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Multistate Standard-Setting Technical Report

PRAXIS™ MIDDLE SCHOOL MATHEMATICS (5169)

Licensure and Credentialing Research

ETS

Princeton, New Jersey

February 2013

To support the decision-making process of education agencies establishing a passing score (cut score) for the Praxis™ Middle School Mathematics (5169) test, research staff from Educational Testing Service (ETS) designed and conducted a multistate standard-setting study.

PARTICIPATING STATES

Panelists from 18 states and Washington, DC were recommended by their respective education agency. The education agencies recommended panelists with (a) experience either as middle school mathematics teachers or college faculty who prepare middle school mathematics teachers and (b) familiarity with the knowledge and skills required of beginning middle school mathematics teachers.

RECOMMENDED PASSING SCORE

ETS provides a recommended passing score from the multistate standard-setting study to help education agencies determine an appropriate operational passing score. For the Praxis Middle School Mathematics test, the recommended passing score[1] is 31 out of a possible 45 raw-score points. The scaled score associated with a raw score of 31 is 165 on a 100–200 scale.

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[1] Results from the two panels participating in the study were averaged to produce the recommended passing score.

To support the decision-making process for education agencies establishing a passing score (cut score) for the Praxis™ Middle School Mathematics (5169) test, research staff from ETS designed and conducted a multistate standard-setting study in February 2013 in Princeton, New Jersey. Education agencies[2] recommended panelists with (a) experience, either as middle school mathematics teachers or college faculty who prepare middle school mathematics teachers and (b) familiarity with the knowledge and skills required of beginning middle school mathematics teachers. Eighteen states and Washington, DC (see Table 1) were represented by 30 panelists. (See Appendix A for the names and affiliations of the panelists.)

Table 1
Participating Jurisdictions and Number of Panelists

Alaska (1 panelist)	New Jersey (2 panelists)
Arkansas (1 panelist)	Nevada (2 panelists)
Idaho (2 panelists)	South Carolina (2 panelists)
Kentucky (1 panelist)	South Dakota (2 panelists)
Louisiana (1 panelist)	Utah (2 panelists)
Maryland (2 panelists)	Vermont (1 panelist)
Mississippi (2 panelists)	Washington, DC (2 panelists)
North Carolina (2 panelists)	West Virginia (1 panelist)
North Dakota (1 panelist)	Wyoming (1 panelist)
New Hampshire (2 panelists)	

The following technical report contains three sections. The first section describes the content and format of the test. The second section describes the standard-setting processes and methods. The third section presents the results of the standard-setting study.

ETS provides a recommended passing score from the multistate standard-setting study to education agencies. In each jurisdiction, the department of education, the board of education, or a designated educator licensure board is responsible for establishing the operational passing score in accordance with applicable regulations. This study provides a recommended passing score,[3] which represents the combined judgments of two panels of experienced educators. Each jurisdiction may want

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[2] States and jurisdictions that currently use Praxis were invited to participate in the multistate standard-setting study.
[3] In addition to the recommended passing score underlined averaged across the two panels, the recommened passing scores for each panel are presented.

to consider the recommended passing score but also other sources of information when setting the final Praxis Middle School Mathematics passing score (see Geisinger & McCormick, 2010). A jurisdiction may accept the recommended passing score, adjust the score upward to reflect more stringent expectations, or adjust the score downward to reflect more lenient expectations. There is no *correct* decision; the appropriateness of any adjustment may only be evaluated in terms of its meeting the jurisdiction's needs.

Two sources of information to consider when setting the passing score are the standard error of measurement (SEM) and the standard error of judgment (SEJ). The former addresses the reliability of the Praxis Middle School Mathematics test score and the latter, the reliability of panelists' passing-score recommendation. The SEM allows a jurisdiction to recognize that any test score on any standardized test—including a Praxis Middle School Mathematics test score—is not perfectly reliable. A test score only *approximates* what a candidate truly knows or truly can do on the test. The SEM, therefore, addresses the question: How close of an approximation is the test score to the *true* score? The SEJ allows a jurisdiction to gauge the likelihood that the recommended passing score from a particular panel would be similar to the passing scores recommended by other panels of experts similar in composition and experience. The smaller the SEJ, the more likely that another panel would recommend a passing score consistent with the recommended passing score. The larger the SEJ, the less likely the recommended passing score would be reproduced by another panel.

In addition to measurement error metrics (e.g., SEM, SEJ), each jurisdiction should consider the likelihood of classification error. That is, when adjusting a passing score, policymakers should consider whether it is more important to minimize a false-positive decision or to minimize a false-negative decision. A false-positive decision occurs when a candidate's test score suggests he should receive a license/certificate, but his actual level of knowledge/skills indicates otherwise (i.e., the candidate does not possess the required knowledge/skills). A false-negative decision occurs when a candidate's test score suggests that she should not receive a license/certificate, but she actually does possess the required knowledge/skills. The jurisdiction needs to consider which decision error may be more important to minimize.

Middle School Mathematics (5169)

	Test at a Glance		
Test Name	**Middle School Mathematics**		
Test Code	**5169**		
Time	**120 Minutes**		
Number of Questions	**55 Selected Response Questions**		
Format	**Multiple-choice**		
	Content Categories	Approximate Number of Questions	Approximate Percent of Examination
	I. Arithmetic and Algebra	34	62%
	II. Geometry and Data	21	38%

About This Test

The Middle School Mathematics measures whether entry-level middle school mathematics educators have the standards-relevant knowledge, skills, and abilities believed necessary for competent professional practice.

This test may contain some questions that will not count toward your score.

Topics Covered

I. ARITHMETIC AND ALGEBRA

A. Numbers and Operations

- Understands operations and properties of the real number system.
    — Solve problems using addition, subtraction, multiplication, and division of rational numbers.
    — Apply the order of operations.
    — Given operations on a number system, determine whether the properties hold (e.g., commutative, associative, distributive).
    — Compare, classify, and order real numbers.
    — Perform operations involving exponents, including negative exponents.
    — Simplify and approximate radicals.
    — Represent and compare very large and very small numbers (e.g., scientific notation).

- Understands the relationships among fractions, decimals, and percents.
    — Convert among fractions, decimals, and percents.
    — Represent fractions, decimals, and percents using various models.

- Knows how to use ratio reasoning to solve problems.
    — Apply the concept of a ratio and use ratio language and notation to describe a relationship between two quantities.
    — Compute unit rates.
    — Use ratio reasoning to convert rates.
    — Solve problems involving scale factors.

- Knows how to use proportional relationships to solve real-world problems.
    — Recognize and represent proportional and inversely proportional relationships between two quantities.
    — Use proportional relationships to solve multistep ratio and percent problems.

- Knows how to use basic concepts of number theory (e.g., divisibility, prime factorization, multiples) to solve problems.
    — Recognize relationships involving prime and composite numbers.
    — Solve problems involving odd or even numbers.
    — Solve problems involving factors, multiples, and divisibility.

- Knows a variety of strategies to determine the reasonableness of results.
    — Recognize the reasonableness of results within the context of a given problem.
    — Test the reasonableness of results using estimation.
    — Estimate absolute and relative error in the numerical answer to a problem.

B. Algebra

- Knows how to evaluate and manipulate algebraic expressions, equations, and formulas.
    — Perform arithmetic operations on polynomials.
    — Manipulate and perform arithmetic operations on problems involving rational expressions.
    — Evaluate, manipulate, and compare algebraic expressions involving radicals and exponents, including negative exponents.
    — Use variables to construct and solve equations in real-world contexts.
    — Translate verbal relationships into algebraic equations or expressions.

- Knows how to recognize and represent linear relationships algebraically.
  - — Determine the equation of a line.
  - — Recognize and use the basic forms of linear equations.

- Knows how to solve linear equations and inequalities.
  - — Solve one-variable linear equations and inequalities algebraically and represent solutions on a number line.

- Knows how to represent and solve nonlinear equations and inequalities.
  - — Solve one-variable nonlinear equations and inequalities (e.g., absolute value, quadratic) algebraically and represent solutions on a number line.

- Knows how to represent and solve systems of equations and inequalities.
  - — Represent and solve systems of linear equations and inequalities with two variables algebraically and graphically.

- Knows how to recognize and represent simple sequences or patterns (e.g., arithmetic, geometric).
  - — Evaluate, extend, or algebraically represent rules that involve number patterns.
  - — Describe or extend patterns involving shapes or figures.
  - — Explore patterns in order to make conjectures, predictions, or generalizations.

C. Functions and Their Graphs

- Knows how to identify, define, and evaluate functions.
  - — Know function notation.
  - — Given a set of conditions, decide whether they represent a function.
  - — Evaluate functions for given values (algebraically, graphically, tabular).

- Knows how to determine and interpret the domain and the range of a function numerically, graphically, and algebraically.
  - — Determine the domain and range of a given table of values.
  - — Determine the domain and range from a given graph of a function.
  - — Determine the domain and range of a given function.
  - — Interpret domain and range in real-world settings.

- Understands basic characteristics of linear functions (e.g., slope, intercepts).
  - — Determine the slope of a given linear function.
  - — Interpret slope as a constant rate of change.
  - — Determine the x- and y-intercepts of a given linear function.
  - — Interpret the x- and y-intercepts of a given linear function.

- Understands the relationships among functions, tables and graphs.
  - — Determine and interpret the x- and y-intercepts of any given function.
  - — Given a graph (e.g., linear, quadratic, absolute value, simple exponential), select an equation that best represents the graph.
  - — Determine the graphical properties and sketch a graph given an equation of a linear, quadratic, absolute value, or simple exponential function.

- Knows how to analyze and represent functions that model given information.
  - — Develop a model (e.g., graph, equation, table) of a given set of conditions.
  - — Evaluate whether a particular mathematical model (e.g., graph, equation, table) can be used to describe a given set of conditions.

II. GEOMETRY AND DATA

A. Geometry and Measurement

- Knows how to solve problems involving perimeter, area, surface area, and volume.
  - Calculate and interpret perimeter and area of geometric shapes.
  - Calculate and interpret surface area and volume of geometric shapes.
  - Use two-dimensional representations of three-dimensional objects to visualize and solve problems.

- Understands the concepts of similarity and congruence.
  - Use similarity and congruence to solve problems with two-dimensional and three-dimensional figures.

- Understands properties of lines (e.g., parallel, perpendicular, intersecting) and angles.
  - Solve problems involving parallel, perpendicular, and intersecting lines.
  - Apply angle relationships (e.g., supplementary, vertical, alternate interior) to solve problems.

- Understands properties of triangles.
  - Solve problems that involve sides (e.g., Pythagorean theorem) and angles.
  - Solve problems that involve medians, midpoints, and altitudes.
  - Solve problems involving special triangles (e.g., isosceles, equilateral, right).

- Understands properties of quadrilaterals (e.g., rectangle, rhombus, trapezoid) and other polygons.
  - Know geometric properties of various quadrilaterals (e.g., parallelogram, trapezoid)
  - Know relationships among quadrilaterals.
  - Solve problems involving angles and diagonals.

- Solve problems involving polygons with more than four sides.

- Understands properties of circles.
  - Solve problems involving circumference and area of a circle.
  - Solve problems involving diameter or radius of a circle.
  - Solve basic problems involving central angles, tangents, arcs, and sectors.

- Knows how to interpret geometric relationships in the xy-plane (e.g., transformations, distance, midpoint).
  - Use coordinate geometry to represent and examine the properties of geometric shapes (e.g., Pythagorean theorem, area of rectangle).
  - Determine the distance between two points.
  - Determine the midpoint of two points.
  - Interpret and solve problems involving transformations.

- Understands systems of measurement (e.g., metric, customary).
  - Solve measurement and estimation problems involving time, length, temperature, volume, and mass in both U.S. customary and metric systems, where appropriate.
  - Convert units within each system.

- Is familiar with how geometric constructions are made.
  - Identify formal geometric constructions made with a variety of tools and methods (e.g., copying a segment, bisecting an angle, constructing parallel and perpendicular lines).

B. Probability, Statistics, and Discrete Mathematics

- Knows how to interpret and analyze data presented in various forms.
    — Analyze and interpret various displays of data (e.g., box plots, histograms, scatter plots, stem-and-leaf plots).
    — Draw conclusions based on graphical displays (e.g., misleading representation of data, line of best fit, interpolation).

- Knows how to represent data in various forms.
    — Construct circle graphs, bar graphs, line graphs, histograms, scatter plots, double bar graphs, double line graphs, stem-and-leaf plots, box plots, and line plots/dot plots.
    — Choose an appropriate graph based on data.

- Knows how to develop, use, and evaluate probability models.
    — Use counting techniques, including the counting principle, to answer questions involving a finite sample space.
    — Solve probability problems involving independent and dependent events.
    — Solve problems using geometric probability.

- Understands concepts associated with measures of central tendency and dispersion (spread).
    — Solve for the mean and weighted average of a given set of data.
    — Determine and interpret mean, median, and mode in a variety of problems.
    — Determine and interpret common features of a data set (e.g., range and outliers).
    — Choose an appropriate measure of central tendency to represent a given data set.

- Knows how to model and solve problems using simple diagrams, flowcharts, or algorithms.
    — Construct, use, and interpret simple diagrams (e.g., Venn diagrams, flowcharts) to solve problems.
    — Apply a given algorithm to solve a problem.

5