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Validity Evidence Based on Internal Structure: Examination of the Factor Structure of the Ohio Achievement Tests

AIR Technical Team

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AMERICAN INSTITUTES FOR RESEARCH

Memorandum

To: Ohio Department of Education

From: AIR Technical Team

Date: February 20, 2008

Re: Validity Evidence Based on Internal Structure: Examination of the Factor Structure of the Ohio Achievement Tests

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Executive Summary

As part of its review of statewide assessment systems under the No Child Left Behind legislation, the U.S. Department of Education requires states to provide evidence bearing on the validity or appropriateness of interpretations of test scores on statewide achievement tests. In preparation for the U.S. Department of Education review of Ohio's statewide assessment system, the Ohio Department of Education is developing a conceptual framework for demonstrating the validity of test score interpretations resulting from its system of achievement and graduation tests. As the primary contractor for the Ohio Achievement Tests (OAT), the American Institutes for Research (AIR) is assisting the Department in collecting and analyzing data addressing the conditions under which, and the degree to which, test scores resulting from the Ohio Achievement Tests can be meaningfully interpreted.

This report describes the results of analyses designed to investigate the internal structure of the Ohio Achievement Tests across subjects and grade levels. In addition to defining the curricular content that Ohio students are expected to achieve, the Ohio Academic Content Standards define a structure of academic achievement in each of the core academic subject areas. Reading achievement is defined by four content standards: Acquisition of Vocabulary, Reading Process, Reading Applications: Literary Text, and Reading Applications: Informational, Technical, and Persuasive Text. Student skills in these four content standards are posited to underlie academic

achievement in reading more generally. For mathematics, student skills in the content standards of Data Analysis and Probability; Geometry; Measurement; Number, Number Sense and Operations; and Patterns, Functions and Algebra are posited to underlie student academic achievement in mathematics generally, with high-achieving students demonstrating proficiency across content standards. Writing achievement is defined by two content standards for grade 4, Writing Applications and Writing Conventions, and by three content standards for grade 7, Writing Applications, Writing Conventions, and Writing Process. Science achievement is defined by four content standards: Earth and Space Sciences, Life Sciences, Physical Sciences, and Scientific Processes. The Scientific Processes Achievement standard is based on the Scientific Inquiry, Scientific Ways of Knowing, and Science and Technology content standards; these content standards were combined in order to ensure reliability of the content standards while maintaining and adequate number of content standards.

Finally for social studies, four content standards, Economics, Government, and Citizenship; People in Societies and Geography; History; and Social Studies Skills and Methods define achievement. As in science, some original social studies content standards were combined into aggregate standards. Three standards – Economics, Government, and Citizenship Rights and Responsibilities – were combined to form the single standard of Economics, Government, and Citizenship; Geography and People in Societies content standards were combined to create the People in Societies and Geography.

Results reported here are based on the analysis of student responses from the spring 2007 operational administration of the Ohio Achievement Tests for Reading and Mathematics, grades 3 through 8; Writing in grades 4 and 7; and Science and Social Studies, grades 5 and 8. The sample consists of all Ohio public school students who participated in the spring 2007 operational administration, with sample sizes ranging from approximately 129,500 to 141,000 students for each grade and subject. The Reading Achievement Tests contain 36 to 38 operational items in both multiple-choice and open-ended question formats. The mathematics achievement tests contain 38 to 40 operational items and both multiple-choice and open-ended question formats. The writing achievement tests consist of 15 selected response items and two essay prompts. The science achievement tests contain 38 operational items of both multiple-

choice and open-ended question formats. The social studies achievement tests contain 38 operational items of both multiple-choice and open-ended question formats.

Structural equation modeling techniques were employed to perform second-order confirmatory factor analyses on the structure of the Ohio Achievement Tests. Within each subject area, items measure a single standard. Standards within each subject area are, in turn, indicators of achievement in the subject area. For example, the Reading Achievement Test is designed to measure four standards: Acquisition of Vocabulary, Reading Applications: Literary Text, Reading Applications: Informational, Technical and Persuasive Text, and Reading Process. These first-order factors in turn define overall achievement in reading. In these models, each item is an indicator of a single primary factor or academic content standard. In turn, each academic content standard serves as an indicator of achievement in the subject area. Paths from the content standards to the items represent the first-order factor loadings, the degree to which the items are correlated with the underlying academic content standard construct. Paths from reading achievement to the content standards represent the second-order factor loadings, indicating the degree to which the academic content standard constructs are correlated with the underlying construct of reading achievement.

Across grades tested for reading, writing, mathematics, science and social studies, the structural models defined by the Ohio Academic Content Standards fit the data well. Although items within a subject area are intercorrelated, each item on the test serves as an indicator for primarily one content standard, and items defining each content standard generally loaded moderately strongly on the intended content standard factor. In turn, the content standards defining the broad subject areas of each achievement domain loaded extremely highly on the intended subject area achievement factor. Joint model fit criteria proposed by Hu and Bentler (1999) indicated adequate model fit (CFI > .96 and SRMR $\leq$ 0.10 or SRMR $\leq$ 0.10 and RMSEA $\leq$ 0.06) of the Ohio Academic Content Standards for all subjects across all grades.

We conclude that the structure of the Ohio Achievement Tests in reading, writing, mathematics, science and social studies conforms to the structural model of reading and mathematics achievement, respectively, as defined in the Ohio Academic Content Standards. These results

support the validity of the structural model for both the achievement tests and the overall standards framework.

Introduction

As part of its review of statewide assessment systems under the No Child Left Behind legislation, the U.S. Department of Education requires states to provide evidence bearing on the validity or appropriateness of interpretations of test scores on statewide achievement tests. In preparation for the U.S. Department of Education review of Ohio's statewide assessment system, the Ohio Department of Education (ODE) is developing a conceptual framework for demonstrating the validity of test score interpretations resulting from its system of achievement and graduation tests. As the primary contractor for the Ohio Achievement Tests, the American Institutes for Research (AIR) is assisting the Department in collecting and analyzing data addressing the conditions under which, and the degree to which, test scores resulting from the Ohio Achievement Tests can be meaningfully interpreted.

Validity is not an attribute of tests but rather refers to a process whereby the meaning and interpretation of test scores can be established for a variety of intended and even unintended purposes. As such, a test is not valid or invalid; rather, the soundness of interpretations based on test scores is evaluated on the basis of evidence about test properties and test performance across subgroups within the intended (or even unintended) test population.

As the *Standards for Educational and Psychological Testing* (AERA, APA, & NCME, 1999) notes, the validity of any intended score interpretation relies, at its core, on all the evidence accrued about the technical quality of a testing system, including test development and construction procedures, test score reliability, accurate scaling and equating, procedures for setting meaningful performance standards, standardized test administration and scoring procedures, and attention to fairness for all test takers. Evidence for these attributes of the Ohio Achievement Tests are provided as part of the series of technical reports submitted to ODE following each test administration cycle.

Although necessary, these documents, and the evidence they provide, are not sufficient evidence of the validity of Ohio Achievement Test score interpretations. Accrual of validity evidence is an ongoing process, and evidence for the validity of test score interpretation can come from a variety of sources. The *Standards for Educational and Psychological Testing* (AERA, APA, & NCME, 1999) lists the following sources for validity evidence: evidence based on test content,

evidence based on response processes, evidence based on internal structure, evidence based on relations to other variables, and evidence based on consequences of testing.

This document is one of several reports commissioned by the Ohio Department of Education to obtain further evidence about the validity of the achievement tests beyond what is reported in the standard technical reports. This report examines evidence based on the internal structure of the Ohio Achievement Tests administered in March 2007, allowing ODE to evaluate the degree to which relationships among test items and test subscales correspond to the conceptual framework outlined in the Ohio Academic Content Standards.

Ohio has developed a set of academic content standards that define what students should know and be able to do by the end of each grade in each of the major academic subject areas: English language arts, mathematics, science, and social studies. These areas are also to be assessed through the Ohio Achievement Tests as part of Ohio's accountability system under No Child Left Behind. The Academic Content Standards are organized into a three-level framework that includes standards, benchmarks and indicators. Standards represent broad statements about the major content areas within each subject and the learning goals for Ohio students across the K–12 curriculum. Benchmarks denote more specifically what students should know and be able to do at specific points during their schooling. Benchmarks are used to measure student progress toward meeting academic standards. Indicators are specific statements that identify exemplar knowledge and skills that indicate whether students have achieved a benchmark.

The Ohio Achievement Tests measure student progress toward achievement of the Ohio Academic Content Standards. The achievement tests are grade-appropriate, meaning that they measure student progress toward grade-level benchmarks within each academic content standard. The validity of Ohio Achievement Test score interpretations are evaluated along several dimensions. As a criterion-referenced system of tests, the meaning of Ohio Achievement Test scores are, in part, appropriately evaluated by the degree to which test content is aligned with the Ohio Academic Content Standards.

Alignment of content standards is achieved through a rigorous test development process that stems from the Ohio Academic Content Standards and refers back to those standards in a highly iterative test development process that includes the Ohio Department of Education, the American

Institutes for Research (AIR; the test contractor) and two committees composed of Ohio citizens, including not only primary and secondary educators and administrators but also representatives from colleges and universities and other stakeholder groups. The Fairness/Sensitivity Committee (FSC) is charged with ensuring that test content does not unfairly disadvantage students because of group membership, and the Content Advisory Committee (CAC) is specifically charged with ensuring that test content is aligned with academic content standards and is grade-appropriate. Committees review items twice during the item development process, once prior to the inclusion of items on field-test forms and again following field-testing, with item performance information, prior to the inclusion of items in the operational item bank.

This review-intensive item development process ensures that items included in the operational test bank and subsequently appearing on operational test forms are tightly aligned to the Ohio Academic Content Standards and that test scores provide valid feedback to parents and the educational community about student, classroom, school, district, and statewide progress toward achieving those standards.

In addition to defining the content domain for academic achievement in each target subject area, the Ohio Academic Content Standards represent a structural model of student achievement in each subject area. For example, the Ohio Academic Content Standards for English Language Arts [ELA] comprise 10 learning standards:

1. Phonemic Awareness, Word Recognition and Fluency;
2. Acquisition of Vocabulary;
3. Reading Process: Concepts of Print, Comprehension Strategies and Self-Monitoring Strategies;
4. Reading Applications: Informational, Technical and Persuasive Text;
5. Reading Applications: Literary Text;
6. Writing Process;
7. Writing Applications;
8. Writing Conventions;
9. Research;
10. Communication: Oral and Visual.

The first five ELA standards make up the reading subject area, and the three writing standards define the writing subject area. Although the Ohio Achievement Tests are designed to measure student progress toward achievement standards in both of these subject areas, not all academic content standards are measured in each subject area test. The Phonemic Awareness standard, for example, is primarily targeted to the development of basic skills underlying reading acquisition, including learning to recognize and decode printed words. Students are expected to achieve this standard by the early elementary school years. Thus, although the Phonemic Awareness standard is assessed in the Ohio Diagnostic Tests administered to K–2 students, this standard is not assessed in the reading achievement tests.

In the writing subject area, the emphasis on the Writing Process standard, which focuses on student achievement across each of the major phases of writing, from organizing to drafting and revising text, increases across the school years. This standard, although important during the elementary school years, is not measured on the Grade 4 Writing Achievement Test but rather will be included with Writing Applications and Writing Conventions in the Grade 7 Writing Achievement Test.

The Ohio Academic Standards for Mathematics have five content standards:

1. Number, Number Sense and Operations;
2. Measurement;
3. Geometry and Spatial Sense;
4. Patterns, Functions and Algebra;
5. Data Analysis and Probability.

There is also a process standard called Mathematical Processes. Each of the five content standards is assessed on each grade-level mathematics achievement test. The Mathematical Processes standard is embedded within each of the content standards and is not independently assessed in the achievement tests.

The Ohio Academic Standards for Science have four content standards:

1. Earth and Space Sciences;
2. Life Sciences;
3. Physical Sciences;
4. Scientific Processes
    a. Scientific Inquiry
    b. Scientific Ways of Knowing
    c. Science and Technology

The Ohio Academic Standards for Social Studies have four content standards:

1. Economics, Government, and Citizenship
    a. Economics;
    b. Government;
    c. Citizenship Rights and Responsibilities;
2. People in Societies and Geography
    a. People in Societies;
    b. Geography;
3. History;
4. Social Studies Skills and Methods.

Methods

Participants. The sample consists of all students who participated in the Ohio K–8 Achievement Tests during the May 2007 administration period, ranging from approximately 129,500 to 141,000 students for each grade and subject. Demographic characteristics of the sample are presented in Tables 1 and 2. Males made up about 51% of the sample across grades and subjects. Approximately 75% of the students were White, with African-Americans making up about 16% of the sample, Hispanics about 2%, and Asian/Pacific Islanders about 2%.

Table 1. Number of Achievement Test Respondents by Gender

	Gender				
	Female		**Male**		
Achievement Test	**n**	**%**	**n**	**%**	**Total**
Grade 3	64286	49.05%	66476	50.72%	131057
Grade 4	62885	48.56%	66309	51.20%	129498
Grade 5	63504	48.82%	66259	50.94%	130076
Grade 6	65390	48.76%	68330	50.95%	134107
Grade 7	66726	48.50%	70480	51.23%	137580
Grade 8	68799	48.66%	72142	51.02%	141387
TOTAL	391590	48.72%	409996	51.01%	803705

Table 2. Number of Achievement Test Respondents by Ethnicity

	Ethnicity												
	American Indian		**Asian/Pacific Islander**		**Black/African American**		**Hispanic**		**White**		**Multi-Ethnic**		
Grade	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**Total**
3	191	0.2	2235	1.7	21122	16.1	3647	2.8	97495	74.4	4968	3.8	131057
4	163	0.1	2074	1.6	20399	15.8	3291	2.5	97516	75.3	4663	3.6	129498
5	190	0.2	2122	1.6	20790	16.0	3279	2.5	98034	75.4	4359	3.6	130076
6	185	0.1	2039	1.5	21684	16.2	3130	2.3	101275	75.5	4096	3.1	134107
7	212	0.2	2008	1.6	23244	16.9	3205	2.3	103552	75.3	3774	2.7	137580
8	199	0.1	1979	1.4	24038	17.0	3057	2.2	106773	75.5	3535	2.5	141387
TOTAL	1140	0.1	12457	1.7	131277	16.3	19609	2.4	604645	75.2	25395	3.2	803705

Design. Results are based on the analysis of operational assessments of the Ohio Achievement Tests for reading and mathematics, grades 3 through 8, writing, grades 4 and 7, and science and social studies, grades 5 and 8, administered to Ohio public school students in spring 2007. The Reading Achievement Tests contain 36 to 38 operational items – both multiple-choice and open-ended question formats. The Mathematics Achievement Tests contain 38 to 40 items of both multiple-choice and open-ended question formats. The Writing Achievement Tests consist of 15 multiple-choice and two essay prompts. The Science Achievement Test consists of 38 items in both multiple-choice and open-ended question formats. The Social Studies Achievement Tests consist of 38 items of both multiple-choice and open-ended question formats. The structure of the assessments is summarized in Table 3.

Table 3: Design of the Ohio Achievement Tests – Number of items on each test form by type

	Grade											
	3		**4**		**5**		**6**		**7**		**8**	
Subject	**MC**	**CR**	**SR**	**CR**	**MC**	**CR**	**MC**	**CR**	**MC**	**CR**	**MC**	**CR**
Reading	29	7 or 8	29	7 or 8	29	7 or 8	29	8	29	7	32	6
Writing			15	2					15	4		
Mathematics	32	8	32	8	32	8	32	7	32	7	32	6
Science					32	6					32	6
Social Studies					32	6					32	6

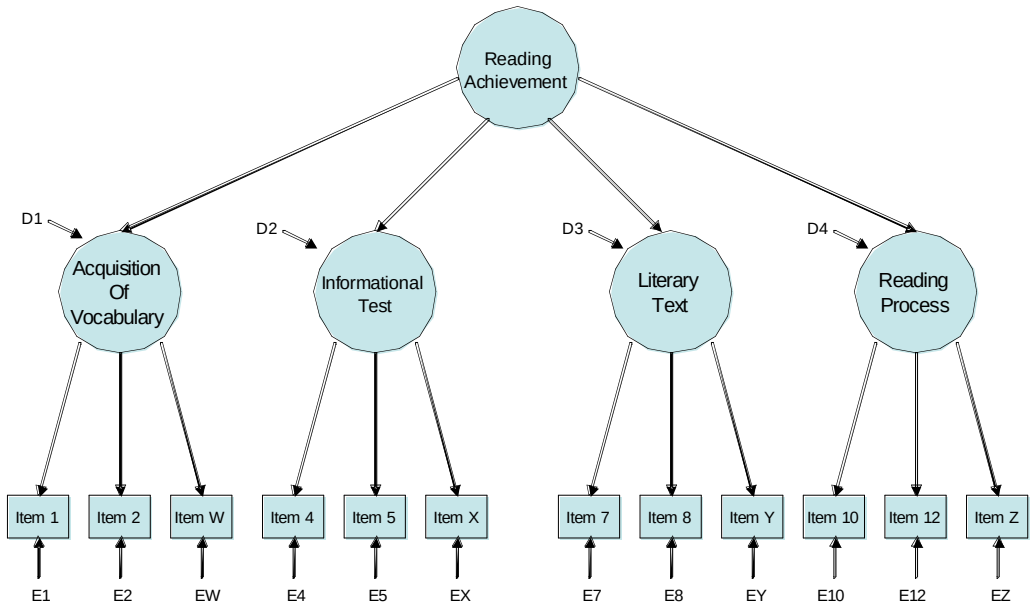
Analyses. MPlus 4.21 (Muthen & Muthen, 2007), commercially available software for structural equation modeling, was used to perform second-order confirmatory factor analyses on the structure of the Ohio Achievement Tests[1]. Within each subject area, items measure a single standard. Standards within each subject area are, in turn, indicators of achievement in the subject area.

As noted above, the Reading Achievement Tests measure four standards: Acquisition of Vocabulary; Reading Applications: Literary Text; Reading Applications: Informational, Technical and Persuasive Text; and Reading Process. These first-order factors define overall achievement in reading. The form of the second-order confirmatory factor analyses for reading across all grades is illustrated in Figure 1.

[1] The second-order model for grade 4 writing, which only has two content standards, resulted in an under-identified model. Additional model constraints are, therefore, imposed for the purpose identification.

As the figure illustrates, each item is an indicator of a single primary factor or academic content standard. Because items are never pure indicators of an underlying factor, each item also includes an error component (denoted as "E" in the figure). Similarly, each academic content standard serves as an indicator of reading achievement. As at the item level, the content standards include an error term (denoted as "D" in the figure) indicating that the content standards are not pure indicators of overall reading achievement. The paths from the content standards to the items represent the first-order factor loadings, the degree to which items are correlated with the underlying academic content standard construct. Similarly, the paths from reading achievement to the content standards represent the second-order factor loading, indicating the degree to which academic content standard constructs are correlated with the underlying construct of reading achievement.

Figure 1. Second-Order Confirmatory Factor Analysis Model for Reading Achievement*

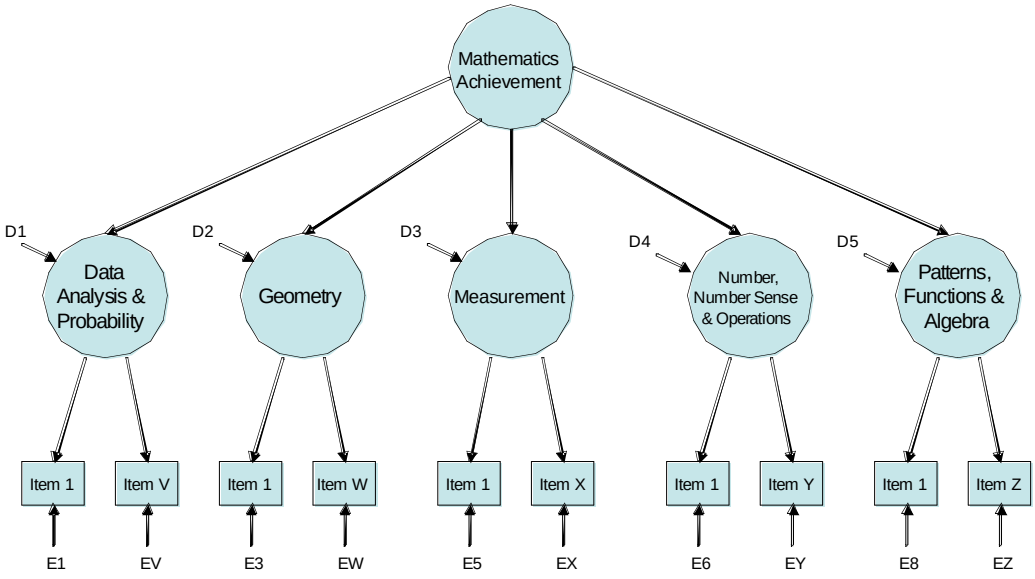


*

Note. The number of items per factor shown in the figure is for illustrative purposes only. In the 2007 reading achievement assessments the number of items per factor ranged from 7 to 13, depending on content standard and grade level.

The Mathematics Achievement Tests measure five standards: Data Analysis and Probability; Geometry; Measurement; Number, Number Sense and Operations; and Patterns, Functions and Algebra. These first-order factors in turn define overall achievement in mathematics. The form of the second-order confirmatory factor analyses for mathematics across all grades is illustrated in Figure 2.

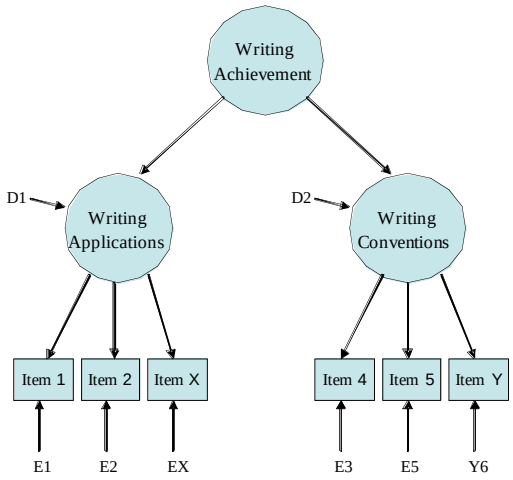
Figure 2. Second-Order Confirmatory Factor Analysis Model for Mathematics Achievement



*Note. The number of items per factor shown in the figure is for illustrative purposes only. In the 2007 mathematics achievement assessments, the number of items per factor ranged from 6 to 13, depending on content standard and grade level.

The Grade 4 Writing Achievement Test measures two standards: Writing Applications and Writing Conventions. These first-order factors in turn define overall achievement in writing. The form of the second-order confirmatory factor analysis for grade 4 writing is illustrated in Figure 3.

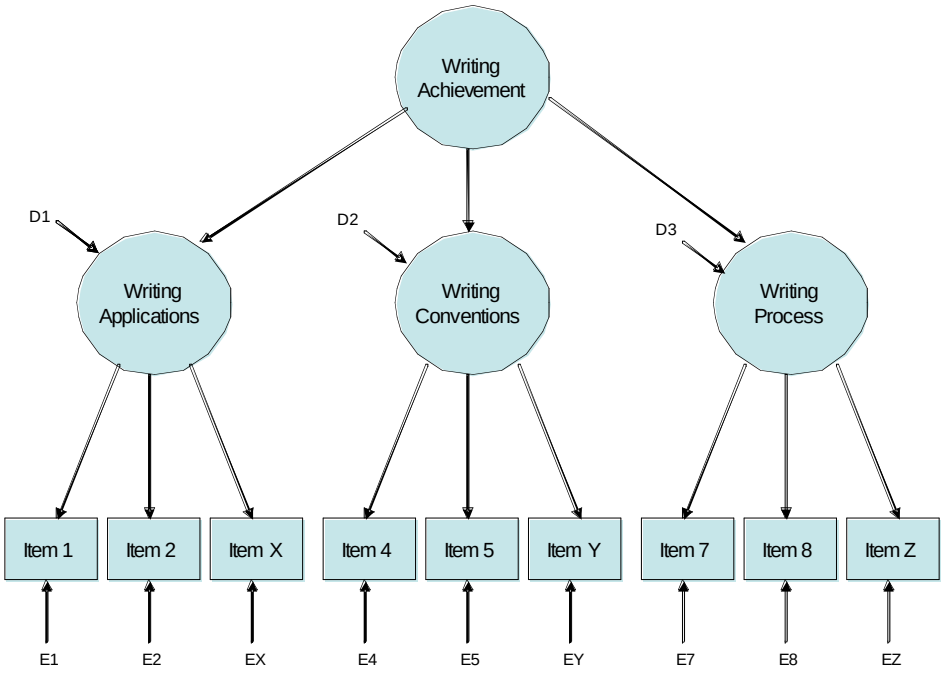
Figure 3. Second-Order Confirmatory Factor Analysis Model for Grade 4 Writing Achievement



*Note. The number of items per factor shown in the figure is for illustrative purposes only. In the 2007 Grade 4 Writing Achievement Test, two items contributed to the assessment of the Writing Applications standard and 15 items assessed the Writing Conventions standard.

The Grade 7 Writing Achievement Test measures three standards: Writing Applications, Writing Conventions, and Writing Process. These first-order factors in turn define overall achievement in grade 7 writing. The form of the second-order confirmatory factor analysis for grade 7 writing is illustrated in Figure 4.

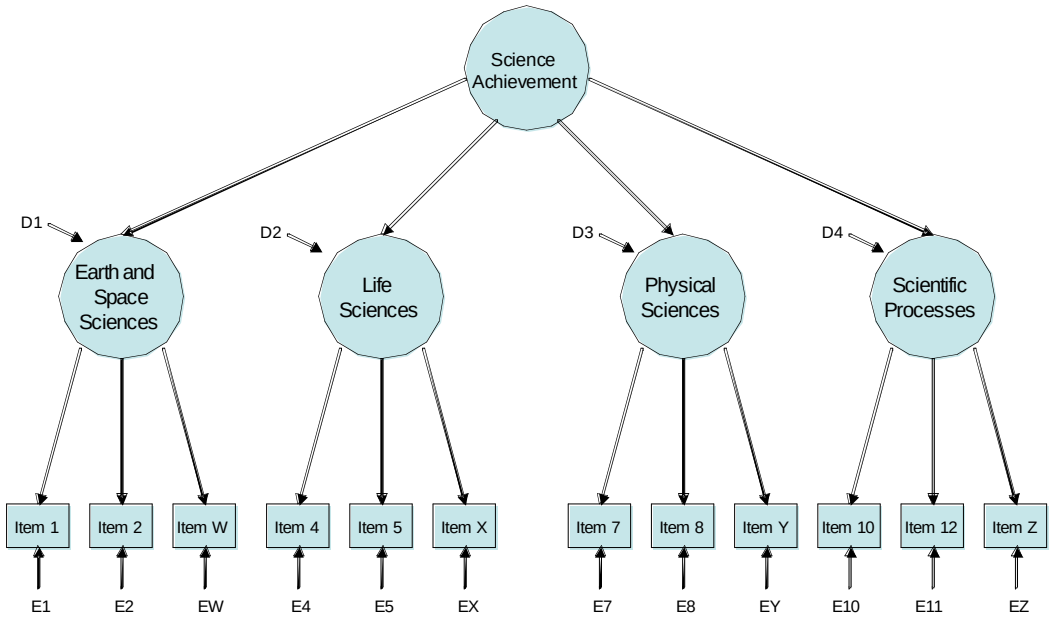
Figure 4. Second-Order Confirmatory Factor Analysis Model for Grade 7 Writing Achievement



*Note. The number of items per factor shown in the figure is for illustrative purposes only. In the 2007 Grade 7 Writing Achievement Test, two items contributed to the assessment of the Writing Applications standard and 15 items assessed the Writing Conventions standard.

The science achievement tests measure four standards: Earth and Space Sciences, Life Sciences, Physical Sciences, and Scientific Processes. The Ohio Academic Content Standards in turn define overall achievement on the science achievement test for grades 5 and 8. The factor structure for science is shown in Figure 5.

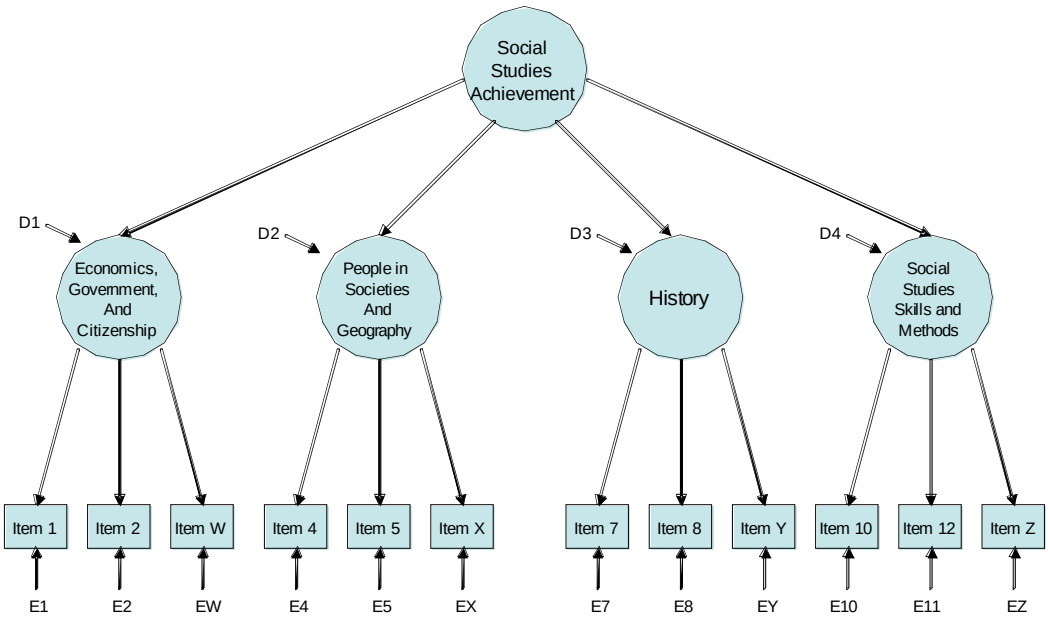
Figure 5. Second-Order Confirmatory Factor Analysis Model for Science Achievement



*Note. The number of items per factor shown in the figure is for illustrative purposes only. In the 2007 science achievement assessments, the number of items per factor ranged from 8 to 11, depending on content standard and grade level.

The Social Studies Achievement Tests measure four standards: Economics, Government, and Citizenship; People in Societies and Geography; History; and Social Studies Skills and Methods. The Ohio Academic Content Standards in turn define overall achievement on the social studies achievement test for grades 5 and 8. The factor structure for social studies is shown in Figure 6.

Figure 6. Second-Order Confirmatory Factor Analysis Model for Social Studies Achievement



*Note. The number of items per factor shown in the figure is for illustrative purposes only. In the 2007 social studies achievement assessments, the number of items per factor ranged from 7 to 12, depending on content standard and grade level.

Factor Analytic Methods: A series of confirmatory factor analyses (CFA) were conducted using the statistical program Mplus for each grade and subject assessment. These psychometric tools are useful data analytic methods commonly used for collecting validity evidence on the internal structure of assessments.

In factor analytic terms, a test structure that is strictly unidimensional implies a single-order factor model where all test items load onto a single underlying factor. This model is subsequently referred to as the *base model* and is used as the basis for comparison. If the internal structure of the test were strictly unidimensional, then the overall person ability measure, theta (θ), would be the single common factor and the correlation matrix among test items would suggest no discernable pattern among factors. As such, there would be no empirical or logical basis to report scores for the separate performance categories.

As previously stated, the method of reporting scores used for the Ohio Achievement Test implies separate factors for each reporting category connected by a single underlying factor. This model is subsequently referred to as the *implied model.* In factor analytic terms, this suggests that test items load onto separate first-order factors with the first-order factors connected to a single underlying second-order factor.

Fortunately, empirical methods such as confirmatory factor analysis (CFA) exist, thus making it possible to collect validity evidence on the degree to which the implied model is reasonable when compared to the base model. Hence, the purpose of the subsequent analyses is to collect validity evidence on the measurement model and reporting structures used for the Ohio Achievement Tests via a direct comparison of the implied and base models.

The factor analysis models are based on the matrix $\mathbf{S}$ of tetrachoric and polychoric sample correlations among the item scores (Olsson, 1979) and the matrix $\mathbf{W}$ of asymptotic covariances among these sample correlations (Jöreskog, 1994), which is employed as the weighting matrix in a weighted least squares estimation approach (Browne, 1984; Muthén, 1984) to minimize the fit function:

$$F_{WLS} = \text{vech}(\mathbf{S} - \hat{\mathbf{R}})' \mathbf{W}^{-1} \text{vech}(\mathbf{S} - \hat{\mathbf{R}}) \qquad (0.1)$$

In (0.1), $\hat{\mathbf{R}}$ is the implied correlation matrix, given the estimated factor model, and the function *vech* vectorizes a symmetric matrix. That is, *vech* stacks each column of the matrix to form a vector.

Testing the implied model against the base model requires development of two factor analyses for each grade and subject. For the base model, we posit a first-order factor analysis where all

test items load onto a single common factor. The first-order model can be mathematically represented as:

$$\Sigma = \Lambda\Phi\Lambda' + \Theta \qquad (0.2)$$

where Λ is the matrix of item factor loadings (with Λ' representing its transpose), and Θ is the uniqueness, or measurement error. The matrix Φ is the correlation among the separate factors. For the base model, items are posited to load only onto a single underlying factor. Hence Λ is a *p x 1* vector where *p* is the number of test items and Φ is a scalar equal to 1. Therefore, it is possible to drop the matrix Φ from the general notation. However, this notation is retained to more easily facilitate comparisons with the implied model, such that the base model can subsequently be viewed as a special case of the second-order factor analysis.

For the implied model, a second-order factor analysis was posited where test items are constrained to load onto the reporting categories they are designed to measure and all reporting categories share a common underlying factor[2]. The second-order factor analysis can be mathematically represented as:

$$\Sigma = \Lambda\left(\Gamma\Phi\Gamma' + \Psi\right)\Lambda' + \Theta \qquad (0.3)$$

where Σ is the implied correlation matrix among test items, Λ is the *p x k* matrix of first-order factor loadings relating item scores to first-order factors, Γ is the *k x 1* matrix of second-order factor loadings relating the first-order factors to the second-order factor with *k* denoting the number of factors, Φ is the correlation matrix of the second-order factors , and Ψ is the matrix of first-order factor residuals. All other notation is the same as the first-order model. Note that the second-order model expands the first-order model such that $\Phi \rightarrow \Gamma\Phi\Gamma' + \Psi$. As such, the first-order model is said to be nested within the second-order model.

2 The second-order factor model requires at least three primary factors to be identified. The second-order factor model with two primary factors must be constrained, 1) loading to one primary factor and 2) specifying variance of the second-order factor to one.

Results

Factor loadings by subject and grade are presented in the appendix. In each table, factor loading for each item on its intended scale is shown for each of the first-order factors, followed by the loadings for each standard on the second-order factor. Loadings for items are generally moderate to high, loading above 0.3. The primary factor standards typically load above 0.9 on the general, second-order achievement factor. In the case where items loaded less than 0.3 on the first-order factors, item loadings were estimated for all other first-order factors. Notable results for such free-estimation are provided under "Modification."

Joint fit criteria proposed by Hu and Bentler (1999), which account for differences in model specification such as sample size and model complexity, were used to evaluate the model fit:

> Comparative Fit Index (CFI; Bentler, 1990) over 0.96 and the Standardized Root-mean-squared Residual (SRMR; Bentler, 1995) less than 0.10; or
> SRMR less than 0.10 and the Root Mean Square Error of Approximation (RMSEA; Steiger and Lind, 1980) less than 0.06.

Reading

Grade 3 Reading: Table A-1 presents the standardized factor loadings for the grade 3 reading solution.

<u>Base Model</u>: Considering a strictly unidimensional test structure, all items load greater than 0.3 on the reading achievement factor. The base model meets the joint criteria (RMSEA = 0.022; SRMR = 0.042), indicating reasonable model fit.
<u>Implied Model</u>: All four of the primary factor standards load above .9 on the general, second-order reading achievement factor. The second-order model meets the joint criteria (CFI=0.932, RMSEA=0.022 and SRMR=0.038) indicating reasonable model fit.

Grade 4 Reading: Standardized factor loadings for the grade 4 reading solution are shown in Table A-2.

<u>Base Model</u>: As with grade 3 reading, all items load greater than 0.3 on the reading achievement factor. The base model meets the joint criteria (RMSEA = 0.017; SRMR = 0.048), indicating

reasonable model fit.

Implied Model: Loadings for items are generally moderate, with no item loading below 0.3 on their intended factor. All four of the primary factor standards load above 0.9 on the general, second-order reading achievement factor. The second-order model meets the joint criteria (CFI=0.948, RMSEA=0.017 and SRMR=0.046) indicating reasonable model fit.

Grade 5 Reading: Standardized factor loadings for the grade 5 reading solution are shown in Table A-3.

Base Model: All items load greater than 0.3 on Reading Achievement. The base model meets the joint criteria (RMSEA = 0.017; SRMR = 0.037), indicating reasonable model fit.

Implied Model: Loadings for items are generally moderate with no item loading below 0.3 on their intended factor. All four of the primary factor standards load above 0.9 on the general, second-order reading achievement factor. The second-order model meets the joint criteria (CFI=0.884, RMSEA=0.016 and SRMR=0.035) indicating reasonable model fit.

Grade 6 Reading: Standardized factor loadings for the grade 6 reading solution are shown in Table A-4.

Base Model: As with previous grades in reading, loadings for items are generally moderate, with no item loading below 0.3 on Reading Achievement. The base model meets the joint criteria (RMSEA = 0.018; SRMR = 0.035), indicating reasonable model fit.

Implied Model: No items load below 0.3 on their intended factor. All four of the primary factor standards load above 0.9 on the general, second-order reading achievement factor. The second-order model meets the joint criteria (CFI=0.865, RMSEA=0.017 and SRMR=0.035) indicating reasonable model fit.

Grade 7 Reading: Standardized factor loadings for the grade 7 reading solution are shown in Table A-5.

Base Model: Although average item loadings are generally at the same level as in the other grades, two items have loadings below 0.3 on their Reading Achievement. Item 11 loads on Reading Achievement as 0.276 and item 12 loads at 0.222. The base model meets the joint criteria (RMSEA = 0.016; SRMR = 0.033), indicating reasonable model fit.

Implied Model: Although average item loadings are generally at the same level as in the other grades, two items have loadings below 0.3 on their intended factor. Item 11 has a loading of 0.277 and item 12 has a loading of 0.224, with both items loading on the Literary Text factor. Consistent with the other reading achievement tests, the four primary factor standards load above .9 on the second-order reading achievement factor. The second-order model meets the joint criteria (CFI=0.897, RMSEA=0.016 and SRMR=0.033) indicating reasonable model fit.
Modification: Allowing items 11 and 12 to freely associate with any available content standard did not result in a significant expected improvement in model fit for the implied model (maximum chi-square change = 0.12%).

Grade 8 Reading. Standardized factor loadings for the grade 8 reading solution are shown in Table A-6.

Base Model: As with previous grades in reading, loadings for items are generally moderate, with no item loading below 0.3 on Reading Achievement. The base model meets the joint criteria (RMSEA = 0.017; SRMR = 0.035), indicating reasonable model fit.
Implied Model: Loadings for items are generally moderate, with no item loading below .3 on the intended factor. All four of the primary factor standards load above 0.9 on the general, second-order reading achievement factor. The second-order model meets the joint criteria (CFI=0.861, RMSEA=0.017 and SRMR=0.035) indicating reasonable model fit.

Mathematics

Grade 3 Mathematics. Table A-7 presents the standardized factor loadings for the grade 3 mathematics solution.

Base Model: The loading for items are generally moderate, with no item loading below .3 on Mathematics Achievement. The base model meets the joint criteria (RMSEA = 0.012; SRMR = 0.037), indicating reasonable model fit.
Implied Model: The loading for items are generally moderate, with no item loading below 0.3 on their intended factor. All five of the primary factor standards load above 0.9 on the general, second-order mathematics achievement factor. The second-order model meets the joint criteria (CFI=0.898, RMSEA=0.012 and SRMR=0.035) indicating reasonable model fit.

Grade 4 Mathematics: Table A-8 presents the standardized factor loadings for the grade 4 mathematics solution.

Base Model: Although average item loadings are generally at the same level as in the other grades, one item loads below 0.3 on Reading Achievement; item 28 has a loading of only 0.177. The base model meets the joint criteria (RMSEA = 0.025; SRMR = 0.051), indicating reasonable model fit.
Implied Model: One item loads below 0.3 on its intended factor. Item 28 has a loading of only 0.179 on the Data Analysis and Probability factor. Consistent with the other mathematics achievement tests, the five primary factor standards load above 0.9 on the second-order reading achievement factor. The second-order model meets the joint criteria (CFI=0.860, RMSEA=0.016 and SRMR=0.037) indicating reasonable model fit.
Modification: Allowing item 28 to freely associate with any available content standard did not result in a significant expected improvement in model fit for the implied model (maximum chi-square change = 0.10%).

Grade 5 Mathematics: Table A-9 presents the standardized factor loadings for the grade 5 mathematics solution.

Base Model: Although average item loadings are generally at the same level as in the other grades, item 31 has a loading of only 0.192 on Reading Achievement. The base model meets the joint criteria (RMSEA = 0.016; SRMR = 0.034), indicating reasonable model fit.
Implied Model: One item loads below 0.3 on its intended factor. Item 30 has a loading of only 0.194 on the Measurement factor. Consistent with the other mathematics achievement tests, the five primary factor standards load above 0.9 on the second-order mathematics achievement factor. The second-order model meets the joint criteria (CFI=0.897, RMSEA=0.016 and SRMR=0.033) indicating reasonable model fit.
Modification: Allowing item 30 to freely associate with any available content standard did not result in a significant expected improvement in model fit for the implied model (maximum chi-square change = 0.19%).

Grade 6 Mathematics: Table A-10 presents the standardized factor loadings for the grade 6 mathematics solution.

Base Model: The loading for items are generally moderate, with no item loading below 0.3 on Mathematics Achievement. The base model meets the joint criteria (RMSEA = 0.016; SRMR = 0.033), indicating reasonable model fit.
Implied Model: As with grade 3 mathematics, loadings for items are generally moderate, with no item loading below 0.3 on their intended factor. All five of the primary factor standards load above 0.9 on the general, second-order mathematics achievement factor. The second-order model meets the joint criteria (CFI=0.894, RMSEA=0.015 and SRMR=0.032) indicating reasonable model fit.

Grade 7 Mathematics: Standardized factor loadings for the grade 7 mathematics solution are shown in Table A-11.

Base Model: Although average item loadings are generally moderate in magnitude, several items have loadings below 0.3 on Mathematics Achievement. Item 3 has a negative loading of -0.136, item 42 has a loading of 0.270, item 18 has a loading of 0.077, items 8 has a loading of 0.063, item 17 has a loading of 0.144, and item 37 has a loading of 0.162. The base model meets the joint criteria (RMSEA = 0.042; SRMR = 0.097), indicating reasonable model fit.
Implied Model: Similar to the base model results, a number of items load below 0.3 on their intended factor. Item 3 has a negative loading of -0.137 and item 42 has a loading of 0.274, both on the Data Analysis and Probability factor; item 18 loads weakly on the Geometry factor; and items 8, 17 and 37 load below 0.30 on the Patterns, Functions, and Algebra first-order factor. All of the primary factor standards load above 0.9 on the second-order mathematics achievement factor. The second-order model meets the joint criteria (CFI=0.835, RMSEA=0.020 and SRMR=0.040) indicating reasonable model fit.
Modification: Allowing items 3, 8, 18, 27, 37, 42 to freely associate with any available content standard did not result in a significant expected improvement in model fit for the implied model (maximum chi-square change = 0.07%)[3].

Grade 8 Mathematics: Table A-12 presents the standardized factor loadings for the grade 8 mathematics solution.

[3] Item 42, however, evidences an expected chi-square change of 0.5% when loading on "Number, Number Sense, and Operations" content standard. When loading on this first-order factor the specific standardized item loading is expected to be -0.731.

Base Model: Although average item loadings are generally moderate in magnitude, several items have loadings below .3 on Mathematics Achievement. Item 14 has a loading of 0.296, item 12 has a loading of 0.233, item 29 has a loading of 0.228, item 42 has a loading of 0.252, item 19 has a loading of 0.068, item 30 has a loading of 0.164, and item 38 has a loading of 0.115. The base model meets the joint criteria (RMSEA = 0.018; SRMR = 0.033), indicating reasonable model fit.

Implied Model: As in the base model, a number of items show loadings less than .3 on their intended factor. Item 14 has a loading of 0.299 on the Data Analysis and Probability factor; items 12, 29, and 42 load weakly on the Measurement factor; and items 19, 30 and 38 load below 0.30 on the Patterns, Functions, and Algebra first-order factor. All of the primary factor standards load above 0.9 on the second-order mathematics achievement factor. The second-order model meets the joint criteria (CFI=0.882, RMSEA=0.040 and SRMR=0.054) indicating reasonable model fit.

Modification: Allowing items 12, 14, 29, 38, and 42 to freely associate with any available content standard did not result in a significant expected improvement in model fit for the implied model (maximum chi-square change = 0.43%). Item 19, however, yielded an expected loading of 0.386 on the "Number, Number Sense, and Operations" content standard (expected reduction in chi-square = 0.54%); Item 30 is expected to load 0.592 on "Geometry," reducing chi-square by an expected 0.56%.

Writing

Grade 4 Writing: Table A-13 presents the standardized factor loadings for the grade 4 writing solution.

Base Model: All items load greater than 0.3 on the writing achievement factor. The base model meets the joint criteria (RMSEA = 0.025; SRMR = 0.051), indicating reasonable model fit.

Implied Model: The Writing Applications factor is defined by only two items, with the first item defining the factor most strongly. Items defining the Writing Conventions factor are generally moderately strong indicators of the underlying factor with no item loading less than .3 on the underlying factor. The second-order Writing Achievement factor is primarily defined by the Writing Application content standard factor due to the additional constraints imposed on the

model (see footnotes 1 and 2); the Writing Convention content standard loads only 0.814 on the second-order factor. The model meets the joint criteria (CFI=0.936, RMSEA=0.020 and SRMR=0.041) indicating reasonable model fit.

Grade 7 Writing: Table A-14 presents the standardized factor loadings for the grade 7 writing solution.

Base Model: One item loads less than 0.3 on the writing achievement factor; item 14 has a loading of 0.196. The base model meets the joint criteria (RMSEA = 0.042; SRMR = 0.097), indicating reasonable model fit.
Implied Model: As above in grade 4 writing, the Writing Applications factor is defined by only two items, with the second extended-answer item defining the factor most strongly. Items defining the Writing Conventions factor are generally moderately strong indicators of the underlying factor, with only Writing Process item 14 loading less than 0.3 on the underlying factor. All of the primary factor standards load above 0.9 on the second-order writing achievement factor. The model meets the joint criteria (CFI=0.955, RMSEA=0.040 and SRMR=0.088) indicating reasonable model fit.
Modification: Allowing item 14 to freely associate with any available content standard did not result in a significant expected improvement in model fit for the implied model (maximum chi-square change = 0.03%).

Science

Grade 5 Science: Standardized factor loadings for the grade 5 science solution are shown in Table A-15.

Base Model: Three items load less than 0.3 on Science Achievement. Item 10 has a loading of 0.140, item 13 has a loading of 0.224, and item 33 has a loading of 0.210. The base model meets the joint criteria (RMSEA = 0.014; SRMR = 0.024), indicating reasonable model fit.
Implied Model: Although average item loadings are generally at the same level as in the other grades, three items have loadings below 0.3 on their intended factor. Item 10 has a loading of only 0.141, item 13 has a loading of 0.225, and item 33 has a loading of 0.211, all on the Life Science factor. The four primary factor standards load above 0.9 on the second-order science

achievement factor. The model meets the joint criteria (CFI=0.892, RMSEA=0.013 and SRMR=0.023) indicating reasonable model fit.
Modification: Allowing items 10, 13, and 33 to freely associate with any available content standard did not result in a significant expected improvement in model fit for the implied model (maximum chi-square change = 0.07%).

Grade 8 Science: Standardized factor loadings for the grade 8 science solution are shown in Table A-16.

Base Model: Although average item loadings are generally at the same level as in the other grades, one item has a loading below 0.3 on Science Achievement. Item 3 loads 0.197 on the science achievement factor. The base model meets the joint criteria (RMSEA = 0.019; SRMR = 0.038), indicating reasonable model fit.
Implied Model: Similar to the base model, item 3 has a loading of 0.198 on the Scientific Processes factor under the implied model. The four primary factor standards load above 0.9 on the second-order science achievement factor. The model meets the joint criteria (CFI=0.851, RMSEA=0.019 and SRMR=0.038) indicating reasonable model fit.
Modification: Allowing item 3 to freely associate with any available content standard did not result in a significant expected improvement in model fit for the implied model (maximum chi-square change = 0.11%).

Social Studies

Grade 5 Social Studies: Standardized factor loadings for the grade 5 social studies solution are shown in Table A-17.

Base Model: Although average item loadings are generally at the same level as in the other subjects and grades, several items have loadings below 0.3 on Social Studies Achievement. Item 2 has a loading of 0.266, item 1 has a loading of 0.226, item 19 has a loading of 0.264, item 22 has a loading of 0.253, and item 25 has a loading of 0.273. The base model meets the joint criteria (RMSEA = 0.017; SRMR = 0.030), indicating reasonable model fit.
Implied Model: Similar to the base model, five items load less than 0.3 on their intended factor. Item 2 has a loading of 0.272 on the Economics, Government, and Citizenship factor; item 1

loads weakly on the People in Societies and Geography factor; items 19 and 22 load below 0.30 on the History first-order factor; and item 25 has a loading of 0.274 on the Social Studies Skills and Methods factor. The four primary factor standards load above 0.9 on the second-order social studies achievement factor. The model meets the joint criteria (CFI=0.827, RMSEA=0.017 and SRMR=0.029) indicating reasonable model fit.
Modification: Allowing items 1, 2, 19, and 22 to freely associate with any available content standard did not result in a significant expected improvement in model fit for the implied model (maximum chi-square change = 0.98%). Item 25 produced an expected loading of 0.972 on Economics, Government, and Citizenship factor, reducing chi-square by an expected 0.33%.

Grade 8 Social Studies: Standardized factor loadings for the grade 8 social studies solution are shown in Table A-18.

Base Model: Item loadings are generally greater than 0.3 on Social Studies Achievement, with the exception of item 40 which has a loading of 0.187. The base model meets the joint criteria (RMSEA = 0.016; SRMR = 0.028), indicating reasonable model fit.
Implied Model: Similar to the base model, item 40 loaded 0.187 on the Economics, Government, and Citizenship factor. The four primary factor standards load above 0.9 on the second-order social studies achievement factor. The model meets the joint criteria (CFI=0.879, RMSEA=0.016 and SRMR=0.028) indicating reasonable model fit.
Modification: Allowing item 40 to freely associate with any available content standard did not result in a significant expected improvement in model fit for the implied model (maximum chi-square change = 0.89%).

Fit Summary

Tables 4a and 4b summarize model-fit indices for the one factor models and second-order factor models, described in-text above for each subject and grade. All models are shown to meet the joint criteria as specified by Hu and Bentler (1999); each subject-by-grade produced Standardized Root-Mean-Squared Residuals (SRMR) less than 0.10 and Root Mean Square Error of Approximation (RMSEA) less than 0.06. Table 5 presents the chi-square statistics for each grade and subject representing the difference between the chi-squares obtained from the base, one-factor model and the implied, second-order model. The column *DF* indicates the degrees of

freedom – the difference between the number of parameters estimated in the base model and the implied model. The last column presents the critical value from the chi-square distribution corresponding to an alpha of 0.05, given the degrees of freedom in the column *DF*. Significant results indicate that data support the validity of the second-order model with regards to the validity of the Ohio Achievement Test content standards. The results displayed in Table 5 demonstrate that the second-order model fits significantly better than the one factor model.

Table 4a. Summary of Model Fit Statistics for the One Factor Models

		χ^2	**# of Free Parameters**	**CFI**	**RMSEA**	**SRMR**
G3	Reading	41622.9	37	0.929	0.022	0.042
	Math	14971.1	40	0.892	0.012	0.037
G4	Reading	22599.0	36	0.915	0.017	0.048
	Writing	6918.9	17	0.894	0.025	0.051
	Math	27537.8	40	0.851	0.017	0.039
G5	Reading	23265.6	37	0.875	0.017	0.037
	Math	24698.1	40	0.894	0.016	0.034
	Science	17044.7	38	0.885	0.014	0.024
	Social	26301.0	38	0.823	0.017	0.030
G6	Reading	26536.3	37	0.863	0.018	0.035
	Math	24153.5	39	0.888	0.016	0.033
G7	Reading	21378.9	36	0.895	0.016	0.033
	Writing	37490.5	19	0.949	0.042	0.097
	Math	40325.9	39	0.832	0.020	0.041
G8	Reading	27674.7	38	0.86	0.017	0.035
	Math	29745.8	38	0.886	0.018	0.033
	Science	33869.2	38	0.848	0.019	0.038
	Social	23621.2	38	0.877	0.016	0.028

Table 4b. Summary of Model Fit Statistics for the Second-Order Models

		χ^2	# of Free Parameters	CFI	RMSEA	SRMR
G3	Reading	39840.0	41	0.932	0.022	0.038
	Math	14164.0	45	0.898	0.012	0.035
G4	Reading	21825.4	40	0.948	0.017	0.046
	Writing	6153.6	18	0.936	0.02	0.041
	Math	25849.4	45	0.86	0.016	0.037
G5	Reading	21656.9	41	0.884	0.016	0.035
	Math	24017.7	45	0.897	0.016	0.033
	Science	16076.9	42	0.892	0.013	0.023
	Social	25668.2	42	0.827	0.017	0.029
G6	Reading	25991.0	41	0.865	0.017	0.035
	Math	22936.3	44	0.894	0.015	0.032
G7	Reading	21073.6	40	0.897	0.016	0.033
	Writing	33578.9	22	0.955	0.04	0.088
	Math	39518.8	44	0.835	0.02	0.04
G8	Reading	27620.6	42	0.861	0.017	0.035
	Math	28059.1	43	0.893	0.017	0.032
	Science	33302.6	42	0.851	0.019	0.038
	Social	23386.3	42	0.879	0.016	0.028

Table 5. Summary of Likelihood Ratio Test Between One-Factor and Second-Order Models

		χ^2	DF	Critical Value
G3	Reading	1782.899	4	9.488
	Math	807.115	5	11.070
G4	Reading	773.617	4	9.488
	Writing	765.316	1	3.841
	Math	1688.412	5	11.070
G5	Reading	1608.785	4	9.488
	Math	680.447	5	11.070
	Science	967.787	4	9.488
	Social	632.755	4	9.488
G6	Reading	545.240	4	9.488
	Math	1217.131	5	11.070
G7	Reading	305.316	4	9.488
	Writing	3911.523	3	7.815
	Math	807.086	5	11.070
G8	Reading	54.094	4	9.488
	Math	1686.680	5	11.070
	Science	566.591	4	9.488
	Social	234.836	4	9.488

Note: all $\chi 2$ values are significant at $\alpha = 0.05$.

Conclusion

This report describes the results of analyses designed to investigate the internal structure of the Ohio Achievement Tests across subjects and grade levels. In addition to defining the curricular content that Ohio students are expected to achieve, the Ohio Academic Content Standards define a structure of academic achievement in each core academic subject area. Reading achievement is defined by four content standards: Acquisition of Vocabulary, Reading Process, Reading Applications: Literary Text, and Reading Application: Informational, Technical and Persuasive Text. Student skills in these four content standards are posited to underlie academic achievement in reading more generally. Similarly for writing, mathematics, science, and social studies, student skills in the content standards are posited to underlie student academic achievement in the given subject area generally, with high-achieving students demonstrating proficiency across content standards.

Across grades tested, for all subjects, the structural models defined by the Ohio Academic Content Standards fit the data well. Although items within a subject area are intercorrelated, each item on the test serves as an indicator for primarily one content standard, and items defining each content standard generally load moderately strongly on the intended content standard factor. In turn, the content standards defining the broad subject areas of reading, mathematics, writing, science and social studies achievement load extremely highly on the intended subject area achievement factor. The joint fit criteria proposed by Hu and Bentler (1999) indicate good fit ($CFI > .96$ and $SRMR \leq 0.10$ or $SRMR \leq 0.10$ and $RMSEA \leq 0.06$) of the Ohio Academic Content Standard achievement models to the achievement test data.

In summary, the structure of the Ohio Achievement Tests in reading, mathematics, writing, science and social studies conforms to the associated structural model of achievement as defined in the Ohio Academic Content Standards. These results support the validity of the structural model for both the achievement tests and the overall standards framework.

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Appendix: Standardized Factor Loading Tables by Subject and Grade

Table A-1. Standardized Factor Loading — Grade 3 Reading

	AV	IT	LT	RP	Reading Achievement
Item 1	0.865				0.865
Item 2	0.876				0.877
Item 3	0.9				0.900
Item 4	0.925				0.923
Item 5	0.665				0.666
Item 14	0.861				0.862
Item 19	0.589				0.591
Item 21	0.762				0.764
Item 27	0.729				0.731
Item 41	0.504				0.506
Item 9		0.722			0.724
Item 11		0.479			0.483
Item 12		0.77			0.772
Item 13		0.669			0.671
Item 15		0.706			0.706
Item 39		0.646			0.648
Item 40		0.631			0.631
Item 42		0.634			0.637
Item 16			0.93		0.923
Item 18			0.6		0.598
Item 23			0.738		0.738
Item 25			0.709		0.709
Item 26			0.687		0.688
Item 30			0.884		0.881
Item 31			0.781		0.779
Item 7				0.893	0.886
Item 8				0.808	0.806
Item 10				0.71	0.706
Item 17				0.76	0.757
Item 20				0.777	0.774
Item 22				0.728	0.724
Item 24				0.724	0.721
Item 28				0.867	0.863
Item 29				0.864	0.860
Item 37				0.573	0.572
Item 38				0.752	0.749
Item 43				0.669	0.666
AV					0.980
IT					1.000
LT					0.996
RP					0.991

**Note: AV = Acquisition of Vocabulary; IT = Informational Text; LT = Literary Text; RP = Reading Process.*

Table A-2. Standardized Factor Loading — Grade 4 Reading

	AV	IT	LT	RP	Reading Achievement
Item 5	0.48				0.471
Item 6	0.716				0.706
Item 8	0.737				0.726
Item 15	0.62				0.608
Item 17	0.462				0.454
Item 27	0.58				0.571
Item 36	0.652				0.641
Item 42	0.65				0.638
Item 7		0.546			0.544
Item 9		0.433			0.43
Item 12		0.552			0.549
Item 13		0.708			0.704
Item 24		0.744			0.739
Item 25		0.77			0.766
Item 26		0.706			0.702
Item 2			0.57		0.568
Item 3			0.688		0.686
Item 19			0.718		0.715
Item 20			0.447		0.447
Item 34			0.752		0.75
Item 38			0.794		0.791
Item 39			0.751		0.749
Item 40			0.682		0.679
Item 1				0.396	0.396
Item 4				0.688	0.687
Item 10				0.719	0.718
Item 11				0.439	0.439
Item 14				0.398	0.399
Item 16				0.527	0.527
Item 18				0.639	0.638
Item 21				0.681	0.679
Item 22				0.665	0.665
Item 23				0.702	0.701
Item 35				0.482	0.482
Item 37				0.787	0.785
Item 41				0.685	0.684
AV					0.974
IT					0.989
LT					0.991
RP					0.997

**Note: AV = Acquisition of Vocabulary; IT = Informational Text; LT = Literary Text; RP = Reading Process.*

Table A-3. Standardized Factor Loading — Grade 5 Reading

	AV	IT	LT	RP	Reading Achievement
Item 5	0.633				0.619
Item 6	0.524				0.513
Item 9	0.652				0.638
Item 11	0.781				0.763
Item 12	0.483				0.473
Item 17	0.511				0.503
Item 27	0.591				0.581
Item 36	0.412				0.403
Item 40	0.363				0.356
Item 13		0.608			0.596
Item 14		0.525			0.517
Item 15		0.632			0.625
Item 22		0.66			0.648
Item 24		0.568			0.555
Item 26		0.693			0.680
Item 28		0.653			0.637
Item 1			0.614		0.616
Item 4			0.408		0.409
Item 16			0.664		0.664
Item 18			0.407		0.407
Item 21			0.505		0.505
Item 35			0.752		0.751
Item 37			0.486		0.486
Item 39			0.518		0.518
Item 43			0.758		0.757
Item 2				0.355	0.355
Item 3				0.578	0.579
Item 7				0.501	0.501
Item 8				0.621	0.622
Item 10				0.647	0.646
Item 19				0.631	0.634
Item 20				0.68	0.680
Item 23				0.654	0.653
Item 25				0.522	0.522
Item 38				0.81	0.810
Item 41				0.638	0.637
Item 42				0.678	0.677
AV					0.964
IT					0.960
LT					1.000
RP					1.000

**Note: AV = Acquisition of Vocabulary; IT = Informational Text; LT = Literary Text; RP = Reading Process.*

Table A-4. Standardized Factor Loading — Grade 6 Reading

	AV	IT	LT	RP	Reading Achievement
Item 6	0.572				0.566
Item 9	0.377				0.373
Item 12	0.552				0.543
Item 18	0.589				0.580
Item 22	0.578				0.570
Item 28	0.542				0.534
Item 37	0.741				0.730
Item 43	0.527				0.519
Item 10		0.524			0.523
Item 11		0.641			0.640
Item 26		0.746			0.744
Item 27		0.511			0.509
Item 38		0.35			0.349
Item 39		0.717			0.714
Item 40		0.533			0.531
Item 41		0.712			0.709
Item 42		0.577			0.575
Item 2			0.498		0.494
Item 3			0.327		0.323
Item 4			0.598		0.592
Item 5			0.654		0.648
Item 8			0.555		0.549
Item 14			0.444		0.440
Item 15			0.537		0.533
Item 16			0.452		0.448
Item 17			0.594		0.589
Item 19			0.624		0.619
Item 21			0.357		0.354
Item 1				0.609	0.608
Item 7				0.332	0.332
Item 13				0.54	0.539
Item 20				0.543	0.542
Item 23				0.474	0.473
Item 24				0.432	0.432
Item 25				0.321	0.321
Item 35				0.544	0.543
Item 36				0.709	0.708
AV					0.979
IT					0.996
LT					0.982
RP					1.000

**Note: AV = Acquisition of Vocabulary; IT = Informational Text; LT = Literary Text; RP = Reading Process.*

Table A-5. Standardized Factor Loading — Grade 7 Reading

	AV	IT	LT	RP	Reading Achievement
Item 2	0.549				0.548
Item 3	0.577				0.576
Item 10	0.698				0.697
Item 16	0.453				0.452
Item 20	0.686				0.685
Item 27	0.723				0.722
Item 37	0.546				0.546
Item 1		0.525			0.522
Item 5		0.699			0.695
Item 7		0.718			0.714
Item 8		0.668			0.664
Item 14		0.588			0.585
Item 15		0.587			0.583
Item 17		0.726			0.722
Item 18		0.675			0.672
Item 19		0.438			0.436
Item 23		0.656			0.652
Item 25		0.574			0.571
Item 26		0.627			0.625
Item 11			0.277		0.276
Item 12			0.224		0.222
Item 13			0.572		0.570
Item 35			0.603		0.599
Item 36			0.624		0.620
Item 38			0.649		0.645
Item 41			0.522		0.519
Item 42			0.406		0.403
Item 4				0.383	0.383
Item 6				0.334	0.334
Item 9				0.357	0.357
Item 21				0.626	0.625
Item 22				0.607	0.606
Item 24				0.632	0.632
Item 34				0.753	0.752
Item 39				0.607	0.606
Item 40				0.693	0.691
AV					1.000
IT					0.986
LT					0.993
RP					1.000

**Note: AV = Acquisition of Vocabulary; IT = Informational Text; LT = Literary Text; RP = Reading Process.*

Table A-6. Standardized Factor Loading — Grade 8 Reading

	AV	IT	LT	RP	Reading Achievement
Item 2	0.685				0.682
Item 5	0.610				0.608
Item 11	0.378				0.377
Item 18	0.582				0.580
Item 25	0.621				0.619
Item 41	0.684				0.681
Item 42	0.496				0.495
Item 10		0.383			0.382
Item 12		0.634			0.633
Item 14		0.647			0.647
Item 15		0.774			0.773
Item 17		0.495			0.494
Item 20		0.531			0.530
Item 21		0.492			0.491
Item 22		0.516			0.515
Item 24		0.593			0.592
Item 37		0.333			0.332
Item 38		0.440			0.440
Item 39		0.339			0.339
Item 43		0.450			0.450
Item 1			0.480		0.478
Item 3			0.686		0.683
Item 6			0.723		0.720
Item 7			0.436		0.435
Item 8			0.495		0.494
Item 26			0.370		0.368
Item 27			0.639		0.637
Item 28			0.735		0.733
Item 29			0.551		0.549
Item 4				0.744	0.744
Item 9				0.615	0.615
Item 13				0.619	0.619
Item 16				0.662	0.661
Item 19				0.320	0.320
Item 23				0.704	0.704
Item 30				0.568	0.568
Item 40				0.316	0.316
Item 44				0.615	0.614
AV					0.995
IT					0.999
LT					0.994
RP					1.000

**Note: AV = Acquisition of Vocabulary; IT = Informational Text; LT = Literary Text; RP = Reading Process.*

Table A-7. Standardized Factor Loading — Grade 3 Mathematics

	DA	G	M	NN	PF	Mathematics Achievement
Item 4	0.543					0.536
Item 8	0.688					0.681
Item 13	0.786					0.779
Item 20	0.604					0.596
Item 32	0.529					0.523
Item 36	0.438					0.432
Item 41	0.762					0.752
Item 6		0.536				0.522
Item 9		0.65				0.633
Item 14		0.344				0.333
Item 17		0.637				0.621
Item 31		0.59				0.575
Item 35		0.635				0.618
Item 39		0.319				0.312
Item 45		0.592				0.576
Item 1			0.772			0.775
Item 5			0.582			0.582
Item 11			0.695			0.696
Item 27			0.582			0.583
Item 30			0.45			0.451
Item 38			0.513			0.513
Item 44			0.659			0.661
Item 2				0.573		0.572
Item 7				0.415		0.416
Item 10				0.621		0.620
Item 16				0.687		0.686
Item 19				0.653		0.653
Item 29				0.52		0.520
Item 33				0.64		0.638
Item 37				0.666		0.666
Item 40				0.451		0.451
Item 43				0.658		0.659
Item 46				0.454		0.453
Item 3					0.763	0.760
Item 12					0.462	0.459
Item 15					0.629	0.624
Item 18					0.608	0.603
Item 28					0.654	0.651
Item 34					0.423	0.421
Item 42					0.645	0.639

	DA	G	M	NN	PF	Mathematics Achievement
DA						0.979
G						0.957
M						1.000
NN						0.998
PF						0.989

**Note: DA = Data Analysis & Probability; G = Geometry; M = Measurement; NN = Number, Number Sense & Operation; PF = Patterns, Functions, & Algebra.*

Table A-8. Standardized Factor Loading — Grade 4 Mathematics

	DA	G	M	NN	PF	Mathematics Achievement
Item 2	0.515					0.517
Item 8	0.565					0.562
Item 15	0.745					0.745
Item 28	0.179					0.177
Item 32	0.556					0.556
Item 35	0.543					0.542
Item 38	0.541					0.541
Item 44	0.816					0.815
Item 5		0.497				0.478
Item 9		0.410				0.393
Item 11		0.682				0.655
Item 17		0.602				0.580
Item 34		0.339				0.328
Item 39		0.527				0.508
Item 42		0.614				0.588
Item 4			0.352			0.342
Item 12			0.682			0.671
Item 18			0.497			0.486
Item 30			0.519			0.509
Item 33			0.622			0.610
Item 41			0.480			0.473
Item 1				0.612		0.605
Item 6				0.648		0.641
Item 10				0.639		0.634
Item 14				0.441		0.435
Item 16				0.561		0.556
Item 19				0.410		0.407
Item 27				0.549		0.550
Item 29				0.637		0.633
Item 31				0.685		0.679
Item 36				0.524		0.519
Item 40				0.703		0.701
Item 43				0.691		0.685
Item 46				0.593		0.587
Item 3					0.412	0.414
Item 7					0.625	0.621
Item 13					0.667	0.663
Item 20					0.702	0.695
Item 37					0.551	0.546
Item 45					0.668	0.663

	DA	G	M	NN	PF	Mathematics Achievement
DA						1.000
G						0.946
M						0.976
NN						0.973
PF						0.989

**Note: DA = Data Analysis & Probability; G = Geometry; M = Measurement; NN = Number, Number Sense & Operation; PF = Patterns, Functions, & Algebra.*

Table A-9. Standardized Factor Loading — Grade 5 Mathematics

	DA	G	M	NN	PF	Mathematics Achievement
Item 3	0.591					0.634
Item 6	0.360					0.744
Item 12	0.548					0.464
Item 17	0.662					0.571
Item 33	0.630					0.722
Item 41	0.565					0.551
Item 4		0.347				0.590
Item 11		0.468				0.506
Item 15		0.777				0.706
Item 19		0.653				0.676
Item 31		0.523				0.192
Item 38		0.681				0.573
Item 43		0.501				0.626
Item 1			0.616			0.537
Item 8			0.446			0.548
Item 13			0.624			0.646
Item 20			0.677			0.637
Item 30			0.194			0.629
Item 34			0.474			0.629
Item 37			0.584			0.606
Item 2				0.637		0.360
Item 7				0.540		0.562
Item 10				0.508		0.613
Item 14				0.709		0.662
Item 18				0.681		0.485
Item 28				0.761		0.519
Item 32				0.726		0.465
Item 35				0.475		0.675
Item 39				0.765		0.565
Item 42				0.628		0.498
Item 44				0.352		0.623
Item 46				0.516		0.345
Item 5					0.750	0.439
Item 9					0.565	0.770
Item 16					0.575	0.663
Item 27					0.487	0.758
Item 29					0.642	0.473
Item 36					0.633	0.761
Item 40					0.554	0.351
Item 45					0.627	0.439

	DA	G	M	NN	PF	Mathematics Achievement
DA						1.000
G						0.989
M						0.976
NN						0.988
PF						0.99

**Note: DA = Data Analysis & Probability; G = Geometry; M = Measurement; NN = Number, Number Sense & Operation; PF = Patterns, Functions, & Algebra.*

Table A-10. Standardized Factor Loading — Grade 6 Mathematics

	DA	G	M	NN	PF	Mathematics Achievement
Item 4	0.484					0.482
Item 10	0.432					0.430
Item 14	0.553					0.549
Item 21	0.643					0.639
Item 35	0.614					0.610
Item 39	0.532					0.530
Item 1		0.614				0.601
Item 12		0.681				0.665
Item 17		0.460				0.451
Item 29		0.670				0.654
Item 33		0.591				0.578
Item 38		0.593				0.580
Item 41		0.671				0.658
Item 45		0.373				0.366
Item 5			0.628			0.618
Item 9			0.641			0.632
Item 16			0.729			0.717
Item 20			0.442			0.438
Item 30			0.623			0.614
Item 34			0.601			0.593
Item 43			0.591			0.582
Item 2				0.652		0.652
Item 7				0.406		0.406
Item 11				0.693		0.692
Item 15				0.622		0.622
Item 18				0.437		0.437
Item 32				0.717		0.715
Item 36				0.495		0.494
Item 40				0.609		0.609
Item 44				0.608		0.608
Item 3					0.662	0.659
Item 6					0.728	0.725
Item 8					0.669	0.667
Item 13					0.593	0.591
Item 19					0.416	0.415
Item 28					0.536	0.533
Item 31					0.676	0.673
Item 37					0.740	0.737
Item 42					0.371	0.370

	DA	G	M	NN	PF	Mathematics Achievement
DA						0.992
G						0.965
M						0.976
NN						1.000
PF						0.994

**Note: DA = Data Analysis & Probability; G = Geometry; M = Measurement; NN = Number, Number Sense & Operation; PF = Patterns, Functions, & Algebra.*

Table A-11. Standardized Factor Loading — Grade 7 Mathematics

	DA	G	M	NN	PF	Mathematics Achievement
Item 3	-0.137					-0.136
Item 19	0.556					0.552
Item 21	0.717					0.710
Item 33	0.447					0.443
Item 34	0.402					0.398
Item 38	0.639					0.633
Item 42	0.274					0.270
Item 2		0.371				0.368
Item 6		0.569				0.563
Item 9		0.593				0.587
Item 12		0.661				0.655
Item 15		0.466				0.462
Item 18		0.077				0.077
Item 32		0.369				0.366
Item 39		0.47				0.466
Item 44		0.521				0.516
Item 5			0.656			0.650
Item 13			0.447			0.445
Item 28			0.574			0.568
Item 30			0.435			0.433
Item 31			0.705			0.699
Item 35			0.463			0.460
Item 41			0.795			0.787
Item 43			0.408			0.404
Item 1				0.606		0.598
Item 7				0.489		0.483
Item 10				0.359		0.355
Item 16				0.819		0.808
Item 20				0.49		0.487
Item 36				0.72		0.713
Item 40				0.567		0.560
Item 45				0.672		0.664
Item 4					0.336	0.330
Item 8					0.063	0.063
Item 11					0.598	0.586
Item 14					0.646	0.635
Item 17					0.147	0.144
Item 29					0.576	0.566
Item 37					0.164	0.162

	DA	G	M	NN	PF	Mathematics Achievement
DA						0.991
G						0.991
M						0.987
NN						0.978
PF						0.981

**Note: DA = Data Analysis & Probability; G = Geometry; M = Measurement; NN = Number, Number Sense & Operation; PF = Patterns, Functions, & Algebra.*

Table A-12. Standardized Factor Loading — Grade 8 Mathematics

	DA	G	M	NN	PF	Mathematics Achievement
Item 4	0.329					0.332
Item 9	0.596					0.606
Item 14	0.299					0.296
Item 21	0.818					0.821
Item 34	0.449					0.455
Item 39	0.701					0.716
Item 3		0.538				0.555
Item 8		0.460				0.459
Item 11		0.725				0.706
Item 15		0.598				0.597
Item 20		0.640				0.621
Item 32		0.629				0.635
Item 36		0.694				0.662
Item 40		0.530				0.541
Item 1			0.511			0.510
Item 6			0.791			0.739
Item 12			0.246			0.233
Item 17			0.352			0.348
Item 29			0.242			0.228
Item 37			0.336			0.338
Item 42			0.263			0.252
Item 2				0.515		0.513
Item 7				0.575		0.556
Item 18				0.654		0.684
Item 28				0.739		0.716
Item 31				0.668		0.630
Item 35				0.466		0.475
Item 43				0.615		0.633
Item 5					0.695	0.698
Item 10					0.324	0.323
Item 13					0.558	0.562
Item 16					0.752	0.758
Item 19					0.064	0.068
Item 30					0.181	0.164
Item 33					0.486	0.498
Item 38					0.117	0.115
Item 41					0.559	0.570
Item 44					0.440	0.438

	DA	G	M	NN	PF	Mathematics Achievement
DA						0.988
G						0.975
M						0.963
NN						0.945
PF						0.988

**Note: DA = Data Analysis & Probability; G = Geometry; M = Measurement; NN = Number, Number Sense & Operation; PF = Patterns, Functions, & Algebra.*

Table A-13. Standardized Factor Loadings — Grade 4 Writing Two-Factor Model

	Writing Applications	Writing Conventions	Writing Achievement
Item 1	0.654		0.593
Item 17	0.671		0.579
Item 2		0.680	0.660
Item 3		0.647	0.658
Item 4		0.708	0.697
Item 5		0.703	0.697
Item 6		0.560	0.567
Item 7		0.446	0.466
Item 8		0.405	0.416
Item 9		0.598	0.572
Item 10		0.522	0.502
Item 11		0.624	0.603
Item 12		0.848	0.846
Item 13		0.810	0.815
Item 14		0.383	0.358
Item 15		0.680	0.680
Item 16		0.620	0.600
Writing Applications			1.000
Writing Conventions			0.814

Table A-14. Standardized Factor Loadings — Grade 7 Writing One-Factor Model

	Writing Applications	Writing Conventions	Writing Process	Writing Achievement
Item 1	0.833			0.823
Item 18	0.870			0.855
Item 2		0.906		0.901
Item 3		0.372		0.376
Item 6		0.507		0.508
Item 12		0.485		0.487
Item 15		0.662		0.663
Item 17		0.749		0.745
Item 19		0.928		0.923
Item 4			0.346	0.334
Item 5			0.600	0.580
Item 7			0.582	0.560
Item 8			0.511	0.495
Item 9			0.599	0.578
Item 10			0.750	0.727
Item 11			0.747	0.724
Item 13			0.564	0.545
Item 14			0.203	0.196
Item 16			0.736	0.714
Writing Applications				0.970
Writing Conventions				1.000
Writing Process				0.919

Table A-15. Standardized Factor Loading — Grade 5 Science

	ES	LS	PS	SP	Science Achievement
Item 6	0.617				0.611
Item 7	0.477				0.473
Item 15	0.478				0.474
Item 23	0.575				0.570
Item 34	0.493				0.490
Item 39	0.411				0.408
Item 40	0.440				0.436
Item 41	0.395				0.391
Item 42	0.643				0.638
Item 43	0.696				0.690
Item 2		0.494			0.487
Item 3		0.543			0.534
Item 4		0.663			0.654
Item 5		0.510			0.503
Item 14		0.597			0.589
Item 24		0.668			0.658
Item 36		0.629			0.620
Item 38		0.542			0.535
Item 44		0.546			0.538
Item 1			0.525		0.520
Item 9			0.617		0.611
Item 10			0.141		0.140
Item 12			0.558		0.552
Item 13			0.225		0.224
Item 25			0.624		0.617
Item 27			0.569		0.562
Item 28			0.610		0.604
Item 33			0.211		0.210
Item 35			0.489		0.484
Item 8				0.456	0.449
Item 11				0.562	0.555
Item 16				0.484	0.476
Item 26				0.615	0.607
Item 29				0.342	0.338
Item 30				0.684	0.675
Item 31				0.633	0.625
Item 32				0.545	0.538
Item 37				0.503	0.498
ES					0.987
LS					0.976
PS					0.986
SP					0.978

**Note: ES = Earth and Space Sciences; LS = Life Sciences; PS = Physical Sciences; SP = Scientific Processes.*

Table A-16. Standardized Factor Loading — Grade 8 Science

	ES	LS	PS	SP	Science Achievement
Item 7	0.495				0.495
Item 8	0.551				0.550
Item 11	0.609				0.608
Item 12	0.569				0.568
Item 24	0.522				0.521
Item 30	0.304				0.304
Item 37	0.628				0.627
Item 40	0.351				0.350
Item 42	0.721				0.720
Item 44	0.613				0.612
Item 2		0.558			0.552
Item 14		0.539			0.533
Item 23		0.668			0.660
Item 25		0.658			0.650
Item 27		0.642			0.635
Item 28		0.643			0.636
Item 29		0.458			0.452
Item 35		0.470			0.465
Item 36		0.587			0.580
Item 39		0.491			0.485
Item 41		0.331			0.552
Item 1			0.413		0.328
Item 5			0.378		0.412
Item 6			0.516		0.377
Item 13			0.442		0.516
Item 15			0.647		0.441
Item 26			0.765		0.645
Item 31			0.417		0.763
Item 34			0.619		0.417
Item 43			0.671		0.617
Item 3				0.198	0.197
Item 4				0.352	0.351
Item 9				0.467	0.464
Item 10				0.666	0.661
Item 16				0.598	0.594
Item 32				0.562	0.557
Item 33				0.604	0.599
Item 38				0.756	0.749
ES					1.000
LS					0.978
PS					0.999
SP					0.988

**Note: ES = Earth and Space Sciences; LS = Life Sciences; PS = Physical Sciences; SP = Scientific Processes.*

Table A-17. Standardized Factor Loading — Grade 5 Social Studies

	EG	PS	H	SS	Social Studies Achievement
Item 2	0.272				0.266
Item 3	0.311				0.307
Item 6	0.444				0.441
Item 7	0.423				0.418
Item 9	0.613				0.610
Item 15	0.377				0.373
Item 23	0.670				0.666
Item 37	0.544				0.539
Item 40	0.662				0.654
Item 41	0.375				0.370
Item 42	0.420				0.416
Item 1		0.228			0.226
Item 8		0.515			0.513
Item 10		0.417			0.415
Item 18		0.678			0.674
Item 20		0.402			0.401
Item 27		0.446			0.444
Item 35		0.412			0.410
Item 38		0.627			0.624
Item 44		0.518			0.516
Item 5			0.487		0.478
Item 11			0.421		0.415
Item 12			0.610		0.595
Item 14			0.615		0.603
Item 17			0.367		0.363
Item 19			0.268		0.264
Item 22			0.255		0.253
Item 24			0.370		0.364
Item 26			0.674		0.659
Item 39			0.411		0.405
Item 4				0.365	0.365
Item 13				0.505	0.503
Item 16				0.584	0.582
Item 21				0.608	0.605
Item 25				0.274	0.273
Item 34				0.640	0.637
Item 36				0.513	0.510
Item 43				0.531	0.529
EG					0.986
PS					0.996
H					0.965
SS					0.996

**Note: EG = Economics, Government, and Citizenship; PS = People in Societies and Geography; H = History; SS = Social Studies Skills and Methods.*

Table A-18. Standardized Factor Loading — Grade 8 Social Studies

	EG	PS	H	SS	Social Studies Achievement
Item 1	0.655				0.654
Item 2	0.293				0.292
Item 4	0.311				0.311
Item 12	0.625				0.625
Item 14	0.590				0.589
Item 15	0.534				0.534
Item 18	0.487				0.486
Item 27	0.423				0.423
Item 34	0.651				0.651
Item 38	0.584				0.584
Item 40	0.187				0.187
Item 44	0.458				0.458
Item 6		0.695			0.694
Item 8		0.489			0.488
Item 9		0.750			0.749
Item 11		0.584			0.582
Item 17		0.738			0.736
Item 20		0.586			0.585
Item 22		0.400			0.399
Item 35		0.463			0.462
Item 41		0.422			0.422
Item 5			0.608		0.608
Item 10			0.457		0.457
Item 13			0.421		0.421
Item 19			0.686		0.685
Item 23			0.574		0.573
Item 25			0.335		0.335
Item 26			0.600		0.599
Item 39			0.661		0.660
Item 42			0.391		0.391
Item 43			0.600		0.599
Item 3				0.627	0.619
Item 7				0.573	0.565
Item 16				0.470	0.464
Item 21				0.682	0.673
Item 24				0.636	0.628
Item 36				0.415	0.409
Item 37				0.458	0.452
EG					1.000
PS					0.997
H					1.000
SS					0.978

**Note: EG = Economics, Government, and Citizenship; PS = People in Societies and Geography; H = History; SS = Social Studies Skills and Methods.*