Defining Postsecondary Expectations for Mathematics in Nevada

As recommended in the American Diploma Project (ADP) legal research report, the ADP asked members of the postsecondary community in Nevada to define their expectations of high school graduates (related to admissions and placement decisions), to comment on what is now expected of high school students for graduation in the commonwealth, and to identify the gaps that may exist between those different sets of expectations. The ADP's gap-analysis work consists of two parts. **Part one** focused on an analysis of the content of high school exit and college entrance/placement assessments; **part two** focused on defining postsecondary expectations and determining the degree to which current ADP state standards and assessments reflect those expectations.

In **part one,** the Education Trust assembled English Language Arts (ELA) and mathematics faculty members from K-12 systems and from two- and four-year colleges in the five ADP partner states (Indiana, Kentucky, Massachusetts, Nevada, and Texas). At these meetings, the faculty members examined the content of partner-state high school graduation assessments, national college admissions and placement tests (i.e., SAT, ACT, COMPASS, Accuplacer), a sampling of postsecondary institutional placement tests, and the GED.

The results from part one comprise Education Trust's five state reports, reflecting the feedback received from faculty members to the aforementioned assessments, as well as the Education Trust's analytical "cross-state" report. These reports discuss the relative strengths and weaknesses of the assessments and how well each assessment might serve postsecondary institutions in making admissions and placement decisions. By examining individual test items, the faculty members were able to examine the breadth and depth of content coverage, as well as the types and quality of test items.[1] The first part of the gap-analysis work revealed that:

- Although Nevada's High School Proficiency Examination (HSPE) in Mathematics is administered in 11th grade, the reviewers stated that it does not adequately assess high school level mathematics. The gap between the mathematics needed to succeed in college and the mathematics content in the HSPE is too

[1] The Education Trust gap-analysis reports were circulated in 2002 and are available on the ADP website <http://www.americandiplomaproject.org/>.

great for it to be useful in its current form to postsecondary institutions for admissions or placement.

In **part two,** Achieve and ADP staff, using an assessment-to-standards alignment protocol developed by Achieve, conducted an alignment study of the HSPE assessments to the Nevada Content Standards. With the assessment-content analysis and the alignment studies complete, ADP staff met with faculty members from two- and four-year colleges in Indiana, representing a broad range of content areas (organized into the "ELA" and "Math" Teams) to:

1. define their expectations for incoming students,

2. prioritize their expectations for students, as may be contained in Indiana's Academic Standards,

3. determine the degree to which the current standards and assessments together reflect those expectations, and

4. identify any gaps (missing content) in the standards and assessments.

In this round of discussion, it was particularly helpful to have had a cross-section of faculty from the humanities, sciences and social sciences, since reading, writing and mathematics skills are necessary for success in all credit-bearing courses throughout college, not just English and mathematics.

Part One Findings (Mathematics): Assessment Content Analysis

While the reviewers commended the Nevada High School Proficiency Examination (HSPE) in Mathematics for emphasizing mathematical processes and assessing the students' procedural abilities, the scarcity of advanced high school mathematics on the current HSPE restricts its usefulness as a placement or admissions tool.

- Significant gaps exist between the content assessed by the HSPE and college expectations: the HSPE predominantly measures middle school and lower high school content.[2] The SAT I and the ACT also contain many items at the middle school level: 40 percent of the items in the case of the former and one third in the case of the latter.

- The HSPE contains a larger share of statistics and probability items (roughly 25 percent), and a smaller share of algebra items, than either the SAT I or the ACT. The SAT I and ACT are predominantly tests of algebra concepts and skills: 58 percent of the SAT I and 53 percent of the ACT are algebra items. The algebra content of the SAT I is, however, predominantly Algebra I, while the ACT is better balanced between Algebra I and II.

- The strengths of the SAT I are its emphasis on symbolic representations and students' reasoning abilities and its inclusion of more problem-solving items than the HSPE. The ACT and SAT I assess important mathematical skills and knowledge needed for college admissions and placement, but neither test assesses mathematical processes as well as the HSPE does.

Reviewers' policy recommendations:

In order to facilitate every student's transition from high school to college and placement in credit-bearing college level courses, the University and Community College System of Nevada and the Nevada Department of Education ought to collaborate to establish effective college admissions/placement criteria. These criteria might include specific minimum required high school mathematics courses, grade point averages, and scaled score for admissions or placement on subsequent versions of the HSPE. The fact that Nevada has a uniform system of higher education makes the implementation of this recommendation all the more possible.

[2] Reviewers did note, however, that much of the content gap (notably the lack of Algebra II on the graduation test) was a matter of the Nevada assessment system: until the 8th grade examination is implemented, the HSPE serves the dual purposes of assessing middle school and high school content.

Part Two Findings (Mathematics[3]): Definition of Postsecondary Expectations and Examination of Alignment among Standards, Assessments and Expectations

Part two of the postsecondary-expectations analysis began by Achieve, Inc. and ADP staff conducting an assessment-to-standards alignment study of the HSPE in Mathematics and the Nevada Grade 8 and Grade 12 Content Standards. [4] The alignment protocol used was designed by Achieve to determine the extent to which standards-based assessments actually assess the content standards that a state has defined for students. Following is a brief description of the Achieve protocol.[5]

The protocol considers four dimensions in its analysis of the degree of alignment between an assessment and a set of standards.

- ***Content centrality:*** This criterion provides a deeper analysis of the match between the content of each examination question and the content of the related standard by examining the degree or quality of the match. Reviewers assign each item to one of four categories based on the degree of alignment: "2" = clearly consistent; "1a" = not specific enough; "1b" = somewhat consistent; "0" = inconsistent.

- ***Performance centrality:*** This criterion focuses on the degree of the match between the type of performance (cognitive demand) presented by each examination item and the type of performance described by the related standard. Each item makes a certain type of cognitive demand on a student (e.g., the item requires a certain performance such as "select," "identify," "compare," or "analyze"). Reviewers assign each item to one of four categories based on the degree of alignment: "2" = clearly consistent; "1a" = not specific enough; "1b" = somewhat consistent; "0" = inconsistent.

- ***Challenge:*** This criterion is applied to a set of items to determine whether doing well on these items requires students to master challenging subject matter. Reviewers consider two factors in evaluating sets of examination items against the challenge criterion: *source* of challenge and *level* of challenge.

    - ***Source of challenge*** attempts to uncover whether the individual examination items in a set are difficult because of the knowledge and skills they target, or because of other reasons not related to the subject matter, such as relying unfairly on students' background knowledge. Reviewers rate each item as having an appropriate (1) or inappropriate (0) source of challenge.

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[3] See the enclosed, "Defining Postsecondary Expectations for Reading and Writing in Nevada," for the English Language Arts portion of the analysis from **part two**.

[4] The HSPE by design assesses some content from the grade eight standards.

[5] See the enclosed, "Benchmarking and Alignment of Standards and Testing, CSE Technical Report" for a complete description of the Achieve protocol.

- ***Level of challenge*** compares the emphasis of performance required by a *set* of items to the emphasis of performance described by the related standard. In addition to evaluating alignment, reviewers also judge whether the set of examination items has a span of difficulty appropriate for students at a given grade level based on the standards, the assessment and supporting materials. Reviewers assign each item to one of four categories indicating its type of cognitive demand: 4 = extended thinking; 3 = strategic thinking; 2 = skill/concept; 1 = recall.

- ***Balance and range****:* No one assessment can measure the full range of knowledge and skills described in the state standards. Evaluating balance and range provides both qualitative and quantitative descriptive information about the choices states or test developers have made.

  - ***Balance*** compares the emphasis of content supplied by an item *set* to the emphasis of content described by the standards. In addition to evaluating alignment, reviewers also judge whether the set of items emphasizes the more important content at the grade level. Reviewers write a succinct summary of the balance of each item set.

  - **Range** is a measure of coverage or breadth (the numerical proportion of all content addressed).

With the alignment study complete (*see appendices below for summary data for each of the above categories*), Achieve and ADP staff met with faculty members from two- and four-year colleges in Nevada, representing a range of content areas, for the following discussion.

Step One: Define Expectations for Incoming Students

Thinking more about what is actually needed, rather than bowing to the current state of student mathematics expertise, what follows is a list of minimum competencies/ concepts articulated by the Nevada Math Team for students entering **non-math-dependent fields** (these students would most likely take College Math Course 120)[6]:

1. Basic computational skills (with rational numbers)
   a. Arithmetic fluency
   b. Number theory (*e.g.,* prime numbers, greatest common denominator)
   c. Ratios, proportions and percents
   d. Concept of magnitude
   e. Concept of reasonableness of answers
2. Graphical fluency
   a. Reading and interpreting simple (*i.e.,* bar, line, circle) graphs

[6] Essentially, these students are expected to have mastered pre-algebra skills; Algebra I skills are "desirable."

    b. Understanding how graphs represent certain situations
3. Basic geometric concepts
    a. Pythagorean Theorem, parallelism, perpendicularity, congruence, similarity
    b. Basic measurement, including perimeter and area
    c. Polygons and circles
4. Basic algebra concepts
    a. Concepts of variable and function (implicit)
    b. Setting-up and solving simple linear equations
    c. Factoring polynomials
    d. Elementary pattern recognition
    e. Basic symbolic representation
    f. Concept of linear inequalities
5. Word problems
    a. Translate literal expressions into symbolic representation
    b. Translate symbolic representation into literal expressions

Again, thinking more about what is actually needed, rather than bowing to the current state of student mathematics expertise, what follows is a list of minimum competencies/ concepts (above and beyond those listed above) articulated by the Nevada Math Team for **math, science and engineering majors** (these students would most likely take Math Course 128):

1. Basic Computation
    a. Scientific notation, absolute value (numerical analysis)
    b. Dimensional analysis (*e.g.,* unit conversion) – to generalize
    c. Properties of real and complex numbers
    d. Computational skills with real and complex numbers
    e. Matrix arithmetic (engineering)
    f. Ability to use computing tools
2. Algebra I and II
    a. Manipulating and solving linear and literal equations
    b. Solving systems of linear equations (2 equations by 2 variables)
    c. Solving quadratic equations by factoring, quadratic formula, completing the square
    d. Solving other non-linear equations
    e. Graphing/interpreting graphs of
        i. linear equations and parabolas,
        ii. circles
        iii. slope and intercepts
    f. Analyzing functions represented symbolically, literally, by tables, and by graphs
        i. domain and range
3. Geometry
    a. Precision, tolerance, accuracy (measurement)

b. Basic area, volume and perimeter formulas for plane or solid quadrilaterals
    i. Write and explain the meaning of formulas
c. Deductive and inductive reasoning
d. Proofs/geometric reasoning
e. Right triangles, special right triangles

4. Conceptual understanding/solving complex word problems
    a. Ability to generalize, transfer understanding in one mathematical area to another
    b. Pattern recognition
    c. Logical reasoning
    d. Solving word problems (relevant to students' real world experiences)
    e. Recognition of insufficient/extraneous information

Step Two: Prioritize expectations for students, as reflected in the Nevada Content Standards

Question One: Are the competencies required for college-level work in a broad range of disciplines represented in the Nevada Mathematics Content Standards and Objectives?

Answer: The Math Team concluded that, yes, the Nevada mathematics Content Standards and objectives are comprehensive and contain most of the content that represents college readiness for *non-mathematics-dependent* fields.

- The team identified 88 percent of the objectives within the Content Standards to be either "important" or "vital" content for students to know in order to be college-ready.

- The team identified as missing from the standards Algebra II content vital to the preparation of students intending to study *mathematics* or *mathematics-dependent fields* in college.

Step Three: Determine the degree to which current Nevada Mathematics Content Standards and High School Proficiency Examination (HSPE) in Mathematics reflect postsecondary expectations

Question Two: How does the standards balance/emphasis of the HSPE in Mathematics compare to the emphasis that the college personnel place on the knowledge and skills needed to begin college-level work?

Answer: With the exception of geometry, the balance/emphasis of the standards in the mathematics assessments aligns closely to the college expectations (*see TABLE MATH1*).

- The Math Team, arguing in favor of formal geometry as it teaches students how to think logically, would place a greater emphasis on the geometry standard than does the HSPE.

- The team would also continue to place a strong emphasis on the algebra standard. While the percentages differ somewhat, algebra is the top priority of both the Math Team and on the HSPE. Please note that although there may be more than an adequate number of algebra-related items on the HSPE, the items themselves are inadequate for higher education purposes in terms of both the level of algebra assessed and their level of cognitive demand (discussed below).

TABLE MATH1: Mathematics Standards Emphasis/Balance on HSPE Test

Standards	NV Math Team Recommendations	HSPE Math Test
STANDARD 1. Numbers, Number Sense, and Computation	18%	16%
STANDARD 2: Patterns, Functions, and Algebra	23%	28%
STANDARD 3: Measurement	17%	21.5%
STANDARD 4: Spatial Relationships and Geometry	20%	13%
STANDARD 5: Data Analysis	22%	21.5%
Total	100%	100%

Question Three: Can the HSPE in Mathematics be used in its current form for postsecondary admissions and/or placement?

Answer: No, the Math Team – understanding that, until the 8th grade examination is added to the Nevada assessment system, the HSPE serves the dual purposes of assessing middle school and high school content – stated that the examination concentrates too much at the middle school level (or lower)[7] and needs to concentrate more heavily on high school content.

- The Achieve alignment study[8] revealed that only 36 percent of the test items on the HSPE in Mathematics are clearly consistent with the content in the standards (*i.e.,* received a "2" for content centrality). Almost two-thirds (64 percent) of the remaining items received a "1b", meaning they were aligned to only part of a standard, often to the lesser part (*see TABLE MATH2*).

- In addition, only 48 percent of the items clearly require the kind of performance articulated in the standards (*i.e.,* received "2s" for performance centrality). Another 37 percent of the items received a "1b", meaning they require the kind of performance in part); and another 15 percent received a "0", meaning the

[7] Almost half of the items on the test align to grade 7 (or below) concepts and skills; another 35 percent align to grade 8.
[8] See appendices for the Achieve study summary data.

performance requirements of the item do not align to those in the standards[9] (*see TABLE MATH2*).

TABLE MATH2: Content & Performance Centrality of the HSPE in Mathematics

Centrality	**# of Items**	**2** (clearly consistent)	**1a** (standard not specific enough)	**1b** (item assesses only a part of the standard)	**0** (inconsistent)
Content	75 (100% of test)	36% of all items received a 2	No items received a 1a	64% of all items received a 1b	No items received a 0
Performance	75 (100% of test)	48% of all items received a 2	No items received a 1a	37% of all items received a 1b	15% items received a 0

- The team found the current version of the HSPE to be pitched more at the pre-algebra than the algebra level.

- The current version of the HSPE – meant to test middle school and early high school mathematics– assesses a low level of cognitive demand that would need to be significantly raised before the examination could be useful to postsecondary institutions. One hundred percent of the test items were rated a level "2" or below; about one third received a "1" or basic comprehension. *(see TABLE MATH3)*

TABLE MATH3: Level of Cognitive Demand of the HSPE in Mathematics

Demand (75 items scored)	**4** (extended thinking)	**3** (strategic thinking)	**2** (skill/concept)	**1** (recall)
	No items received a 4	No items received a 3	68% of all items received a 2	32% of all items received a 1

- Moreover, the important geometry concepts not assessed (defined above as vital minimum higher education competencies/concepts) by the HSPE include:
  - Congruence, similarity, and transformation;
  - Pythagorean Theorem; and
  - Special right triangles and right triangle trigonometry.

- Important data analysis concepts not assessed (defined above as vital minimum higher education competencies/concepts) by the HSPE include:
  - Data organization and analysis (graphical fluency), and
  - Measures of central tendency.

Question Four: What other recommendations does the Math Team have for the state policy panel regarding issues that surround the administration of the HSPE?

[9] This is often the result of a particular limitation of the type of assessment used; in this case, the HSPE is limited to selected response items so students cannot "describe" or "explain" for instance.

Answer: The Math Team made several recommendations:

- The Math Team recommends including in the HSPE constructed-response items that would require students to come up with the answers on their own and demonstrate their understanding of the mathematics and reasoning involved, rather than to simply select the right answer among several provided.[10]

- The team also recommends that the level of cognitive demand of the multiple-choice items be increased by requiring students to:
    - sort through irrelevant or extraneous information and/or identify insufficient information,
    - solve problems using concepts from different standards/domains (*e.g.,* probability and measurement concepts),
    - determine the appropriate order of steps to solve problems, and
    - generalize.

- Calculators are not allowed on the HSPE in Mathematics. The team recommends that as the rigor of the test increases, and as constructed-response items are added, the use of calculators be permitted though restricted to sections of the test that contain more complex, challenging, thought-provoking, reasoning/problem-solving items. The prohibition in sections of the test that contain items of a more computational nature/focus ought to be maintained.

- The team felt that the formula sheet is appropriately limited and reasonable (except for the inclusion of the distance formula), but for the low level of cognitive demand of the HSPE. As the level of cognitive demand is raised, there will be a more appropriate balance between the formula sheets and the exam items. Students will then be required to use simple formulas from the sheet in sophisticated ways to solve complex problems.

Question Five: What peripheral recommendations does the Math Team have for the state policy panel?

Answer:

- The team would like to see HSPE scores reported on high school transcripts by standard (i.e., Numbers, Algebra, Measurement, Geometry, and Data Analysis) to give colleges more information than they currently receive from a single ACT score. Placing scores on transcripts would also provide incentive to students to do their very best on the HSPE.

[10] As costs of development and scoring may be an issue for the state, team members volunteered to work with their K-12 counterparts to develop a selection of constructed response items that students could choose to take, especially college-intending students. Colleges could perhaps create some kind of incentive for students to answer these questions and share the costs for development and scoring.

- Regarding a recommended mathematics-course sequence…

  - The class of 2003 is the first group of students required to pass the new examination; they are also the first required to complete three years of mathematics – one more year than previously required[11]. The Math Team applauds this change, but states that college mathematical readiness is best guaranteed by continuous mathematics study throughout high school. As such, the Math Team recommends that the State Board advise college-intending students to take the traditional sequence of Algebra I, (formal) Geometry, and Algebra II. In addition, they would advise students to take a fourth year of mathematics (a rigorous/substantive course) in order to maximize their college readiness. Without that fourth year of substantive mathematics, students actually lose much of the mathematics competency developed during their first three years of high school.

  - The team supports the plan of the Board of Regents to determine which high school mathematics courses count towards the GPA requirements of the Millennium Scholarships. Soon only grades in Algebra I, Algebra II, Geometry and other higher-level courses will count towards GPAs for Millennium-Scholarship purposes. Currently, the scholarship GPA requirements create an incentive for students to take the lowest-level courses leading to a high remediation rate for scholarship recipients: 40 to 60 percent of scholarship recipients require remedial courses in Nevada colleges. The move to determine student GPAs on core algebra and geometry courses and to require a "B" average should do much to improve student competency in mathematics in Nevada.

  - As was the case in the other partner states, members of the Nevada Math Team stressed the importance of mastering Algebra I, Geometry, and Algebra II rather than being exposed to a superficial treatment of Calculus in high school. They equated a strong, solid foundation in Algebra I, Geometry, and Algebra II with the ability of high school graduates to begin credit-bearing college coursework upon entrance, and argued that having taken a nominal Calculus course at the expense of such a foundation would undermine that preparation.

- Nevada college faculty members expressed interest in conducting a study on the predictive validity of the HSPE for college success. (This corresponds to a recommendation in the legal study to ensure the validity of using an assessment for multiple purposes.) Such a study would correlate different student scores on the state test with how students do on other placement tests and in various college mathematics courses. Such a study would give colleges the information they need about just how to use results from the HSPE for admissions or placement. College personnel have been using SAT I and ACT, and other placement tests for years,

[11] Any mathematics courses will satisfy the requirement.

despite their limitations. Although they may not deem the national admissions and placement tests perfect, college faculty members are in some cases more familiar with their ostensible predictive validity than they are with the HSPE.

APPENDICES

The following tables represent the results from the Achieve alignment study for the Nevada HSPE in Mathematics and the Nevada Content Standards.

Assessment
Nevada High School Proficiency Examination:
Mathematics, Form 1, Spring 2002

Standards
Nevada Mathematics Content Standard
Adopted March 2001

Test Design
Part I* consists of 38 multiple-choice items
Part II* consists of 37 multiple-choice items
75 items scored

** Formula sheet accompanies both Parts I and II of the test*

APPENDIX 1: Item Coverage

APPENDIX 2: Content Centrality

APPENDIX 3: Performance Centrality

APPENDIX 4: Source of Challenge

APPENDIX 5: Level of Cognitive Demand

APPENDIX 6: Range

APPENDIX 7: Level Of Challenge And Balance

APPENDIX 1a: Item Coverage

Note: Shading shows indicators eligible for state assessment.

Nevada Content Standard	# of Items	% of Test
1.0 Numbers, Number Sense, and Computation	**12**	**16%**
Indicator 1.6.1 (Facts)	*2*	
Indicator 1.8.1 (Facts)	*0*	
Indicator 1.12.1 (Facts)	*1*	
Indicator 1.5.2 (Application)	*2*	
Indicator 1.6.2 (Application)	*1*	
Indicator 1.7.2 (Application)	*1*	
Indicator 1.8.2 (Application)	*1*	
Indicator 1.12.2 (Application)	*0*	
Indicator 1.8.3 (Word Problems and Number Theory)	*0*	
Indicator 1.12.3 (Word Problems and Number Theory)	*0*	
Indicator 1.5.4 (Decimals)	*1*	
Indicator 1.12.5 (Computation)	*1*	
Indicator 1.7.6 (Comparison and Ordering)	*1*	
Indicator 1.8.6 (Comparison and Ordering)	*0*	
Indicator 1.8.7 (Estimation and Rounding)	*0*	
Indicator 1.7.9 (Fractions)	*1*	
Indicator 1.8.9 (Fractions)	*0*	
2.0 Patterns, Functions, and Algebra	**21**	**28%**
Indicator 2.8.1 (Patterns)	*3*	
Indicator 2.7.2 (Relationships)	*1*	
Indicator 2.8.2 (Relationships)	*4*	
Indicator 2.12.2 (Relationships)	*0*	
Indicator 2.8.3 (Variables/Unknowns)	*0*	
Indicator 2.12.3 (Variables/Unknowns)	*1*	
Indicator 2.7.4 (Number Sentences and Equations)	*5*	
Indicator 2.8.4 (Number Sentences and Equations)	*0*	
Indicator 2.12.4 (Number Sentences and Equations)	*1*	
Indicator 2.8.5 (Algebraic Basics)	*0*	
Indicator 2.12.5 (Algebraic Basics)	*0*	
Indicator 2.8.6 (Linear Equations)	*4*	
Indicator 2.12.6 (Linear Equations)	*0*	
Indicator 2.8.7 (Equations Solutions)	*2*	
Indicator 2.12.7 (Equation Solutions)	*0*	
3.0 Measurement	**16**	**21.5%**
Indicator 3.6.1 (Comparison and Ordering)	*2*	
Indicator 3.12.1 (Comparison and Ordering)	*0*	
Indicator 3.8.2 (Measurement)	*2*	
Indicator 3.12.2 (Measurement)	*2*	
Indicator 3.4.3 (Estimation and Formulas)	*2*	
Indicator 3.6.3 (Estimation and Formulas)	*1*	
Indicator 3.7.3 (Estimation and Formulas)	*1*	
Indicator 3.8.3 (Estimation and Formulas)	*1*	
Indicator 3.12.3 (Estimation and Formulas)	*0*	
Indicator 3.12.4 (Money)	*0*	
Indicator 3.7.5 (Proportion and Ratio)	*3*	
Indicator 3.8.5 (Proportion and Ratio)	*1*	
Indicator 3.12.5 (Proportion and Ratio)	*1*	
4.0 Spatial Relationships and Geometry	**10**	**13%**
Indicator 4.5.1 (Two-Dimensional Shapes)	*1*	

Nevada Content Standard	# of Items	% of Test
Indicator 4.12.1 (Two-Dimensional Shapes)	*1*	
Indicator 4.8.2 (Congruence, Similarity, and Transformations)	*0*	
Indicator 4.8.3 (Coordinate Geometry and Line of Symmetry)	*0*	
Indicator 4.8.5 (Line, Slopes, and Linear Equations)	*0*	
Indicator 4.12.5 (Line, Slopes, and Linear Equations)	*2*	
Indicator 4.6.6 (Lines, Angles, and Geometric Figures)	*1*	
Indicator 4.7.6 (Lines, Angles, and Geometric Figures)	*1*	
Indicator 4.8.6 (Lines, Angles, and Geometric Figures)	*0*	
Indicator 4.12.6 (Lines, Angles, and Geometric Figures)	*2*	
Indicator 4.6.7 (Pythagorean Theorem)	*1*	
Indicator 4.8.7 (Pythagorean Theorem)	*0*	
Indicator 4.12.7 (Pythagorean Theorem)	*0*	
Indicator 4.8.8 (Draw and Construct)	*0*	
Indicator 4.12.8 (Draw and Construct)	*0*	
Indicator 4.12.9 (Logic and Deductive Reasoning)	*1*	
5.0 Data Analysis	**16**	**21.5%**
Indicator 5.4.1 (Data Collection and Organization)	*1*	
Indicator 5.8.1 (Data Collection and Organization)	*0*	
Indicator 5.12.1 (Data Collection and Organization)	*0*	
Indicator 5.6.2 (Probability)	*2*	
Indicator 5.8.2 (Probability)	*5*	
Indicator 5.12.2 (Probability)	*0*	
Indicator 5.8.3 (Probability Analysis)	*2*	
Indicator 5.12.3 (Probability Analysis)	*0*	
Indicator 5.5.4 (Central Tendency)	*3*	
Indicator 5.7.4 (Central Tendency)	*1*	
Indicator 5.12.4 (Central Tendency)	*0*	
Indicator 5.8.5 (Data Analysis)	*0*	
Indicator 5.12.5 (Data Analysis)	*0*	
Indicator 5.5.6 (Design)	*1*	
Indicator 5.8.6 (Design)	*1*	
Indicator 5.12.6 (Design)	*0*	
TOTAL	**75**	**100%**

APPENDIX 1b: Item Coverage (continued)

Note: Shading shows indicators eligible for state assessment

I. Item Distribution by Grade-Level Mapping

Grade Level	Number of Items	Percentage of Items
4	3	4%
5	8	11%
6	10	13%
7	15	20%
8	26	35%
12	13	17%
TOTAL	**75**	**100%**

II. Item Distribution by Content Standard

Note: Items assessing standards eligible for state assessment compared with items assessing standards eligible only for local assessment.

Standard	Items assessing state assessable standards		Items assessing standards eligible only for local assessment	
	# of items	% of items	# of items	% of items
1.0 Number	4	5%	8	11%
2.0 Algebra	11	15%	10	13%
3.0 Measurement	7	9%	9	12%
4.0 Geometry	7	9%	3	4%
5.0 Data Analysis	11	15%	5	7%
TOTAL	**40**	**53%**	**35**	**47%**

III. Item Distribution by Grade-Level Mapping and Content Standard

Standard	Grade Level (cells reflect numbers of items)									
	Grade 4	Grade 5		Grade 6	Grade 7	Grade 8		Grade 12		TOTAL
1.0 Number	0	2	1	3	3	1	0	1	1	12
2.0 Algebra	0	0	0	0	6	9	4	2	0	21
3.0 Measurement	2	0	0	3	4	4	0	3	0	16
4.0 Geometry	0	1	0	2	1	0	0	6	0	10
5.0 Data Analysis	1	3	1	2	1	8	0	0	0	16
TOTAL	**3**	**6**	**2**	**10**	**15**	**22**	**4**	**12**	**1**	**75**

APPENDIX 2: Content Centrality

Note: Ratings for Content Centrality are "2" = clearly consistent; "1a" = not specific enough; "1b" = somewhat consistent; "0" = inconsistent.

Standard	# of Items	2	1a	1b	0
Numbers, Number Sense, and Computation	12 (16%)	6	0	6	0
Patterns, Functions, and Algebra	21 (28%)	9	0	12	0
Measurement	16 (21.5%)	6	0	10	0
Spatial Relationships and Geometry	10 (13%)	2	0	8	0
Data Analysis	16 (21.5%)	4	0	12	0
TEST AS A WHOLE	75 (100%)	27 (36%)	0	48 (64%)	0

APPENDIX 3: Performance Centrality

Note: Ratings for Performance Centrality are "2" = clearly consistent; "1a" = not specific enough; "1b" = somewhat consistent; "0" = inconsistent.

Standard	# of Items	2	1a	1b	0
Numbers, Number Sense, and Computation	12 (16%)	4	0	6	2
Patterns, Functions, and Algebra	21 (28%)	15	0	4	2
Measurement	16 (21.5%)	7	0	6	3
Spatial Relationships and Geometry	10 (13%)	4	0	4	2
Data Analysis	16 (21.5%)	6	0	8	2
TEST AS A WHOLE	75 (100%)	36 (48%)	0	28 (37%)	11 (15%)

APPENDIX 4: Source of Challenge

Note: Ratings for Source of Challenge are "1" = appropriate, "0" = inappropriate.

Standard	# of Items	1	0
Numbers, Number Sense, and Computation	12 (16%)	11	1
Patterns, Functions, and Algebra	21 (28%)	20	1
Measurement	16 (21.5%)	16	0
Spatial Relationships and Geometry	10 (13%)	10	0
Data Analysis	16 (21.5%)	16	0
TEST AS A WHOLE	75 (100%)	73 (97%)	2 (3%)

APPENDIX 5: Level of Cognitive Demand

Note: Ratings for Level of Cognitive Demand are "4" = extended thinking; "3" = strategic thinking; "2" = skill/concept; "1" = recall.

Standard	# of Items	4	3	2	1
Numbers, Number Sense, and Computation	12 (16%)	0	0	6	6
Patterns, Functions, and Algebra	21 (28%)	0	0	17	4
Measurement	16 (21.5%)	0	0	10	6
Spatial Relationships and Geometry	10 (13%)	0	0	7	3
Data Analysis	16 (21.5%)	0	0	11	5
TEST AS A WHOLE	75 (100%)	0	0	51 68%	24 32%

APPENDIX 6: Range

Note: All grade 8 and grade 12 indicators that are in the five content strands and eligible for state assessment are included in these tallies.

Standard	Portion of Standards Assessed
Numbers, Number Sense, and Computation	2/6 or 0.33
Patterns, Functions, and Algebra	5/9 or 0.56
Measurement	5/6 or 0.83
Spatial Relationships and Geometry	5/8 or 0.63
Data Analysis	3/6 or 0.50
TEST AS A WHOLE	20/35 or 0.57

APPENDIX 7: Level Of Challenge And Balance

Standard/ # of Items	Comments
Numbers, Number Sense, and Computation: 12 items (16%)	All items are Level 1 (6 items) or Level 2 (6 items), and 9 of the 12 items assess indicators below the eighth-grade level—3 at fifth grade, 3 at sixth grade, and 3 at seventh grade. Only 4 items map to indicators identified as eligible for inclusion on the state assessment, with 2 of these items assessing fifth-grade indicators, 1 assessing an eighth-grade indicator, and 1 assessing a high school indicator. Areas not addressed by the test at the eighth-grade or high school level include "Word Problems and Number Theory" and "Estimation and Rounding."
Patterns, Functions, and Algebra: 21 items (28%)	All items are Level 1 (4 items) or Level 2 (17 items). The majority of items (15 items) assess eighth-grade or high school indicators. The remaining 6 items assess seventh-grade indicators. Eleven of the 21 items map to indicators identified as eligible for inclusion on the state test, with 9 of these 11 items assessing eighth-grade skills and the other 2 items assessing high school indicators. The 10 items mapping to indicators not identified for state assessment assess indicators from the seventh- and eighth-grade levels—6 at seventh grade and 4 at eighth grade. The only area not addressed by the test at the eighth-grade or high school level is "Algebraic Basics"
Measurement: 16 items (21.5%)	All items are Level 1 (6 items) or Level 2 (10 items), and 9 of the 16 items assess indicators below the eighth-grade level—2 at fourth grade, 3 at sixth grade, and 4 at seventh grade. Only 7 of the 16 items map to indicators identified as eligible for inclusion on the state test, with 4 assessing eighth-grade indicators and 3 assessing high school indicators. All of the areas targeted for inclusion on the state assessment are addressed by the test at either the eighth-grade or high school level.
Spatial Relationships and Geometry: 10 items (13%)	All items are Level 1 (3 items) or Level 2 (7 items), with 6 of the items assessing high school indicators. The remaining items map to indicators at the fifth-grade (1 item), sixth-grade (2 items), and seventh-grade (1 item). Seven of the 10 items map to indicators identified as eligible for state assessment, although 1 of these is at the fifth-grade level. All 6 items mapping to high school indicators assess indicators identified as state assessable. Areas not addressed by the test at the eighth-grade or high school level include "Congruence, Similarity, and Transformations" and "Pythagorean Theorem." The high school indicator for "Pythagorean Theorem" also includes student expectations with respect to special right triangles and right triangle trigonometry.
Data Analysis: 16 items (21.5%)	All items are Level 1 (5 items) or Level 2 (11items). Half of the items assess eighth-grade indicators, but no items assess high school indicators. The remaining items map to indicators at fourth grade (1 item), fifth grade (4 items), sixth grade (2 items), and seventh grade (1 item). Eleven of the 16 items map to indicators identified as eligible for state assessment, although 3 of these are at the fifth-grade level. All 8 items aligned to eighth-grade indicators assess indicators identified as state assessable. Areas not addressed by the test at the eighth-grade or high school level include "Data Collection and Organization," "Central Tendency," and "Data Analysis."
TEST AS A WHOLE: 75 items (100%)	All items are Level 1 (24 items) or Level 2 (51 items). Thirty-nine items (52% of the items) map to indicators at the eighth-grade and high school levels. The remaining items (48% of the items) map to indicators from grades 4 through 7. The test is most heavily weighted toward Patterns, Functions, and Algebra (28% of items). Almost 22% of the items align to Measurement, and a comparable proportion of items align with Data Analysis indicators. Numbers, Number Sense, and Computation—with 16% of the items—and Spatial Relationships and Geometry—with 13% of the items—receive the least emphasis. A little over half of the items (40 items, or 53%) map to standards identified as eligible for inclusion on the state assessment. The remaining items (35 items, or 47%) were identified as assessable at the local level only.