MQM Comprehensive Examination
Measurement Minor Examination

Day 3

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. The item response functions for three latent trait models are shown below. First, define the term *item response function* in language suitable for a lay audience. Second, identify the name of the model that each equation represents and differentiate between these three models by explaining how they differ in terms of the assumptions or requirements they imply and the types of data for which they are appropriate.

   a. $$\pi_{ni} = \frac{\exp(\theta_n - \delta_i)}{1 + \exp(\theta_n - \delta_i)}$$

   b. $$\pi_{ni} = \frac{\exp[\alpha_i(\theta_n - \delta_i)]}{1 + \exp[\alpha_i(\theta_n - \delta_i)]}$$

   c. $$\pi_{ni} = \frac{\exp\sum_{j=0}^{x}(\theta_n - \delta_i - \tau_{ik})}{\sum_{k=0}^{m_i}\exp\sum_{j=0}^{k}(\theta_n - \delta_i - \tau_{ij})}$$

2. The concept of information in item response theory is closely related to the standard error of measurement in classical test theory.

   a. Define information from an IRT perspective. Give a formula for information and define all of the terms used in the formula.

   b. Define standard error of measurement from a classical test theory perspective. Give a formula for standard error of measurement and define all of the terms used in the formula.

   c. Explain the connection between standard error of measurement and information. Provide at least one mathematical expression that shows the connection.

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. The items and output on the two pages that follow are from an exploratory factor analysis of 19 items that appear on an instrument designed to measure an examinee's attribution of mathematics test performance, where *attribution* is defined as one's beliefs about variables that influence one's test performance. The designers of the instrument wrote items for the instrument to measure various aspects of the test environment, examinee, and test items to which test performance may be attributed.

   The instrument developer chose to retain three factors based on preliminary factor analyses of these data. He also chose to perform an oblique rotation.

   Address the following questions based on your knowledge of exploratory factor analysis and the output provided.

   a. Upon what basis might the analyst have based his decision to retain three factors? Cite the values of specific indices in your explanation.

   b. Is the decision to utilize an oblique rotation reasonable for these data? Cite the values of specific indices in your explanation.

   c. Provide a substantive interpretation of the extracted factors by interpreting the factor pattern and factor structure matrices in light of the item text. Be sure to identify which items define each of the factors that you interpret.

Items and SAS (proc factor) output for Item 3.

Item	*My performance on the tests was largely influenced by ...*	*Strongly Agree*	*Agree*	*Disagree*	*Strongly Disagree*
1	guessing.	○	○	○	○
2	luck (good luck or bad luck).	○	○	○	○
3	my ability or inability to concentrate.	○	○	○	○
4	my ability or inability to do the kind of work required by the test.	○	○	○	○
5	my attitude towards mathematics (positive or negative).	○	○	○	○
6	my health today (healthy or sick).	○	○	○	○
7	my interest or lack of interest in mathematics.	○	○	○	○
8	my knowledge of the mathematics content covered by the test.	○	○	○	○
9	my knowledge or lack of knowledge about mathematics.	○	○	○	○
10	my level of confidence about mathematics tests.	○	○	○	○
11	my level of motivation (high or low).	○	○	○	○
12	other people in the testing room.	○	○	○	○
13	the complexity or simplicity of the test content.	○	○	○	○
14	the effort or lack of effort that I put into answering the questions.	○	○	○	○
15	the method used to administer the tests.	○	○	○	○
16	the presence or absence of distractions in the testing room.	○	○	○	○
17	the specific topics addressed by the questions.	○	○	○	○
18	the strategies I used to solve the problems.	○	○	○	○
19	the types of questions the tests contained.	○	○	○	○

Eigenvalues of the Correlation Matrix

	Eigenvalue	Difference	Proportion	Cumulative
1	4.48161890	1.72837191	0.2359	0.2359
2	2.75324700	0.92130203	0.1449	0.3808
3	1.83194496	0.42052176	0.0964	0.4772
4	1.41142321	0.32564383	0.0743	0.5515
5	1.08577937	0.07297362	0.0571	0.6086
6	1.01280575	0.03955048	0.0533	0.6619
7	0.97325527	0.23060990	0.0512	0.7132

Promax Rotation Method Inter-Factor Correlations

	Factor1	Factor2	Factor3
Factor1	1.00000	0.16286	0.12827
Factor2	0.16286	1.00000	0.17328
Factor3	0.12827	0.17328	1.00000

Promax Rotated Factor Pattern (Standardized Regression Coefficients)

		Factor1	Factor2	Factor3
1	guessing	-0.62026	0.28440	-0.02534
2	luck	-0.64988	0.43730	-0.05495
3	ability to concentrate	-0.02058	0.51383	0.17952
4	ability to do work required by the test	0.66939	0.03665	-0.07678
5	attitude towards mathematics	-0.07142	0.11341	0.83708
6	health today	0.04253	0.56210	0.10728
7	interest in mathematics	-0.06517	0.11725	0.81250
8	knowledge of the mathematics content covered by the test	0.79183	-0.03646	0.16719
9	knowledge about mathematics	0.74743	0.00562	0.14765
10	confidence about mathematics tests	0.15746	0.03663	0.67542
11	level of motivation	0.10360	0.07638	0.64337
12	other people in the testing room	-0.28276	0.67249	-0.03870
13	complexity of the test content	0.42253	0.49198	-0.05838
14	effort put into answering the questions	0.26167	0.39493	0.22451
15	method used to administer the tests	-0.04565	0.50227	0.10591
16	presence of distractions in the testing room	0.01120	0.58196	0.17872
17	specific topics addressed by the questions	0.47685	0.38798	-0.23910
18	strategies used to solve the problems	0.50824	0.06694	0.15374
19	types of questions the tests contained	0.59812	0.36179	-0.27807

Promax Factor Structure (Correlations)

		Factor1	Factor2	Factor3
1	guessing	-0.57719	0.17899	-0.05562
2	luck	-0.58571	0.32194	-0.06254
3	ability to concentrate	0.08613	0.54159	0.26592
4	ability to do work required by the test	0.66551	0.13236	0.01544
5	attitude towards mathematics	0.05443	0.24683	0.84757
6	health today	0.14784	0.58762	0.21014
7	interest in mathematics	0.05814	0.24743	0.82446
8	knowledge of the mathematics content covered by the test	0.80734	0.12147	0.26244
9	knowledge about mathematics	0.76729	0.15294	0.24450
10	confidence about mathematics tests	0.25006	0.17932	0.70197
11	level of motivation	0.19857	0.20474	0.66990
12	other people in the testing room	-0.17820	0.61973	0.04156
13	complexity of the test content	0.49517	0.55068	0.08108
14	effort put into answering the questions	0.35479	0.47645	0.32651
15	method used to administer the tests	0.04974	0.51319	0.18709
16	presence of distractions in the testing room	0.12890	0.61475	0.28099
17	specific topics addressed by the questions	0.50936	0.42421	-0.11070
18	strategies used to solve the problems	0.53886	0.17635	0.23053
19	types of questions the tests contained	0.62137	0.41102	-0.13865

4. Describe two standard setting methods. One of the methods you describe must be the *Angoff* method, but the other method is your choice. In your response, be sure to describe a step-by-step procedure for carrying out each method and the advantages and disadvantages of each method.

5. An educational policy maker wants to set a performance standard for the state 8th grade mathematics exam. This examination consists of multiple-choice questions.

   a. Make a recommendation for the standard setting method that you think will work well in this situation and give the reasons for your recommendation.

   b. Describe in detail the process for using this standard setting procedure beginning with the statement of policy and ending with the approved numerical score on the test.

6. Large scale testing programs regularly run DIF analyses as part of their quality control procedures. Respond to the following questions from the context of such testing programs.

   a. What DIF analysis procedure would you recommend for a large scale testing program? Give the reasons for your recommendation.

   b. What does it mean if an item is determined to have significant DIF? Give an answer that would help a policy maker understand what DIF is all about.

   c. When would you delete an item that has a large DIF statistic from a test? Give the rationale for your answer.