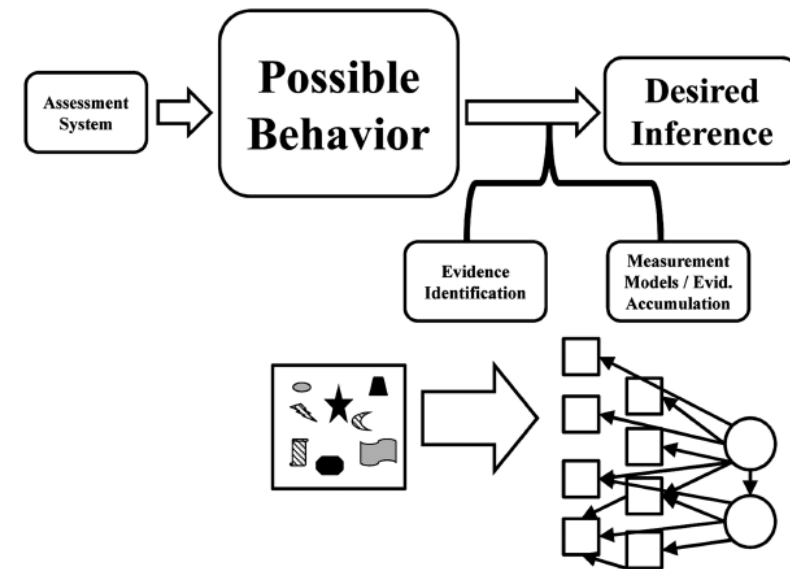


FIGURE 10 Schematic for the evidentiary argument for innovative simulation-based assessment.

Psychometric Methods in VPBA

- Address the challenges

- **Evidence identification**

- Educational data mining finding evidentiary elements via cluster analysis
 - Machine learning finding evidentiary elements via (artificial) neural network analysis and hidden Markov model analysis

- Evidence identification and evidentiary elements (Fig 10 in Levy, 2013)

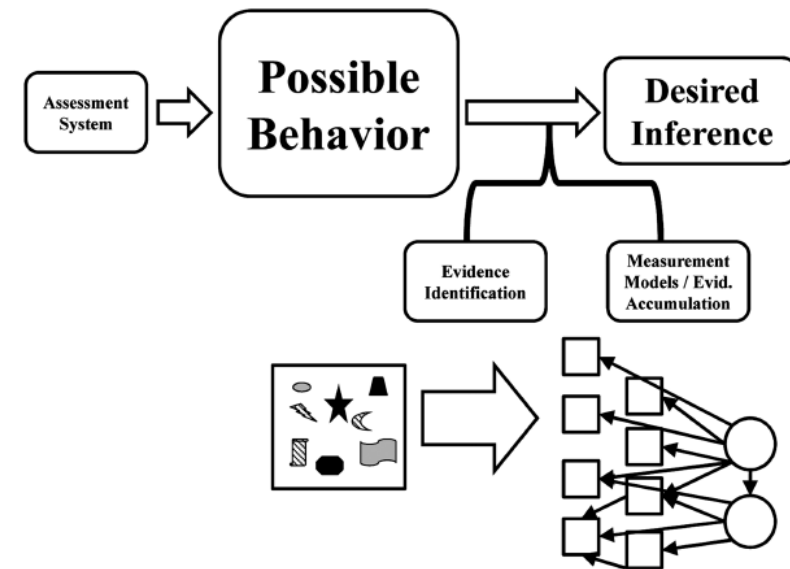


FIGURE 10 Schematic for the evidentiary argument for innovative simulation-based assessment.

Psychometric Methods in VPBA

- Address the challenges
 - **Evidence accumulation**
 - Psychometric models used within the process of evidence accumulation are more confirmatory than exploratory

- Evidence identification and evidentiary elements (Fig 10 in Levy, 2013)

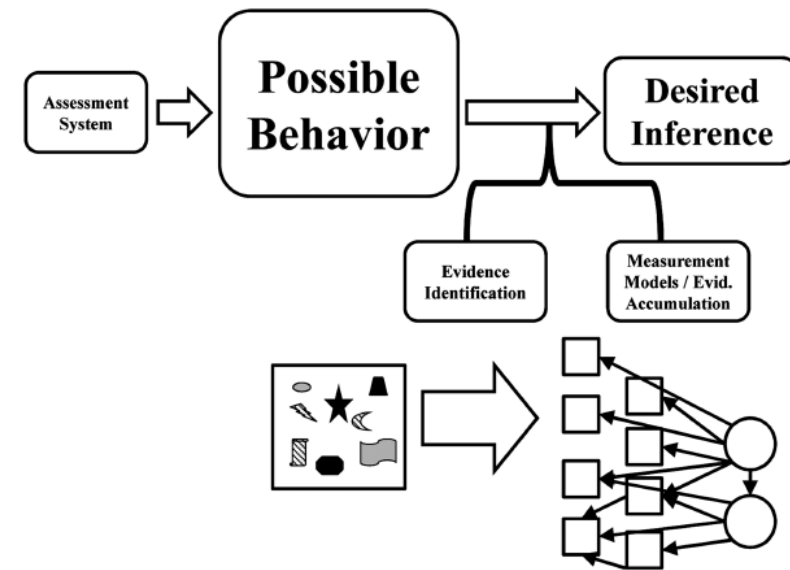


FIGURE 10 Schematic for the evidentiary argument for innovative simulation-based assessment.

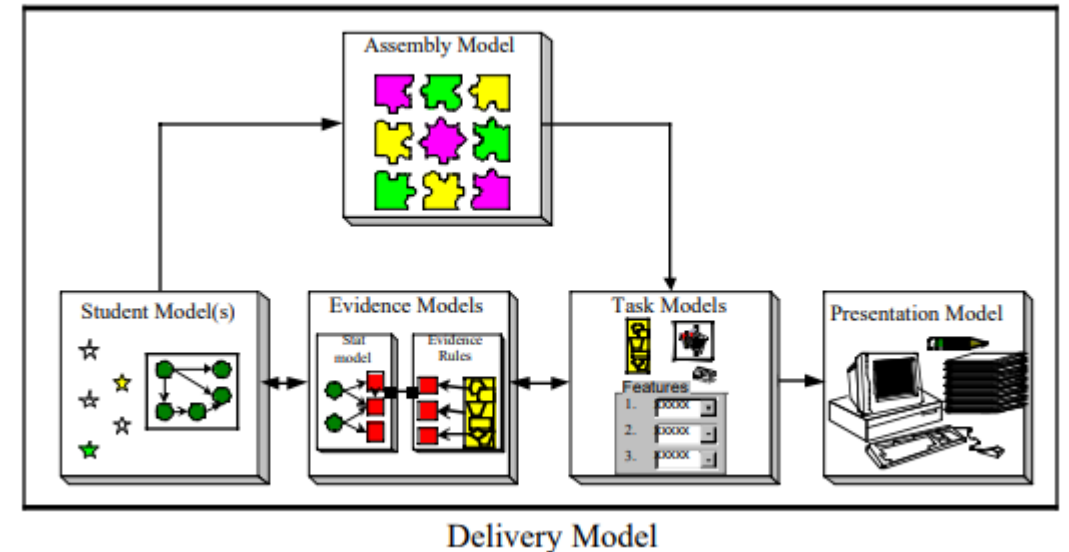
Psychometric Model for VPBA

- Bayesian network (De Klerk, Eggen, & Veldkamp, 2014)
 - A BN is a graphical structure for reasoning under uncertainty
 - In base state, the probabilities may be defined by experts
 - Update probabilities based on empirical data
 - A network consists of nodes, observable and latent variables

Discussion

- Defining domains of human connections
- Psychometric methods
 - Based on ECD and Bayesian Network, we literally address the challenges in psychometric methods but ...
 - There will be more challenges in the development of the HC measure

- ECD (Mislevey, Almond, & Lukas, 2004)



Discussion: Further Measurement Challenges

- What should be the units of measurement?
 - Individuals, relationships, groups, organizations, and societies
- Does simulation performance transfer to real-world behavior?
 - Validation through observations and longitudinal outcomes
- Does human-AI interaction provide valid evidence of human-human relational competence?
 - Differences across interaction partners and contexts
- How should constructs and measures be refined?
 - Iterative revision using field-based evidence
- Can measurement support educational improvement?
 - Beyond a single RQ score: belonging, collaboration, participation, and conflict resolution