



Defining Postsecondary Expectations for Mathematics in Indiana

As recommended in the American Diploma Project (ADP) legal research report, the ADP asked members of the postsecondary community in Indiana 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 Indiana's current Core 40 Assessments might serve the colleges and universities well for the purposes of admissions and/or placement, but a closer look at their alignment of the Core 40 Assessments to Indiana's Academic Standards and to postsecondary faculty expectations was warranted.

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

In **part two**, Achieve and ADP staff, using an assessment-to-standards alignment protocol developed by Achieve, conducted an alignment study of the Core 40 Assessments in English Language Arts and Mathematics (i.e., Grade 11 ELA, Algebra I, Geometry, and Algebra II) and the corresponding sets of Indiana's Academic 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*

Core 40 Algebra I, Geometry, and Algebra II end-of-course assessments compare favorably to the college admissions and placement tests in terms of content, compare unfavorably in terms of rigor.

- Reviewers compared Core 40 end-of-course assessments in Algebra I, Geometry, and Algebra II to the SAT I and college placement tests. While they found the Core 40 tests to be comparable in content, they were not found to be of equivalent rigor.
- The Algebra II test showed little progression in difficulty level from Algebra I.
- The SAT I emphasizes reasoning abilities, unlike the Core 40 assessments. On the other hand, the SAT I is predominantly an Algebra I assessment with scant coverage of Algebra II content.
- The Purdue University algebra placement test (used to determine which credit-bearing course students are ready to enter) is much shorter than the Core 40 assessments and, unlike the Core 40 assessments, contains only multiple-choice items (no open-response questions so highly valued by higher education professors). While the Purdue test was considered to be a traditional test of advanced high school mathematics – its cognitive challenge is higher than that of the Core 40s.

Note: As a result of the review of the Core 40s, the Algebra I test was revised and strengthened.

- Indiana college faculty members expressed interest in conducting a study on the predictive validity of the Core 40 assessments 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 math courses. Such a study would give colleges the information they need about just how to use results from the Core 40s for admissions or placement. College personnel have been using SAT I, SAT II, ACT, and other placement tests for years, 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 Core 40 tests.

*Part Two Findings (Mathematics²):
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 Core 40 Assessment of Algebra I, Geometry, and Algebra II and the corresponding Academic Standards. 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.³

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.

² See the enclosed, “Defining Postsecondary Expectations for Reading and Writing in Indiana,” for the English Language Arts portion of the analysis from **part two**.

³ 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 Indiana, representing a range of content areas, for the following discussion.

Step One: Define Expectations for Incoming Students

Thinking more about what is really needed, rather than bowing to the current state of student mathematics expertise, what follows is a list of minimum competencies and concepts articulated by the Indiana Math Team as for students entering **Intermediate College Algebra**:

1. Basic arithmetic
 - a. WITHOUT the use of a calculator (students are allowed unrestricted use on the Core 40s; the tests ought to be partitioned to allow only for more appropriate use)
 - b. Fractions, decimals, percentages, ratios, proportions, long division
 - c. Convert numbers into scientific notation
 - d. Dimensional analysis
 - e. Correct use of properties of real numbers
 - f. Know whether an answer is reasonable/order of magnitude understanding
2. Algebra I & Algebra II

- a. Solve and check linear equations
 - b. Solve literal equations
 - c. Solve linear inequalities
 - d. Solve systems of linear equations (2 equations by 2 variables)
 - e. Graphing linear equation and sketching graphs of parabolas, circles, sketching slope and intercepts; interpret linear graphs
 - f. Analyze functions in terms of tables, graphs, symbolically and in words; domain and range
 - g. Need some level of awareness of nonlinear functions
 - h. How to use exponents, the exponent rule, rational exponents
 - i. Operations of polynomials including factoring
 - j. Solve basic quadratic equations by factoring
 - k. Exponential and logarithmic functions
3. Geometry
 - a. Know basic area and perimeter formulas for plane or solid quadrilaterals (write a formula and explain what it means)
 - b. Know basic geometric properties and principles
 - c. Understand the intellectual process of proofs
 4. Probability and Statistics
 - a. Only need to be able to interpret and make simple graphs
 5. Conceptual Understanding
 - a. Able to generalize, transfer understanding in one area to another
 - b. Pattern recognition
 - c. Logical reasoning
 - d. Solve word problems that have application to the students' real worlds
 - e. Recognize insufficient or irrelevant information in problems
 6. Mathematical Communication
 - a. Know and use correct mathematical terminology

Thinking more about what is really needed, rather than bowing to the current state of student mathematics expertise, what follows is a list of minimum competencies and concepts (above and beyond those listed above) articulated by the Indiana Math Team as for students entering **Calculus (math and engineering majors)**:

1. Algebra
 - a. Exponential and logarithmic functions
 - b. Solve system of linear inequalities
 - c. Solve quadratic and rational inequalities
 - d. Solve trigonometric functions (polar coordinates)
 - e. Graph linear data, do a linear regression, understand what the output means
 - f. Graph and solve absolute value equations and piecewise defined functions
 - g. Composition and decomposition of functions and inverse functions
 - h. Know how to manipulate and notate functions and know the algebraic steps to solve

- i. Solve quadratic inequalities
- 2. Geometry
 - a. Exposure to mathematical proof by induction
 - b. Visualization, identify cross-sections in solid geometry/nets
 - c. Type of problems make a huge difference in students doing well in calculus; they must have conceptual understanding
- 3. Other Important Content
 - a. Series and sequences

Step Two: Prioritize expectations for students, as reflected in Indiana’s Academic Standards

Question One: Are the competencies required in college for a broad range of disciplines represented in the Indiana Mathematics (Algebra I, Geometry, and Algebra II) Standards, Objectives, and Examples*?

Answer: Yes, the Math Team concluded that *the Indiana Algebra I, Geometry, and Algebra II standards and objectives are strong, comprehensive, and do contain the content that represents college readiness.*

* Regarding examples, the Math Team generalized that they are easier than they ought to be. Because the examples can affect both classroom instruction and assessment items, it is important that they reflect a higher level of rigor relative to the corresponding objectives.⁴

Step Three: Determine the degree to which current Academic Standards and Core 40 Assessments reflect postsecondary expectations

Question Two: How does the standards balance/emphasis of the Algebra I, Geometry, and Algebra II assessments compare to the emphasis that the Math Team places on the knowledge and skills needed to begin college-level work?

Answer: The balance/emphasis of the standards in the mathematics assessments is, for the most part, closely aligned (see *TABLES Math1, Math2, and Math3*). In some key areas, however, the alignment is not close and would need to be better aligned to increase the usefulness of the assessment for higher education admission/placement decisions. The tables below reveal the balance/emphasis of each assessment relative to each standard (in terms of items and points) and how the Math Team would like to see the assessments balanced.⁵

⁴ The American Diploma Project tracked individual objective and example feedback, and will make this feedback available as requested/needed.

⁵ The column totals do not always equal 100% either due to rounding or to the total balance/emphasis feedback from individual Math Team members not equaling 100%.

TABLE Math1: **Algebra I** Standards Emphasis/Balance

| Standards | EOC Assessment | | Math Team |
|--|----------------|---------------|---------------|
| | % Items | % Items | |
| STANDARD 1. Operations with Real Numbers | 10.0% | 10.0% | 9.0% |
| STANDARD 2. Linear Equations and Inequalities | 16.7% | 16.7% | 15.4% |
| STANDARD 3. Relations and Functions | 13.3% | 13.3% | 13.3% |
| STANDARD 4. Graphing Linear Equations and Inequalities | 6.7% | 6.7% | 16.3% |
| STANDARD 5. Pairs of Linear Equations and Inequalities | 13.3% | 13.3% | 8.9% |
| STANDARD 6. Polynomials | 13.3% | 13.3% | 10.0% |
| STANDARD 7. Algebraic Fractions | 3.3% | 3.3% | 5.4% |
| STANDARD 8. Quadratic, Cubic, and Radical Equations | 16.7% | 16.7% | 6.9% |
| STANDARD 9. Mathematical Reasoning and Problem Solving | 6.7% | 6.7% | 16.1% |
| TOTAL | 100.0% | 100.0% | 101.3% |

TABLE Math2: **Geometry** Standards Emphasis/Balance

| Standards | EOC Assessment | | Math Team |
|--|----------------|---------------|---------------|
| | % Items | % Items | |
| STANDARD 1. Points, Lines, Angles, and Planes | 14.8% | 14.8% | 14.9% |
| STANDARD 2. Polygons | 7.4% | 7.4% | 8.0% |
| STANDARD 3. Quadrilaterals | 14.8% | 14.8% | 10.1% |
| STANDARD 4. Triangles | 18.6% | 18.6% | 10.6% |
| STANDARD 5. Right Triangles | 11.1% | 11.1% | 13.4% |
| STANDARD 6. Circles | 11.1% | 11.1% | 12.3% |
| STANDARD 7. Polyhedra and Other Solids | 11.1% | 11.1% | 8.6% |
| STANDARD 8. Mathematical Reasoning and Problem Solving | 11.1% | 11.1% | 22.1% |
| TOTAL | 100.0% | 100.0% | 100.0% |

TABLE Math3: **Algebra II** Standards Emphasis/Balance

| Standards | EOC Assessment | | Math Team |
|--|----------------|---------------|---------------|
| | % Items | % Items | |
| STANDARD 1. Relations and Functions | 24.0% | 24.0% | 14.3% |
| STANDARD 2. Linear and Absolute Value Equations and Inequalities | 12.0% | 12.0% | 11.7% |
| STANDARD 3. Quadratic Equations and Functions | 12.0% | 12.0% | 9.2% |
| STANDARD 4. Conic Sections | 4.0% | 4.0% | 6.8% |
| STANDARD 5. Polynomials | 12.0% | 12.0% | 10.5% |
| STANDARD 6. Algebraic Fractions | 16.0% | 16.0% | 10.3% |
| STANDARD 7. Logarithmic and Exponential Functions | 8.0% | 8.0% | 15.5% |
| STANDARD 8. Sequences and Series | 4.0% | 4.0% | 1.8% |
| STANDARD 9. Counting Principles and Probability | 4.0% | 4.0% | 2.3% |
| STANDARD 10. Mathematical Reasoning and Problem Solving | 4.0% | 4.0% | 17.8% |
| TOTAL | 100.0% | 100.0% | 100.3% |

- Across the board, the Math Team would like *significantly more emphasis on mathematical reasoning and problem solving*. They would dedicate over 16% of the Algebra I, over 22% of the Geometry, and nearly 18% of the Algebra II assessments to this standard. Currently, 6.7% of the Algebra I, 11.1% of the

Geometry, and 4.0% of the Algebra II items measure students' reasoning and problem-solving skills.

- As mentioned above, *mathematical-reasoning and problem-solving* items tend to be structured so as to guide students step-by-step through the problem (with points awarded at each step), thereby undermining the item's ability to assess those skills. The Math Team recommended removing the scaffold and assigning points to the students for their solution to the problem, as well as for finding the correct answer.
- The Math Team stated that *mathematical-reasoning and problem-solving* skills include being able to solve problems that require skills from multiple standards, to construct a multi-step approach to solving complex/demanding open-response questions (*see above*), to factor out irrelevant or extraneous information, to apply their understanding, to make connections, to observe patterns, and to generalize.
- With regard to the Algebra I assessment, the Math Team would also prefer to see less emphasis on the *Quadratic, Cubic, and Radical Equations Standard* and more on the *Graphing Linear Equations and Inequalities Standard*.
- The Geometry assessment most closely reflected the team's standards priorities. Only minor changes to assessment would be needed to bring it even closer to the standards balance advocated by the Math Team.
- The Algebra II assessment had the fewest *mathematical-reasoning and problem-solving* items of the three assessments reviewed, a cause of great concern for the Math Team. The Math Team also placed greater emphasis on the *Logarithmic and Exponential Functions Standard* than does the Algebra II assessment and less emphasis on the *Relations and Functions Standard* and *Algebraic Fractions Standard*.

Question Three: Can the Core 40 Algebra I, Geometry, and Algebra II assessments be used in their current form for college admission or placement purposes?

Answer:

- The Achieve alignment study⁶ revealed that of the three mathematics end-of-course assessments reviewed, the revised Algebra I assessment most closely aligns to the corresponding Algebra I Academic Standards: nearly 87% of items on the Algebra I end-of-course assessment receiving "2s" for content centrality and nearly 97% of items receiving "2s" for performance centrality. The content and performance centralities for the Geometry and Algebra II assessment items

⁶ See appendices for the Achieve study summary data.

are clearly not as strong (see TABLES Math4 and Math5). The stronger correlation of the Algebra I assessment could be attributed to the fact that it was revised and strengthened to reflect the recommendations that resulted from the review of the assessment during Part I of the Higher Education Expectations Research.

TABLE Math4: Content Centrality

| Assessment | # of Items | 2 (clearly consistent) | 1a (standard not specific enough) | 1b (item assesses only a part of the standard) | 0 (inconsistent) |
|------------|--------------|---------------------------|--------------------------------------|---|---------------------|
| Algebra I | 30 (100%) | 26 (86.7%) | 1 (3.3%) | 3 (10.0%) | 0 |
| Geometry | 27 (100%) | 15 (55.6%) | 0 | 12 (44.4%) | 0 |
| Algebra II | 25 (100%) | 15 (60%) | 0 | 10 (40%) | 0 |

TABLE Math5: Performance Centrality

| Assessment | # of Items | 2 (clearly consistent) | 1a (standard not specific enough) | 1b (item assesses only a part of the standard) | 0 (inconsistent) |
|------------|--------------|---------------------------|--------------------------------------|---|---------------------|
| Algebra I | 30 (100%) | 29 (96.7%) | 1 (3.3%) | 0 | 0 |
| Geometry | 27 (100%) | 19 (70.4%) | 0 | 8 (29.6%) | 0 |
| Algebra II | 25 (100%) | 18 (72%) | 0 | 5 (20%) | 2 (8%) |

- The revised Algebra I assessment (Form G) is a strong test well aligned to the Algebra I standards. A solid performance on this assessment would not alone indicate college readiness, but would indicate that students had a solid foundation/mastery of Algebra I skills. Reviewers made two principle recommendations for further revision of the Algebra I assessments:
 - Removing the scaffolding/step-by-step guidance from the open-response/problem-solving items would allow the items to better assess those skills.
 - The standards balance/emphasis of the assessment could better reflect the expectations of the Math Team, especially with regard to the *mathematical reasoning and problem solving* standard currently underemphasized in the assessment (see below).
- The Geometry assessment could be more valuable for postsecondary admissions/placement decisions by strengthening the assessment in two key content areas. The first area is geometric proofs that are the

traditional vehicle within the mathematics curriculum through which students develop their logic/reasoning skills. The second area concerns spatial-relations skills and three-dimensional thinking that are essential to success in the physical sciences (e.g., chemistry and engineering) and that are likewise developed in Geometry. In addition, the assessment could be improved by:

- strengthening the assessment’s content and performance centralities, and
- raising the assessment’s level of cognitive demand (see *TABLE Math6*).

TABLE Math6: Level of Cognitive Demand

| Assessment | # of Items | 4 (extended thinking) | 3 (strategic thinking) | 2 (skill/concept) | 1 (recall) |
|-------------------|-------------------|---------------------------------|----------------------------------|-----------------------------|----------------------|
| Algebra I | 30 (100%) | 0 | 3 (10%) | 14 (46.7%) | 13 (43.3%) |
| Geometry | 27 (100%) | 0 | 2 (7.4%) | 15 (55.6%) | 10 (37%) |
| Algebra II | 25 (100%) | 0 | 1 (4%) | 11 (44%) | 13 (52%) |

- The Algebra II test could not be used in its current form for postsecondary admissions/placement decisions. Algebra II assessment would be the most important of the three end-of-course mathematics assessments reviewed in terms of college admissions and placement: Algebra II is typically taken last (of the three courses) and without it, a high school graduate would not be prepared to begin credit-bearing math courses in college. While the Math Team was in favor of the Algebra II assessment being required for graduation, as it presently stands, the assessment is not sufficiently aligned or rigorous and it is too procedural and too full of content gaps. To make the Algebra II assessment more useful to postsecondary institutions, the Math Team recommended the following:
 - the assessment’s standards balance/emphasis ought to be adjusted to better reflect higher education expectations, especially in terms of *mathematical reasoning and problem solving* (see *below*),
 - the assessment’s level of cognitive challenge ought to be raised, and
 - the assessment’s coverage of high priority objectives (in terms of number of test items) ought to be expanded.⁷

⁷ See the summary guide of the Achieve alignment protocol as well as the Achieve ELA, Algebra I, Geometry, and Algebra II summary alignment reports for more information.

Question Four: What other suggestions do you have for improving the assessment beyond those discussed above?

Answer: The Math Team had concerns about the use of calculators and formula sheets. The inappropriate use of calculators and formula-sheets could render an item a test of a student's ability to use a calculator or read a formula sheet rather than a test of the skill described in the standard or objective.

- The Math Team recommended that calculator use be restricted to sections of the test that contain more complex, challenging, thought-provoking, reasoning/problem-solving items and not be allowed for sections of the test that contain items of a more computational nature/focus.
- The Math Team also recommended that formula sheets likewise be restricted or limited. Formula sheets in a Geometry end-of-course exam were of most concern to the Math Team. Students just completing a Geometry course should be expected to know for the end-of-course assessment the formula that they learned in the course. The Math Team was somewhat flexible with regard to the "less-intuitive" formulas, such as those for prisms, cones, and pyramids.

Question Five: Which two mathematics end-of-course assessments would best serve institutions of higher education with regard to admissions and placement decisions?

Answer:

- The first choice of the Math Team was the Algebra II end-of-course assessment. For the mathematicians on the team, algebra skills were the most vital to success in either College Algebra or Calculus. As such, the two Algebra end-of-course assessments were most important.
 - Another obvious reason the Math Team placed such importance on the Algebra II end-of-course assessment is that it would be taken later than either the Algebra I and Geometry end-of-course assessments (assuming a traditional course-taking progression) and would thereby provide the most up-to-date information on students' development of mathematics skills.
- The second choice of the Math Team was the Geometry end-of-course assessment. For the entire Math Team, the reasoning skills developed in Geometry (geometric proofs) were very important (although algebraic proofs could be as useful in developing these skills). For the mathematicians on the team, the increase in the amount of Algebra I skills (up to 30%) to be assessed on the revised Graduation Qualifying Exam diminished the necessity of the Algebra I end-of-course assessment while the importance of Geometry skills to

the scientist and engineers on the team increased the importance of the Geometry end-of-course assessment.

- Regarding other mathematics courses...
 - The Math Team recommends that students take at a minimum the traditional sequence of Algebra I, (formal) Geometry, Algebra II. In addition, students would be advised to take a fourth year of mathematics (a rigorous/substantive course) in order to maximize their readiness to begin credit-bearing work in college.
 - The Math Team touched on the issue of “what is” v. “what should be” with regard to Data Analysis and Statistics. Currently, higher education departments requiring statistics teach their freshman themselves. Under these circumstances, basic statistics skills (e.g., interpreting simple graphs, charts, and tables) would be sufficient preparation for students entering college.
 - As was the case in the other partner states, members of the Indiana 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.

APPENDICES

The following tables represent the results from the Achieve alignment study for the Indiana Core 40 Assessments (Algebra I, Geometry Algebra II) and the corresponding Academic Standards

Assessments

Indiana Core 40 Assessment:
Revised Algebra I, Form G
Geometry
Algebra II

Standards

Indiana's Academic Standards
Adopted 2000

Test Design

Algebra I: 28 Items, 30 scored*
Geometry: 23 Items, 27 scored*
Algebra II: 20 Items, 25 scored*

** Several items in each test mapped to multiple objectives and each portion of these items was scored separately.*

APPENDIX 1: Item Types and Point Distribution

APPENDIX 2: Content Centrality

APPENDIX 3: Performance Centrality

APPENDIX 4: Source of Challenge

APPENDIX 5: Level of Cognitive Demand

APPENDIX 6: Level of Challenge

APPENDIX 7: Balance

APPENDIX 8: Range

APPENDIX 1: Item Types and Point Distribution

A: Algebra I Item Types and Point Distribution

| Item Type | # of Items | # of Points |
|------------------------|------------|-------------|
| Multiple-Choice Items | 10 | 10 |
| Short-Answer Items | 10 | 20 |
| Open Response Items | 8 | 30 |
| TEST AS A WHOLE | 28* | 60 |

**Note: Items 23 and 24 consist of 2 parts each, with each part mapping to a different objective. For purposes of these summary data tables, the item count is therefore 30 rather than 28.*

B: Geometry Item Types and Point Distribution

| Item Type | # of Items | # of Points |
|------------------------|------------|-------------|
| Multiple-Choice Items | 10 | 10 |
| Short-Answer Items | 8 | 20 |
| Open Response Items | 5 | 40 |
| TEST AS A WHOLE | 23* | 70 |

**Note: Item 20 consists of 2 parts, and Item 23 consists of 3 parts, with each part mapping to a different objective. Item 21 consists of 5 parts, mapping to 2 different objectives. For purposes of these summary data tables, the item count is therefore 27 rather than 23.*

C: Algebra II Item Types and Point Distribution

| Item Type | # of Items | # of Points |
|------------------------|------------|-------------|
| Multiple-Choice Items | 10 | 10 |
| Short-Answer Items | 6 | 20 |
| Open Response Items | 4 | 40 |
| TEST AS A WHOLE | 20 | 70 |

**Note: Item 16 consists of 2 parts, with each part mapping to a different objective. Item 18 consists of 3 parts, with each part mapping to a different objective. Item 20 consists of 5 parts, mapping to 3 different objectives. For purposes of these summary data tables, the item count is therefore 25 rather than 20.*

APPENDIX 2: Content Centrality

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

A: Algebra I Content Centrality

| Algebra I Standard | # of Items | # of Points | 2 | 1a | 1b | 0 |
|--|---------------------|---------------------|----------------------|--------------------|---------------------|----------|
| Operations with Real Numbers | 3 (10%) | 3 (5%) | 2 | 0 | 1 | 0 |
| Linear Equations and Inequalities | 5 (16.7%) | 9 (15%) | 5 | 0 | 0 | 0 |
| Relations and Functions | 4 (13.3%) | 5 (8.3%) | 3 | 1 | 0 | 0 |
| Graphing Linear Equations and Inequalities | 2 (6.7%) | 4 (6.7%) | 2 | 0 | 0 | 0 |
| Pairs of Linear Equations and Inequalities | 4 (13.3%) | 15 (25%) | 4 | 0 | 0 | 0 |
| Polynomials | 4 (13.3%) | 7 (11.7%) | 3 | 0 | 1 | 0 |
| Algebraic Fractions | 1 (3.3%) | 3 (5%) | 1 | 0 | 0 | 0 |
| Quadratic, Cubic, and Radical Equations | 5 (16.7%) | 9 (15%) | 4 | 0 | 1 | 0 |
| Mathematical Reasoning and Problem Solving | 2 (6.7%) | 5 (8.3%) | 2 | 0 | 0 | 0 |
| TEST AS A WHOLE | 30 (100%) | 60 (100%) | 26 (86.7%) | 1 (3.3%) | 3 (10.0%) | 0 |

B: Geometry Content Centrality

| Geometry Standard | # of Items | # of Points | 2 | 1a | 1b | 0 |
|--|---------------------|---------------------|----------------------|----------|----------------------|----------|
| Points, Lines, Angles, and Planes | 4 (14.8%) | 10 (14.3%) | 2 | 0 | 2 | 0 |
| Polygons | 2 (7.4%) | 8 (11.4%) | 2 | 0 | 0 | 0 |
| Quadrilaterals | 4 (14.8%) | 7 (10%) | 4 | 0 | 0 | 0 |
| Triangles | 5 (18.6%) | 9 (12.9%) | 1 | 0 | 4 | 0 |
| Right Triangles | 3 (11.1%) | 9 (12.9%) | 3 | 0 | 0 | 0 |
| Circles | 3 (11.1%) | 5 (7.1%) | 0 | 0 | 3 | 0 |
| Polyhedra and Other Solids | 3 (11.1%) | 9 (12.9%) | 2 | 0 | 1 | 0 |
| Mathematical Reasoning and Problem Solving | 3 (11.1%) | 13 (18.5%) | 1 | 0 | 2 | 0 |
| TEST AS A WHOLE | 27 (100%) | 70 (100%) | 15 (55.6%) | 0 | 12 (44.4%) | 0 |

C: Algebra II Content Centrality

| Algebra II Standard | # of Items | # of Points | 2 | 1a | 1b | 0 |
|--|---------------------|---------------------|--------------------|-----------|--------------------|----------|
| Relations and Functions | 6 (24%) | 18 (25.7%) | 4 | 0 | 2 | 0 |
| Linear and Absolute Value Equations and Inequalities | 3 (12%) | 16 (22.8%) | 1 | 0 | 2 | 0 |
| Quadratic Equations and Functions | 3 (12%) | 9 (12.9%) | 2 | 0 | 1 | 0 |
| Conic Sections | 1 (4%) | 1 (1.4%) | 0 | 0 | 1 | 0 |
| Polynomials | 3 (12%) | 6 (8.6%) | 2 | 0 | 1 | 0 |
| Algebraic Fractions | 4 (16%) | 6 (8.6%) | 3 | 0 | 1 | 0 |
| Logarithmic and Exponential Functions | 2 (8%) | 9 (12.9%) | 1 | 0 | 1 | 0 |
| Sequences and Series | 1 (4%) | 1 (1.4%) | 0 | 0 | 1 | 0 |
| Counting Principles and Probability | 1 (4%) | 1 (1.4%) | 1 | 0 | 0 | 0 |
| Mathematical Reasoning and Problem Solving | 1 (4%) | 3 (4.3%) | 1 | 0 | 0 | 0 |
| TEST AS A WHOLE | 25 (100%) | 70 (100%) | 15 (60%) | 0 | 10 (40%) | 0 |

APPENDIX 3: Performance Centrality

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

A: Algebra I Performance Centrality

| Algebra I Standard | # of Items | # of Points | 2 | 1a | 1b | 0 |
|--|---------------------|---------------------|----------------------|--------------------|----------|----------|
| Operations with Real Numbers | 3 (10%) | 3 (5%) | 3 | 0 | 0 | 0 |
| Linear Equations and Inequalities | 5 (16.7%) | 9 (15%) | 5 | 0 | 0 | 0 |
| Relations and Functions | 4 (13.3%) | 5 (8.3%) | 3 | 1 | 0 | 0 |
| Graphing Linear Equations and Inequalities | 2 (6.7%) | 4 (6.7%) | 2 | 0 | 0 | 0 |
| Pairs of Linear Equations and Inequalities | 4 (13.3%) | 15 (25%) | 4 | 0 | 0 | 0 |
| Polynomials | 4 (13.3%) | 7 (11.7%) | 4 | 0 | 0 | 0 |
| Algebraic Fractions | 1 (3.3%) | 3 (5%) | 1 | 0 | 0 | 0 |
| Quadratic, Cubic, and Radical Equations | 5 (16.7%) | 9 (15%) | 5 | 0 | 0 | 0 |
| Mathematical Reasoning and Problem Solving | 2 (6.7%) | 5 (8.3%) | 2 | 0 | 0 | 0 |
| TEST AS A WHOLE | 30 (100%) | 60 (100%) | 29 (96.7%) | 1 (3.3%) | 0 | 0 |

B: Geometry Performance Centrality

| Geometry Standard | # of Items | # of Points | 2 | 1a | 1b | 0 |
|--|---------------------|---------------------|----------------------|----------|---------------------|----------|
| Points, Lines, Angles, and Planes | 4 (14.8%) | 10 (14.3%) | 3 | 0 | 1 | 0 |
| Polygons | 2 (7.4%) | 8 (11.4%) | 1 | 0 | 1 | 0 |
| Quadrilaterals | 4 (14.8%) | 7 (10%) | 2 | 0 | 2 | 0 |
| Triangles | 5 (18.6%) | 9 (12.9%) | 4 | 0 | 1 | 0 |
| Right Triangles | 3 (11.1%) | 9 (12.9%) | 3 | 0 | 0 | 0 |
| Circles | 3 (11.1%) | 5 (7.1%) | 2 | 0 | 1 | 0 |
| Polyhedra and Other Solids | 3 (11.1%) | 9 (12.9%) | 3 | 0 | 0 | 0 |
| Mathematical Reasoning and Problem Solving | 3 (11.1%) | 13 (18.5%) | 1 | 0 | 2 | 0 |
| TEST AS A WHOLE | 27 (100%) | 70 (100%) | 19 (70.4%) | 0 | 8 (29.6%) | 0 |

C: Algebra II Performance Centrality

| Algebra II Standard | # of Items | # of Points | 2 | 1a | 1b | 0 |
|--|---------------------|---------------------|--------------------|-----------|-------------------|------------------|
| Relations and Functions | 6 (24%) | 18 (25.7%) | 4 | 0 | 2 | 0 |
| Linear and Absolute Value Equations and Inequalities | 3 (12%) | 16 (22.8%) | 3 | 0 | 0 | 0 |
| Quadratic Equations and Functions | 3 (12%) | 9 (12.9%) | 2 | 0 | 1 | 0 |
| Conic Sections | 1 (4%) | 1 (1.4%) | 0 | 0 | 0 | 1 |
| Polynomials | 3 (12%) | 6 (8.6%) | 1 | 0 | 1 | 1 |
| Algebraic Fractions | 4 (16%) | 6 (8.6%) | 3 | 0 | 1 | 0 |
| Logarithmic and Exponential Functions | 2 (8%) | 9 (12.9%) | 2 | 0 | 0 | 0 |
| Sequences and Series | 1 (4%) | 1 (1.4%) | 1 | 0 | 0 | 0 |
| Counting Principles and Probability | 1 (4%) | 1 (1.4%) | 1 | 0 | 0 | 0 |
| Mathematical Reasoning and Problem Solving | 1 (4%) | 3 (4.3%) | 1 | 0 | 0 | 0 |
| TEST AS A WHOLE | 25 (100%) | 70 (100%) | 18 (72%) | 0 | 5 (20%) | 2 (8%) |

APPENDIX 4: Source of Challenge

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

A: Algebra I Source of Challenge

| Algebra I Standard | # of Items | # of Points | 1 | 0 | Not Scored |
|--|---------------------|---------------------|---------------------|----------|------------|
| Operations with Real Numbers | 3 (10%) | 3 (5%) | 3 | 0 | 0 |
| Linear Equations and Inequalities | 5 (16.7%) | 9 (15%) | 5 | 0 | 0 |
| Relations and Functions | 4 (13.3%) | 5 (8.3%) | 4 | 0 | 0 |
| Graphing Linear Equations and Inequalities | 2 (6.7%) | 4 (6.7%) | 2 | 0 | 0 |
| Pairs of Linear Equations and Inequalities | 4 (13.3%) | 15 (25%) | 4 | 0 | 0 |
| Polynomials | 4 (13.3%) | 7 (11.7%) | 4 | 0 | 0 |
| Algebraic Fractions | 1 (3.3%) | 3 (5%) | 1 | 0 | 0 |
| Quadratic, Cubic, and Radical Equations | 5 (16.7%) | 9 (15%) | 5 | 0 | 0 |
| Mathematical Reasoning and Problem Solving | 2 (6.7%) | 5 (8.3%) | 2 | 0 | 0 |
| TEST AS A WHOLE | 30 (100%) | 60 (100%) | 30 (100%) | 0 | 0 |

B: Geometry Source of Challenge

| Geometry Standard | # of Items | # of Points | 1 | 0 | Not Scored |
|--|---------------------|---------------------|---------------------|----------|------------|
| Points, Lines, Angles, and Planes | 4 (14.8%) | 10 (14.3%) | 4 | 0 | 0 |
| Polygons | 2 (7.4%) | 8 (11.4%) | 2 | 0 | 0 |
| Quadrilaterals | 4 (14.8%) | 7 (10%) | 4 | 0 | 0 |
| Triangles | 5 (18.6%) | 9 (12.9%) | 5 | 0 | 0 |
| Right Triangles | 3 (11.1%) | 9 (12.9%) | 3 | 0 | 0 |
| Circles | 3 (11.1%) | 5 (7.1%) | 3 | 0 | 0 |
| Polyhedra and Other Solids | 3 (11.1%) | 9 (12.9%) | 3 | 0 | 0 |
| Mathematical Reasoning and Problem Solving | 3 (11.1%) | 13 (18.5%) | 3 | 0 | 0 |
| TEST AS A WHOLE | 27 (100%) | 70 (100%) | 27 (100%) | 0 | 0 |

C: Algebra II Source of Challenge

| Algebra II Standard | # of Items | # of Points | 1 | 0 | Not Scored |
|--|---------------------|---------------------|---------------------|----------|-------------------|
| Relations and Functions | 6 (24%) | 18 (25.7%) | 6 | 0 | 0 |
| Linear and Absolute Value Equations and Inequalities | 3 (12%) | 16 (22.8%) | 3 | 0 | 0 |
| Quadratic Equations and Functions | 3 (12%) | 9 (12.9%) | 3 | 0 | 0 |
| Conic Sections | 1 (4%) | 1 (1.4%) | 1 | 0 | 0 |
| Polynomials | 3 (12%) | 6 (8.6%) | 3 | 0 | 0 |
| Algebraic Fractions | 4 (16%) | 6 (8.6%) | 4 | 0 | 0 |
| Logarithmic and Exponential Functions | 2 (8%) | 9 (12.9%) | 2 | 0 | 0 |
| Sequences and Series | 1 (4%) | 1 (1.4%) | 1 | 0 | 0 |
| Counting Principles and Probability | 1 (4%) | 1 (1.4%) | 1 | 0 | 0 |
| Mathematical Reasoning and Problem Solving | 1 (4%) | 3 (4.3%) | 1 | 0 | 0 |
| TEST AS A WHOLE | 25 (100%) | 70 (100%) | 25 (100%) | 0 | 0 |

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.

A: Algebra I Level of Cognitive Demand

| Algebra I Standard | # of Items | # of Points | 4 | 3 | 2 | 1 |
|--|---------------------|---------------------|----------|-------------------|----------------------|----------------------|
| Operations with Real Numbers | 3 (10%) | 3 (5%) | 0 | 0 | 0 | 3 |
| Linear Equations and Inequalities | 5 (16.7%) | 9 (15%) | 0 | 0 | 1 | 4 |
| Relations and Functions | 4 (13.3%) | 5 (8.3%) | 0 | 0 | 3 | 1 |
| Graphing Linear Equations and Inequalities | 2 (6.7%) | 4 (6.7%) | 0 | 1 | 1 | 0 |
| Pairs of Linear Equations and Inequalities | 4 (13.3%) | 15 (25%) | 0 | 1 | 3 | 0 |
| Polynomials | 4 (13.3%) | 7 (11.7%) | 0 | 0 | 0 | 4 |
| Algebraic Fractions | 1 (3.3%) | 3 (5%) | 0 | 0 | 1 | 0 |
| Quadratic, Cubic, and Radical Equations | 5 (16.7%) | 9 (15%) | 0 | 0 | 4 | 1 |
| Mathematical Reasoning and Problem Solving | 2 (6.7%) | 5 (8.3%) | 0 | 1 | 1 | 0 |
| TEST AS A WHOLE | 30 (100%) | 60 (100%) | 0 | 3 (10%) | 14 (46.7%) | 13 (43.3%) |

B: Geometry Level of Cognitive Demand

| Geometry Standard | # of Items | # of Points | 4 | 3 | 2 | 1 |
|--|---------------------|---------------------|----------|--------------------|----------------------|--------------------|
| Points, Lines, Angles, and Planes | 4 (14.8%) | 10 (14.3%) | 0 | 0 | 2 | 2 |
| Polygons | 2 (7.4%) | 8 (11.4%) | 0 | 0 | 2 | 0 |
| Quadrilaterals | 4 (14.8%) | 7 (10%) | 0 | 0 | 2 | 2 |
| Triangles | 5 (18.6%) | 9 (12.9%) | 0 | 1 | 3 | 1 |
| Right Triangles | 3 (11.1%) | 9 (12.9%) | 0 | 0 | 2 | 1 |
| Circles | 3 (11.1%) | 5 (7.1%) | 0 | 0 | 0 | 3 |
| Polyhedra and Other Solids | 3 (11.1%) | 9 (12.9%) | 0 | 0 | 3 | 0 |
| Mathematical Reasoning and Problem Solving | 3 (11.1%) | 13 (18.5%) | 0 | 1 | 1 | 1 |
| TEST AS A WHOLE | 27 (100%) | 70 (100%) | 0 | 2 (7.4%) | 15 (55.6%) | 10 (37%) |

C: Algebra II Level of Cognitive Demand

| Algebra II Standard | # of Items | # of Points | 4 | 3 | 2 | 1 |
|--|---------------------|---------------------|----------|----------------|--------------------|--------------------|
| Relations and Functions | 6 (24%) | 18 (25.7%) | 0 | 0 | 1 | 5 |
| Linear and Absolute Value Equations and Inequalities | 3 (12%) | 16 (22.8%) | 0 | 0 | 2 | 1 |
| Quadratic Equations and Functions | 3 (12%) | 9 (12.9%) | 0 | 0 | 2 | 1 |
| Conic Sections | 1 (4%) | 1 (1.4%) | 0 | 0 | 1 | 0 |
| Polynomials | 3 (12%) | 6 (8.6%) | 0 | 0 | 2 | 1 |
| Algebraic Fractions | 4 (16%) | 6 (8.6%) | 0 | 0 | 1 | 3 |
| Logarithmic and Exponential Functions | 2 (8%) | 9 (12.9%) | 0 | 1 | 0 | 1 |
| Sequences and Series | 1 (4%) | 1 (1.4%) | 0 | 0 | 1 | 0 |
| Counting Principles and Probability | 1 (4%) | 1 (1.4%) | 0 | 0 | 0 | 1 |
| Mathematical Reasoning and Problem Solving | 1 (4%) | 3 (4.3%) | 0 | 0 | 1 | 0 |
| TEST AS A WHOLE | 25 (100%) | 70 (100%) | 0 | 1 4% | 11 (44%) | 13 (52%) |

APPENDIX 6: Level of Challenge

Note: Ratings for Level of Challenge are either Appropriate or Low.

A: Algebra I Level of Challenge

| Algebra I Standard | Level of Challenge of Item Set | Comments |
|--|--------------------------------|--|
| Operations with Real Numbers | Appropriate | MC=3 Level 1=3 |
| Linear Equations and Inequalities | Appropriate | MC=2, SA=2, OR=1 Level 1=4, Level 2=1 |
| Relations and Functions | Appropriate | MC=2, SA=1, OR=1 Level 1=1, Level 2=3 |
| Graphing Linear Equations and Inequalities | Appropriate | SA=2 Level 2=1, Level 3=1 |
| Pairs of Linear Equations and Inequalities | Appropriate | OR=4 Level 2=3, Level 3=1 |
| Polynomials | Appropriate | MC=1, SA=3 Level 1=4 |
| Algebraic Fractions | Appropriate | OR=1 Level 2=1 |
| Quadratic, Cubic, and Radical Equations | Appropriate | MC=2, SA=2, OR=1 Level 1=1, Level 2=4 |
| Mathematical Reasoning and Problem Solving | Appropriate | OR=2 Level 2=1, Level 3=1 |
| TEST AS A WHOLE | Appropriate | MC=10, SA=10, OR=10 Level 1=13, Level 2=14, Level 3=3 |

B: Geometry Level of Challenge

| Geometry Standard | Level of Challenge of Item Set | Comments |
|--|--------------------------------|--|
| Points, Lines, Angles, and Planes | Appropriate | MC=2, SA=1, OR=1 Level 1=2, Level 2=2 |
| Polygons | Low | MC=1, OR=1 Level 2=2 |
| Quadrilaterals | Appropriate | MC=1, SA=2, OR=1 Level 1=2, Level 2=2 |
| Triangles | Appropriate | MC=2, SA=2, OR=1 Level 1=1, Level 2=3, Level 3=1 |
| Right Triangles | Appropriate | MC=1, OR=2 Level 1=1, Level 2=2 |
| Circles | Low | MC=1, SA=1, OR=1 Level 1=3 |
| Polyhedra and Other Solids | Appropriate | MC=1, SA=1, OR=1 Level 2=3 |
| Mathematical Reasoning and Problem Solving | Appropriate | MC=1, SA=1, OR=1 Level 1=1, Level 2=1, Level 3=1 |
| TEST AS A WHOLE | Appropriate | MC=10, SA=8, OR=9 Level 1=10, Level 2=15, Level 3=2 |

C: Algebra II Level of Challenge

| Algebra II Standard | Level of Challenge of Item Set | Comments |
|--|---------------------------------------|--|
| Operations with Real Numbers | Appropriate | MC=3 Level 1=3 |
| Linear Equations and Inequalities | Appropriate | MC=2, SA=2, OR=1 Level 1=4, Level 2=1 |
| Relations and Functions | Appropriate | MC=2, SA=1, OR=1 Level 1=1, Level 2=3 |
| Graphing Linear Equations and Inequalities | Appropriate | SA=2 Level 2=1, Level 3=1 |
| Pairs of Linear Equations and Inequalities | Appropriate | OR=4 Level 2=3, Level 3=1 |
| Polynomials | Appropriate | MC=1, SA=3 Level 1=4 |
| Algebraic Fractions | Appropriate | OR=1 Level 2=1 |
| Quadratic, Cubic, and Radical Equations | Appropriate | MC=2, SA=2, OR=1 Level 1=1, Level 2=4 |
| Mathematical Reasoning and Problem Solving | Appropriate | OR=2 Level 2=1, Level 3=1 |
| TEST AS A WHOLE | Appropriate | MC=10, SA=10, OR=10 Level 1=13, Level 2=14, Level 3=3 |

APPENDIX 7: Balance

Note: Ratings for Balance are either Fair or Poor.

A: Algebra I

| Algebra I Standard | Balance of Item Set | Comments |
|--|---------------------|---|
| Operations with Real Numbers | Fair | N/A |
| Linear Equations and Inequalities | Fair | N/A |
| Relations and Functions | Fair | N/A |
| Graphing Linear Equations and Inequalities | Fair | Although only 1 of 6 standards is directly assessed, most are assessed secondarily in the context of other items. |
| Pairs of Linear Equations and Inequalities | Fair | Three of 6 standards relate to varying strategies students might use to solve a pair of linear equations in 2 variables. While Item 25 was mapped to only one standard, it might easily have been mapped to another. |
| Polynomials | Fair | While half the standards are directly assessed, other standards are addressed secondarily, e.g., if students can divide polynomials by monomials they can divide monomials. |
| Algebraic Fractions | Fair | N/A |
| Quadratic, Cubic, and Radical Equations | Fair | Two items assess Std. 8.2, if one assumes that students will use factoring to solve a factorable quadratic equation. Since separate standards address completing the square and the quadratic formula, these might also have been used by students—thereby enhancing the balance. |
| Mathematical Reasoning and Problem Solving | Fair | While the test tends to be procedural and algorithmic, several items (particularly open response items) require students to use more sophisticated reasoning and problem solving skills. |
| TEST AS A WHOLE | Fair | The test is generally well balanced across standards, if one looks at distribution of items. If one looks at distribution of point values across standards, there is a disproportionate emphasis on Pairs of Linear Equations and Inequalities. All three items mapping to this standard are open-response, accounting for 25% of the test's point value. |

B: Geometry

| Geometry Standard | Balance of Item Set | Comments |
|-----------------------------------|---------------------|--|
| Points, Lines, Angles, and Planes | Fair | N/A |
| Polygons | Poor | With 4 unassessed objectives, this 2-item set does not reflect the balance of content in the standard. In addition, the 2 items tend to represent a low level of challenge in that they do not require students to describe, justify, or prove. The 7-point OR item calls on students to apply area formulas that they should have known from earlier grades, although the formulas are also provided. |

| Geometry Standard | Balance of Item Set | Comments |
|--|----------------------------|--|
| Quadrilaterals | Fair | Two items assess G.3.3 but are not duplicative. It would have been good to have an item assessing G.3.2 since this is important content. Items 14 and 15 could have been made more challenging by requiring students to justify or explain their answers, which is consistent with the standard. |
| Triangles | Fair | Several objectives indicate the expectation that students be able to prove, and this item set included one unscaffolded proof. Two items assess G.4.4, but using properties of congruent and similar triangles to solve problems is critical content. No constructions are required by the item set, although 2 objectives reference construction. |
| Right Triangles | Fair | Item set requires students to use Pythagorean Theorem, trig, and special right triangles. |
| Circles | Poor | Two items assess G.6.7, with one emphasizing circumference and one area. Both of these concepts are middle-school concepts, with the formulas provided to students. With 6 of 8 standards unassessed, important content is not assessed—including measures of arcs and related angles and determining the equation of a circle. |
| Polyhedra and Other Solids | Fair | N/A |
| Mathematical Reasoning and Problem Solving | Fair | While some objectives are not identified as primary maps for items, several are addressed secondarily by items—particularly those involving constructions and the development of logical arguments. With respect to the mix of conceptual versus pure mathematical items, this test approximates the Algebra I test. |
| TEST AS A WHOLE | Fair | This test is generally well balanced across standards, both from the perspective of item distribution and point distribution. |

C: Algebra II

| Algebra II Standard | Balance of Item Set | Comments |
|--|----------------------------|---|
| Relations and Functions | Poor | The 6 items/item sets mapping to this standard align with 3 objectives (2 per objective), leaving 5 of 8 objectives not assessed. |
| Linear and Absolute Value Equations and Inequalities | Fair | While balance is fair, it would have been good to include an item that addresses absolute value equations and/or inequalities. |
| Quadratic Equations and Functions | Fair | Given the limited number of items on this test, the item distribution is fair. However, some difficult concepts (e.g., solving quadratic equations in the complex number system and those that contain radical expressions) are not assessed. |
| Conic Sections | Fair | N/A |
| Polynomials | Poor | The items do not span the level of demand expressed in the standards and as clarified by the examples. The two MC items, in particular, address some of the least challenging aspects of this standard. |
| Algebraic Fractions | Fair | N/A |

| Algebra II Standard | Balance of Item Set | Comments |
|--|----------------------------|---|
| Logarithmic and Exponential Functions | Poor | With 6 of 8 objectives not assessed, students are not expected to demonstrate the breadth of knowledge expected of them in this standard. The primary emphasis is on the problem devoted to exponential decay (8 of 9 points). |
| Sequences and Series | Poor | With 3 of 4 objectives not assessed, some of the more challenging aspects of the standard are not assessed (e.g., partial sums and applications of sequences and series to the solution of word problems). Item 1 is a very simple problem, particularly given the MC format of the item. |
| Counting Principles and Probability | Fair | N/A |
| Mathematical Reasoning and Problem Solving | Poor | Several aspects of reasoning and problem solving defined in the standards are not addressed by these items. The one primary mapping to this standard addresses content that students should have mastered prior to Algebra II. |
| TEST AS A WHOLE | Fair | Although this test places heavy emphasis on Relations and Functions and Linear and Absolute Value Equations and Inequalities (as witnessed by the distribution of point values), it is generally well balanced across the standards. |

APPENDIX 8: Range

Note: Ratings for Range are either Good, Acceptable, or Poor.

A: Algebra I

| Algebra I Standard | Portion of Standards Assessed | Range of Item Set |
|--|-------------------------------|-------------------|
| Operations with Real Numbers | 3/5 or 0.60 | Acceptable |
| Linear Equations and Inequalities | 5/6 or 0.83 | Good |
| Relations and Functions | 3/4 or 0.75 | Good |
| Graphing Linear Equations and Inequalities | 1/6 or 0.17 | Poor |
| Pairs of Linear Equations and Inequalities | 4/6 or 0.67 | Good |
| Polynomials | 4/8 or 0.50 | Acceptable |
| Algebraic Fractions | 1/2 or 0.50 | Acceptable |
| Quadratic, Cubic, and Radical Equations | 4/9 or 0.44 | Poor |
| Mathematical Reasoning and Problem Solving | 2/8 or 0.25 | Poor |
| TEST AS A WHOLE | 27/54 or 0.50 | Acceptable |

B: Geometry

| Geometry Standard | Portion of Standards Assessed | Range of Item Set |
|--|-------------------------------|-------------------|
| Points, Lines, Angles, and Planes | 4/4 or 1.00 | Good |
| Polygons | 2/6 or 0.33 | Poor |
| Quadrilaterals | 3/4 or 0.75 | Good |
| Triangles | 4/9 or 0.44 | Poor |
| Right Triangles | 3/6 or 0.50 | Acceptable |
| Circles | 2/8 or 0.50 | Poor |
| Polyhedra and Other Solids | 3/7 or 0.43 | Acceptable |
| Mathematical Reasoning and Problem Solving | 3/9 or 0.33 | Poor |
| TEST AS A WHOLE | 24/53 or 0.45 | Poor |

C: Algebra II

| Algebra II Standard | Portion of Standards Assessed | Range of Item Set |
|--|-------------------------------|-------------------|
| Relations and Functions | 3/8 or 0.38 | Poor |
| Linear and Absolute Value Equations and Inequalities | 3/4 or 0.75 | Good |
| Quadratic Equations and Functions | 3/7 or 0.43 | Poor |
| Conic Sections | 1/2 or 0.50 | Acceptable |
| Polynomials | 3/7 or 0.43 | Poor |
| Algebraic Fractions | 4/6 or 0.67 | Good |
| Logarithmic and Exponential Functions | 2/8 or 0.25 | Poor |
| Sequences and Series | 1/4 or 0.25 | Poor |
| Counting Principles and Probability | 1/2 or 0.50 | Acceptable |
| Mathematical Reasoning and Problem Solving | 1/6 or 0.17 | Poor |
| TEST AS A WHOLE | 22/54 or 0.41 | Poor |