Theory for the Physics Assessment Evidence Project

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1 Models

This project seeks to improve upon the legacy instruments in a number of ways. One important way is to provide a clear specification of what each product of this project (items, inventories, subscales) is intended to measure, then provide compelling evidence it does just that. We will organize these specifications into a set of models.

1.1 Domain Model

The domain model provides a general description of the set knowledge measured by a product understandable to physics instructors. For example, the 1D Kinematics inventory measures conceptual 1D kinematics excluding 1D projectile motion the application of the 1D constant acceleration position and velocity equations. A domain model is arbitrary and the domain models measured should grow out of community input of what domains are interesting.

1.2 Knowledge Model

The knowledge model presents the declarative and procedure knowledge needed to master the domain. The knowledge model presents the information as an instructor or author would communicate information about the domain. The knowledge model is informed by community input but is largely constructed by sampling artifacts of the discipline including textbooks, published conceptual instruments, published research-based materials, and scholarly articles. Because the knowledge model is sample from a broad variety of sources, it ensures the coverage of the domain as defined by the broader physics community.

1.3 Reasoning Model

The reasoning model defines the declarative and procedural reasoning steps each item in the item pool is expected to elicit from students. It may also define alternate correct reasoning paths and common incorrect reasoning measured by

distractors. For an item to be valid there must be qualitative evidence that the reasoning model is followed in the majority of cases. The reasoning model is developed by the item author informed by the knowledge model and refined in the validation process.

1.4 Concept Map

The concept map summarizes the knowledge model in a graphical form.

1.5 Assessment Argument

For each domain of interest, the assessment argument describes how the items and instruments should be used to measure student knowledge. It also details how these measurements should be synthesized and analyzed to determine if a student has achieved a desired level of mastery. The assessment argument is linked to knowledge model expressing how important each element of the model is to demonstrating mastery. The assessment argument is organized around a set of evidence models which demonstrate how a set performance expectations are supported by a set of pieces of evidence. The evidence statements are bound to specific items whose correct solution provide evidence that a student will meet the performance expectation.

1.6 Validity Argument

As part of the assessment argument, one must convince the target audience that the items and instruments use are valid and reliable.

1.7 How the Models Work Together

The knowledge model establishes the scope of the kinds of things students might know about introductory physics. Because the knowledge model is sampled from both community input and the wealth of already published works on introductory physics, it establishes what full mastery would entail. The domain models establish the subsets of the knowledge model that are measured by subscales or instrument; because they rely on a complete model, these specifications can be precise. A concept map provides a summary of the knowledge composing the domain. The reasoning model converts the knowledge elements in the knowledge model to the reasoning steps items are designed to elicit. The assessment argument references the knowledge model as part of developing performance expectations and evidence claims while referencing the item pool in its evidence statements.