LASSO Platform

Calculus Cognitive Diagnostic: Mathematics skills tested in physics courses

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Research Questions

1. How well does the data from the three RBAs support the student model of the skills we propose to measure with the CCD?

2.How well do each of the three RBAs measure students' mastery of the skills in the student model?

Data

TABLE I. The distribution of responses across RBAs.

Assessments	Items	Students	Institutions	Courses
Calculus Concept Assessment (CCA)	17	1,463	7	42
Calculus Concept Inventory (CCI)	22	1,409	5	123
Precalculus Concept Assessment (PCA)	25	1,260	8	40

Theoretical Framework

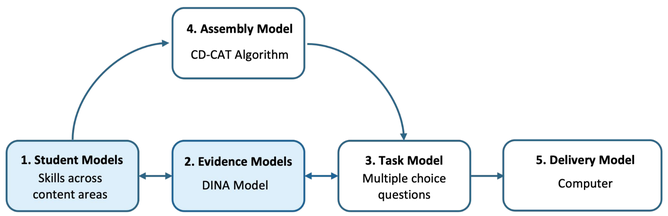
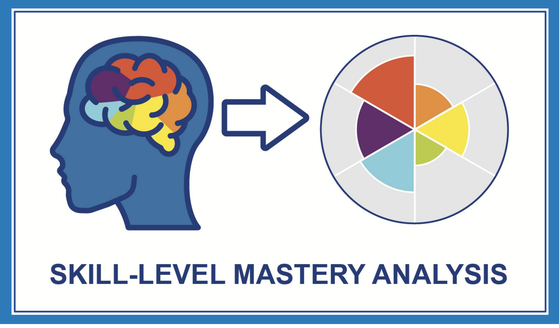


FIG. 1. An evidence-centered design model for the creation of the calculus cognitive diagnostic (CCD).

Mathematics research based assessments can assess essential skills for physics learning.



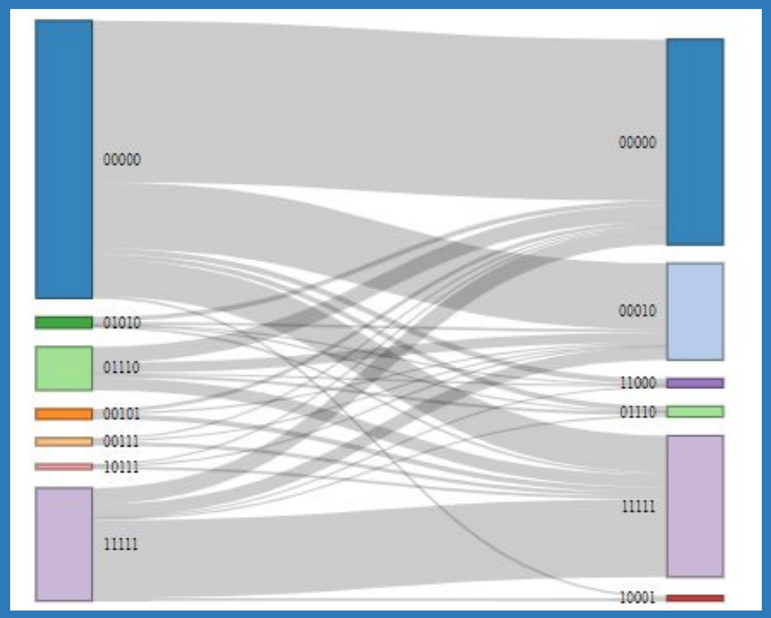


FIG. 2. Skill mastery profiles from the CCA before and after instruction. Skill mastery profiles (11101) provide a binary vector with a 1 indicating mastery for each skill.

Table II. Definition of the skills present in the three RBAs from our Student Models.

Prerequisite Skills	**Content of a pre-calculus course including an understanding of linear, power, polynomial, trigonometric, exponential, and logarithmic functions.**
Limits	**An understanding of limits and limiting processes. Basic limit laws, limits from both tables of data and graphs of functions.**
Derivatives	**The definition and meaning of the tangent line. Determining the slope of the tangent line by calculation, from a graph or a table. Comparing instantaneous and average rates of change. How the graph of the derivative, y' results from the graph of y. Interpretations of higher derivatives.**
Applications of Derivatives	**Using the derivative to solve problems with maxima and minima. Understanding applications and units of derivatives. Understanding both the first and second derivative and their relation to each other and the original function.**
Introduction to Integration	**Understanding integration as accumulation, as the area between curves. Basic integration properties, symmetry, units on integrals and the Fundamental Theorem of Calculus.**

Student Model

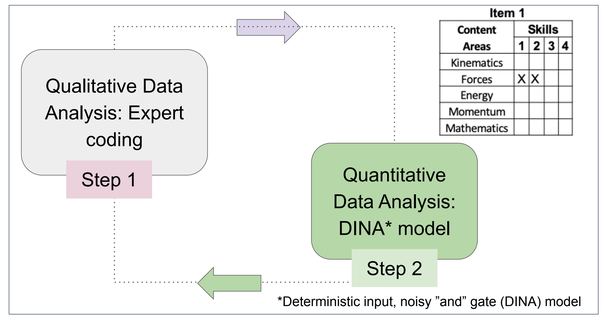


FIG. 3. The iterative process of item skill coding.

TABLE IV. Model fit statistics.

	CCA	CCI	PCA
RMSEA 2	0.035	0.018	0.034
SRMSR	0.037	0.034	0.043

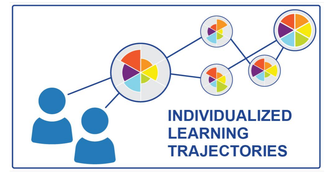
Good fit < 0.05

Classification Accuracy

	CCA	CCI	PCA
Prerequisite Skills	**0.90**	**0.94**	**0.92**
Limits	**0.90**	**0.91**	**0.68**
Derivatives	**0.88**	**0.94**	**-**
Applications of Derivatives	**0.78**	**0.95**	**0.87**
Introduction to Integration	**0.87**	**0.98**	**0.91**

TABLE III. Classification accuracy by assessments and skills.

Implications for instruction



Link to paper and poster

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