

**MQM Comprehensive Examination
Measurement Major**

Day 1

Answer both of the following two questions. Begin each response on a new page, and clearly number the item to which you are responding. **You may not use books or notes when answering these questions.**

1. Identify three unique latent trait indices that are commonly used to evaluate the quality of individual items during instrument development. For each of these indices, do the following:
 - a. Explain what the index represents. If you include equations in your explanation, be sure to identify all elements of each equation.
 - b. Describe guidelines for interpreting the index and suggest criteria for flagging an item for further review.
 - c. Identify at least one plausible explanation for why an item might be flagged based on an examination of the index.
 - d. Identify a comparable raw score index.

2. Lord (1980) indicated that the θ -scale from IRT models and the true score scale from classical test theory are non-linear transformations of each other. In addition, the concept of information in IRT is related to the concept of standard error of measurement in classical test theory.
 - a. Provide a mathematical expression that shows the relationship between the θ -scale from IRT and the true score scale from classical test theory for a test with fixed length of n items. Define all of the terms in the mathematical expression.
 - b. Provide a graphic depiction of the relationship between the θ -scale and the true score scale for a fixed length test. Make sure your graph is clearly labeled. What is the label typically given for the curve in the graph?
 - c. Describe the relationship between the concept of information from IRT and the standard error of measurement from classical test theory. Note that the conditional standard error of measurement for IRT estimates is typically large for extreme θ -values, but small for extreme raw scores. Explain why that is the case.

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Day 2

Answer two of the following four questions. Begin each response on a new page, and clearly number the item to which you are responding. **You may not use books or notes when answering these questions.**

3. First, provide the item response function for the Rasch model for dichotomous data, expressed as the probability of a correct answer (π_{ni1}), and define each element of that equation. Second, beginning with the logit expression of the Rasch dichotomous model,

$$LN\left(\frac{\pi_{ni1}}{\pi_{ni0}}\right) = \theta_n - \delta_i,$$

derive the item response function for the Rasch dichotomous model. Present the derivation in detail with annotations to show the reasons for each step.

4. The following three pages present four substantive models that were created as part of the construct representation phase of an effort to develop an instrument to measure piano proficiency. Figure 1 represents the external model for the construct. Figure 2 represents the internal model for the construct. Figures 3A and 3B represent two potential developmental models for the construct. For each of these models, do the following.
- a. Explain the purpose of that type of model (i.e., external model, internal model, and developmental model) in the instrument development process, and evaluate whether the figure provided accomplishes that purpose.
 - b. Identify one validation hypothesis implied by the figure provided, describe a data analytic procedure that could be used to test that hypothesis, and identify what results would be required in order to support that hypothesis.

Figure 1. Graphical representation of the external model.

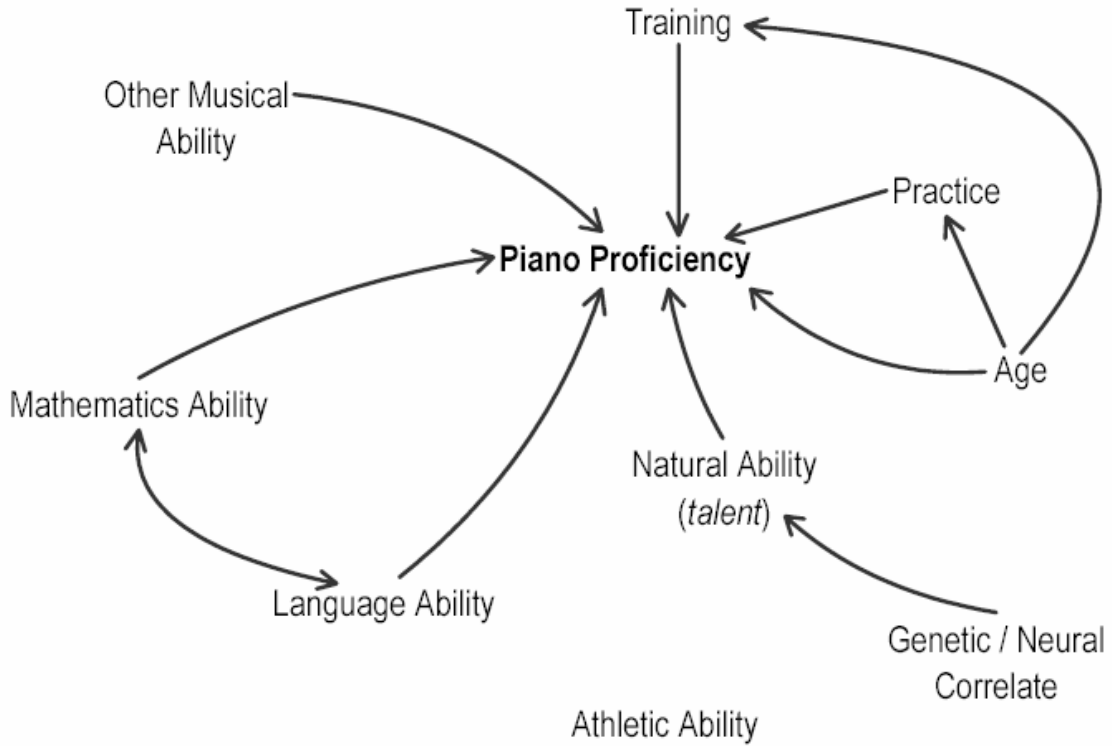


Figure 2. Graphical representation of the internal model.

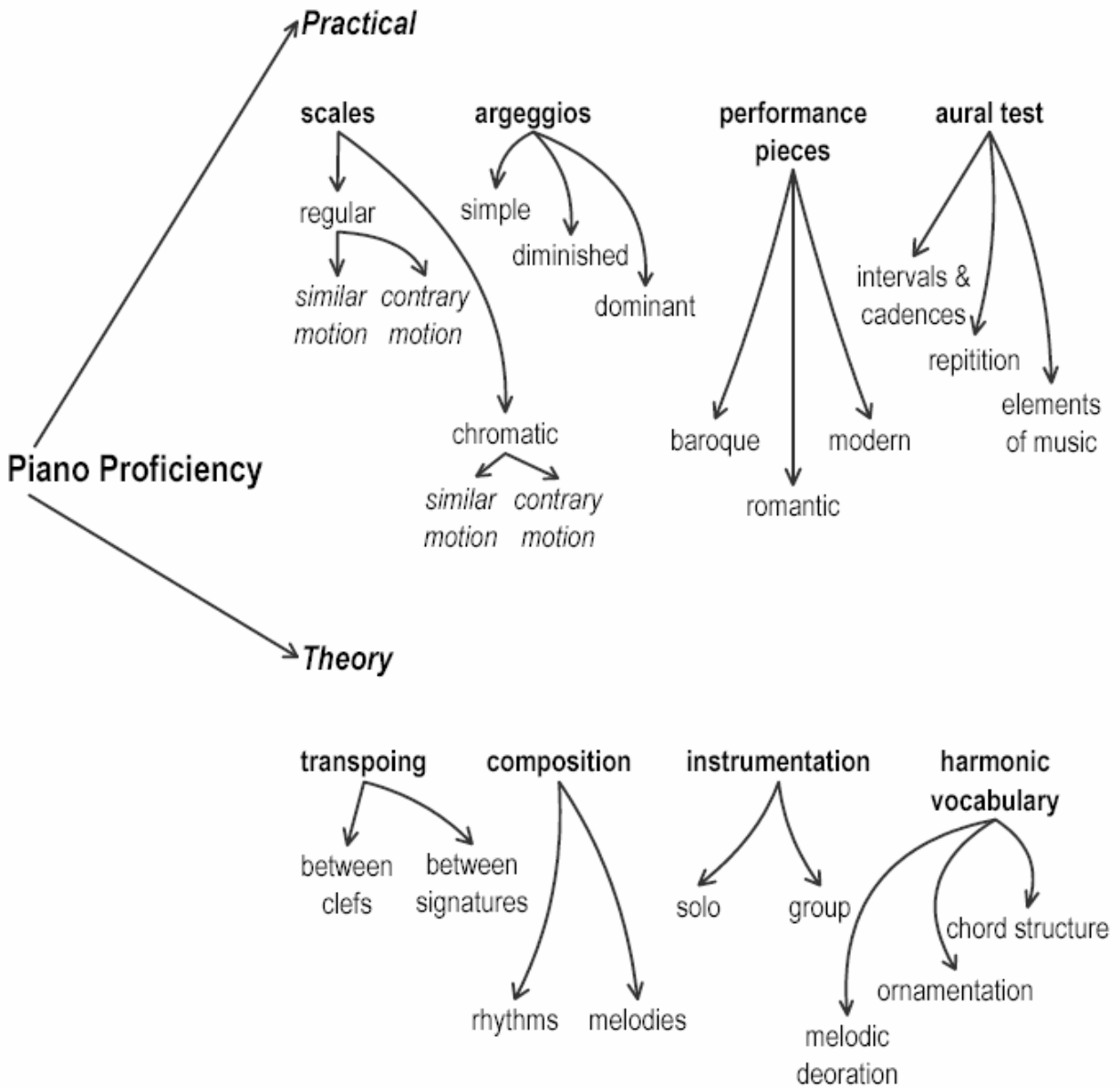


Figure 3a. One-dimensional developmental process model

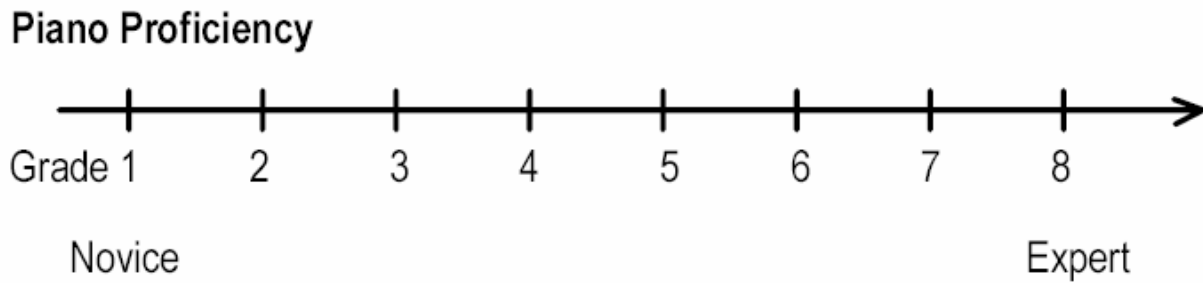
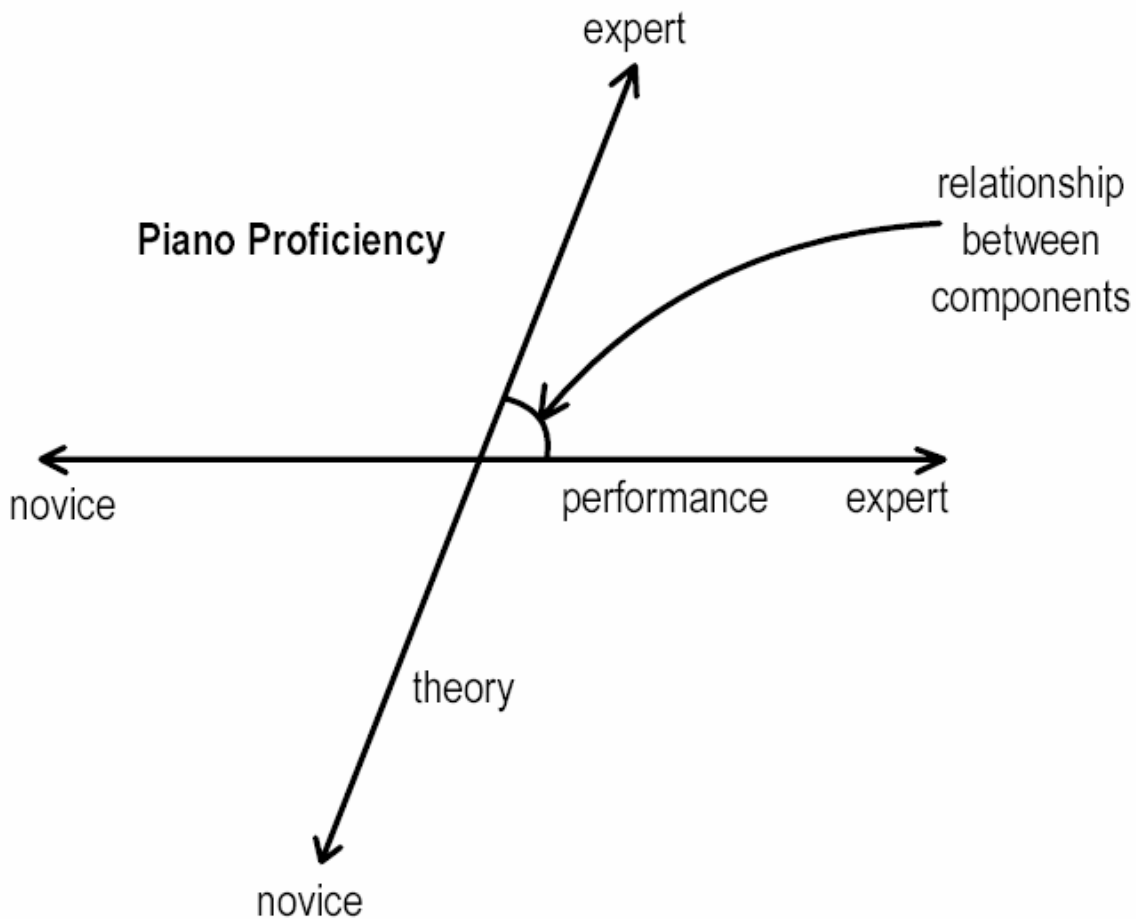


Figure 3b. Two-dimensional developmental process model.



5. Testing companies now often use computerized test assembly software to construct the first forms of tests. The first step in using such that software is to convert the test specifications into mathematical statements called constraints. Provide the mathematical statements for the constraints for the following specifications. Be sure to define all of the symbols in the expressions.
 - a. The test is 50 items long.
 - b. The number of algebra items should be between 10 and 12.
 - c. Items 103 and 104 from the item pool are enemies and should not appear on the same form.
 - d. The discrimination parameters for the items should be larger than .2.
 - e. The difficulty parameters for the items should fall between .3 and .9.

6. A psychometrician for a testing company performed a DIF analysis for a test and found several items with significant uniform DIF and several others with non-uniform DIF. Explain what these two terms mean so that policy makers can understand what they mean. Explain the steps that you would follow to determine if the items should be removed from the test. What results would you have to obtain to recommend removal of the items from the test?