Assessing Student Conceptual Understanding of Force and Motion with Model Analysis

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ABSTRACT

This study aims to assess student conceptual model of understanding about force and motion by employing a new analysis method, called "model analysis". This method was established from qualitative researches in order to qualitatively represent a framework of student understanding. With model analysis, we can obtain students' alternative knowledge and the probabilities for students to use such knowledge in a range of equivalent contexts. The model analysis consists of two algorithms—concentration factor and model estimation. This paper only presents results from using the model estimation algorithm.

In order to use the model analysis efficiently, the data must be collected from a well-designed multiple-choice test. The Force and Motion Conceptual Evaluation (FMCE), the most well-known test for probing mechanics conceptual understanding was administered to 746 engineering freshmen taking an introductory physics with calculus at Chiang Mai University. Only 545 complete student responses were analyzed by the model analysis.

The class model density matrices for both pre/post scores were constructed. In order to determine characteristics of the pre/post class, eigenvalue decomposition was used to analyze both matrices. Each matrix had a large eigenvalue (> 0.65), indicating the dominant features of the single-student model vectors. This model eigenvectors well represented the overall model structure of pre/post class. Then the pre/post class model states were characterized by a class model point on a model plot. Both pre/post points were located in the incorrect model region, so both pre/post class states were still in a misconception state. However, there was a small shift of post-class model point towards the correct model, indicating a small improvement of overall understanding.

Key words: Model Analysis, FMCE, Conceptual Understanding, Force and Motion

INTRODUCTION

Over three decades, results from physics education research (PER) indicate that most students come to a physics classroom with misconceptions, originating