



# Indiana Department of Education

Dr. Katie Jenner, Secretary of Education

## MEMORANDUM

**TO:** State Board of Education

**FROM:** Dr. John Keller, Chief Technology Officer  
Risa A. Regnier, Director of Educator Licensing

**DATE:** April 14, 2021

**RE:** Adoption of Updated Praxis Tests and Recommended Cut Scores

### Background

In October 2018, the IDOE released an RFP for a new licensure test vendor and program as required by the 2018 General Assembly. In July 2019, in accordance with the results of the RFP and action by the 2019 General Assembly, Educational Testing Service (ETS)--with its nationally available Praxis test program--was adopted by the SBOE to provide educator licensure tests as of September 1, 2021.

Since its adoption in July 2019, ETS and IDOE began working to establish test cut scores for the existing Praxis tests Indiana will use, and the development of several new Praxis tests that will be used in Indiana and made available to other ETS client states. As of December 2020, 42 existing Praxis tests and cut scores had been approved by the board. That level of test and cut score adoption has allowed the DOE to work with the two test vendors to facilitate an earlier transition to many of the Praxis tests than previously planned. The 42 tests and scores already adopted will be available for test administration after July 1, 2021; most of the remaining content tests will be implemented September 1, 2021.

As part of its normal test updating schedule, ETS has updated several Praxis tests, including the Middle School Science test, the Middle School Math test, and the Secondary Math test. Following the updating of these tests, a multi-state standard setting (cut score) study was conducted that included Indiana teachers licensed in these content areas as participants. The tests and recommended cut scores were posted for public comment for 30 days.

- There were no public comments received for the Middle School Science test or the Secondary Math test and their recommended cut scores.
- There was one public comment on the Middle School Math test that was in support of the recommended cut score.

### Action Needed

Under 511 IAC 15-7-2 the board must vote final approval of cut scores for the licensure tests after 30 days of public comment.

### DOE Recommendation

Final approval of the panel-recommended cut scores (RSV) for the Middle School Science test (152), the Middle School Math test (157), and the Secondary Math (159) test identified in the attached documents.



Multistate Standard-Setting Technical Report

***PRAXIS*<sup>®</sup> MATHEMATICS (5165)**

Licensure and Credentialing Research

ETS

Princeton, New Jersey

February 2021

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# EXECUTIVE SUMMARY

To support the decision-making process of education agencies establishing a passing score (cut score) for the *Praxis*<sup>®</sup> Mathematics (5165) test, research staff from Educational Testing Service (ETS) designed and conducted a distance-based multistate standard-setting study.

## PARTICIPATING STATES

Panelists from 13 states and Washington, D.C., were recommended by their respective education agencies. The education agencies recommended panelists with (a) experience as either secondary mathematics teachers or college faculty who prepare secondary mathematics teachers and (b) familiarity with the knowledge and skills required of beginning secondary 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* Mathematics test, the recommended passing score<sup>1</sup> is 39 out of a possible 60 raw-score points. The scale score associated with a raw score of 39 is 159 on a 100–200 scale.

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<sup>1</sup> Results from the two panels participating in the study were averaged to produce the recommended passing score.

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# INTRODUCTION

To support the decision-making process for education agencies establishing a passing score (cut score) for the *Praxis*<sup>®</sup> Mathematics (5165) test, research staff from ETS designed and conducted a distance-based multistate standard-setting study in January 2021. Education agencies<sup>2</sup> recommended panelists with (a) experience as either secondary mathematics teachers or college faculty who prepare secondary mathematics teachers and (b) familiarity with the knowledge and skills required of beginning secondary mathematics teachers. Thirteen states and Washington, D.C. (Table 1) were represented by 25 panelists. (See Appendix A for the names and affiliations of the panelists.)

**Table 1**  
***Participating States, Washington, D.C., and Number of Panelists***

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Alabama (2 panelists)	Mississippi (2 panelists)
Arkansas (2 panelists)	Nevada (1 panelist)
Delaware (2 panelists)	South Carolina (2 panelists)
Idaho (1 panelist)	South Dakota (2 panelists)
Indiana (1 panelist)	Tennessee (2 panelists)
Kansas (2 panelists)	Washington, D.C. (2 panelists)
Maryland (2 panelists)	West Virginia (2 panelists)

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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 state and D.C., 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,<sup>3</sup> which represents the combined judgments of two panels of experienced educators. Each state and D.C., may want to consider the recommended passing score but also other sources of information when setting the final *Praxis* Mathematics passing score (see Geisinger & McCormick, 2010). A states and D.C., may accept the recommended passing score, adjust the score upward to reflect more stringent expectations, or

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<sup>2</sup> States and jurisdictions that currently use *Praxis* tests were invited to participate in the multistate standard-setting study.

<sup>3</sup> In addition to the recommended passing score averaged across the two panels, the passing scores for each panel are presented.

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 state and D.C.'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* Mathematics test score and the latter, the reliability of panelists' passing-score recommendation. The SEM allows a state and D.C., to recognize that any test score on any standardized test—including a *Praxis* 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 state and D.C. 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 state and D.C. should consider the likelihood of classification errors. 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 that 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 state and D.C. need to consider which decision error is more important to minimize.

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# OVERVIEW OF THE *PRAXIS*<sup>®</sup> MATHEMATICS TEST

The *Praxis*<sup>®</sup> Mathematics Test at a Glance document (ETS, in press) describes the purpose and structure of the test. In brief, the test measures the knowledge and competencies important for safe and effective beginning practice as a secondary school mathematics teacher.

The three-hour assessment contains 66 selected-response items<sup>4</sup> covering four content areas: *Number & Quantity and Algebra* (approximately 20 items), *Functions and Calculus* (approximately 20 items), *Geometry* (approximately 13 items), and *Statistics & Probability* (approximately 13 items).<sup>5</sup> The reporting scale for the *Praxis* Mathematics test ranges from 100 to 200 scale-score points.

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## PROCESSES AND METHODS

The design of the standard-setting study included two, independent expert panels of educators with experience with the test content and with new teachers or teacher candidates. Before the study, panelists received an email explaining the purpose of the standard-setting study and requesting that they review materials for the study, such as the test specifications and an overview presentation. This review helped familiarize the panelists with the general structure and content of the test. Additionally, panelists were asked to attend a brief, technology check meeting, to ensure that everyone could access the technology needed for the study.

For each panel, the first day of the standard-setting study began with a welcome by the meeting facilitator. After introductions of the panelists and ETS staff, the facilitator engaged the panel in a question and answer period about the overview presentation. Appendix B shows the agenda for the panel meeting.

## REVIEWING THE TEST

Test familiarization was the first activity for the panel. The purpose of test familiarization is for the panelists to review the test and become familiar with the manner in which a candidate would take the test. After the facilitator described the purpose of the review and how to access the test<sup>6</sup>, the standard-

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<sup>4</sup> Six of the 66 selected-response items are pretest items and do not contribute to a candidate's score.

<sup>5</sup> The number of items for each content area may vary slightly from form to form of the test.

<sup>6</sup> The computer-administered test items were available through the ETS IBIS Content Review Tool.

setting panelists took the test and had a discussion of the content measured. This discussion helped bring the panelists to a shared understanding of what the test measures.

The test discussion covered the major content areas being addressed by the test. Panelists were asked to remark on any content areas that would be particularly challenging for entry-level teachers or areas that address content particularly important for entry-level teachers. Overall, this discussion serves to reduce potential judgment errors later in the standard-setting process.

## DEFINING THE JUST QUALIFIED CANDIDATE

Following the review of the test, panelists described the just qualified candidate. The *just qualified candidate description* plays a central role in standard setting (Perie, 2008); the goal of the standard-setting process is to identify the test score that aligns with this description.

Both panels worked together to create the final description of the just qualified candidate — the knowledge/skills that differentiate a *just* from a *not quite* qualified candidate. Each panel first worked separately by working in smaller and then a large group. Then both panels convened and, through whole-group discussion, combined the two descriptions in to the final version of the just qualified candidate to use for the remainder of the study.

The written description of the just qualified candidate summarized the panel discussion in a bulleted format. The description was not intended to describe all the knowledge and skills of the just qualified candidate but only highlight those that differentiate a *just* qualified candidate from a *not quite* qualified candidate. The written description was distributed to panelists to use during later phases of the study (see Appendix C for the just qualified candidate description).

## PANELISTS' JUDGMENTS

The standard-setting process for the *Praxis* Mathematics test was a probability-based Modified Angoff method (Brandon, 2004; Hambleton & Pitoniak, 2006). In this study, each panelist judged each item on the likelihood (probability or chance) that the just qualified candidate would answer the item correctly. Panelists made their judgments using the following rating scale: 0, .05, .10, .20, .30, .40, .50, .60, .70, .80, .90, .95, 1. The lower the value, the less likely it is that the just qualified candidate would answer the item correctly because the item is difficult for the just qualified candidate. The higher the value, the more likely it is that the just qualified candidate would answer the item correctly.

Panelists were asked to approach the judgment process in two stages. First, they reviewed both the description of the just qualified candidate and the item and determined what was the probability that the just qualified candidate would answer the question correctly. The facilitator encouraged the panelists to consider the following rules of thumb to guide their decision:

- Items in the 0 to .30 range were those the just qualified candidate would have a low chance of answering correctly.
- Items in the .40 to .60 range were those the just qualified candidate would have a moderate chance of answering correctly.
- Items in the .70 to 1 range were those that the just qualified candidate would have a high chance of answering correctly.

Next, panelists decided how to refine their judgment within the range. For example, if a panelist thought that there was a high chance that the just qualified candidate would answer the question correctly, the initial decision would be in the .70 to 1 range. The second decision for the panelist was to judge if the likelihood of answering it correctly is .70, .80, .90, .95 or 1.

After the training, panelists made practice judgments and discussed those judgments and their rationales. All panelists completed a post-training evaluation to confirm that they had received adequate training and felt prepared to continue; the standard-setting process continued only if all panelists confirmed their readiness.

Following this first round of judgments (*Round 1*), item-level feedback was provided to the panel. The panelists' judgments were displayed for each item and summarized across panelists. Items were highlighted to show when panelists converged in their judgments (at least two-thirds of the panelists located an item in the same difficulty range) or diverged in their judgments.

The panelists discussed their item-level judgments. These discussions helped panelists maintain a shared understanding of the knowledge/skills of the just qualified candidate and helped to clarify aspects of items that might not have been clear to all panelists during the Round 1 judgments. The purpose of the discussion was not to encourage panelists to conform to another's judgment, but to understand the different relevant perspectives among the panelists.

In Round 2, panelists discussed their Round 1 judgments and were encouraged by the facilitator (a) to share the rationales for their judgments and (b) to consider their judgments in light of the rationales provided by the other panelists. Panelists recorded their Round 2 judgments only for items



when they wished to change a Round 1 judgment. Panelists’ final judgments for the study, therefore, consist of their Round 1 judgments and any adjusted judgments made during Round 2.

Other than the description of the just qualified candidate, results from Panel 1 were not shared with Panel 2. The item-level judgments and resulting discussions for Panel 2 were independent of judgments and discussions that occurred with Panel 1.

## RESULTS

### EXPERT PANELS

Table 2 presents a summary of the panelists’ demographic information. The panel included 26 educators representing 12 states and D.C. (See Appendix A for a listing of panelists.) Twelve panelists were teachers, eight were college faculty, two were specialists, and three held another position. All of the faculty members’ job responsibilities included the training of secondary mathematics teachers.

The number of experts by panel and their demographic information are presented in Appendix D (Table D1).

**Table 2**  
*Panel Member Demographics (Across Panels)*

	<i>N</i>	<i>%</i>
<b>Current position</b>		
Teacher	12	48
College faculty	8	32
Mathematics Specialist	2	8
Other	3	12
<b>Race</b>		
White	23	92
Black or African American	2	8
<b>Gender</b>		
Female	18	72
Male	7	28
<b>Are you currently certified to teach mathematics in your state?</b>		
Yes	22	88
No	3	12

*(continues on next page)*

**Table 2 (continued)**  
**Panel Member Demographics (Across Panels)**

	N	%
<b>Are you currently teaching mathematics in your state?</b>		
Yes	19	76
No	6	24
<b>Are you currently supervising or mentoring mathematics teachers?</b>		
Yes	23	92
No	2	8
<b>At what K–12 grade level are you currently teaching mathematics?</b>		
Elementary (K–5 or K–6)	1	4
Middle school (6–8 or 7–9)	1	4
Middle and High school	1	4
High school (9–12 or 10–12)	10	40
All Grades	1	4
Not currently teaching at the K–12 level	11	44
<b>Including this year, how many years of experience do you have teaching mathematics?</b>		
3 years or less	0	0
4–7 years	0	0
8–11 years	7	28
12–15 years	3	12
16 years or more	15	60
<b>Which best describes the location of your K–12 school?</b>		
Urban	3	12
Suburban	7	28
Rural	4	16
Not currently working at the K–12 level	11	44
<b>If you are college faculty, are you currently involved in the training/preparation of teacher candidates in mathematics?</b>		
Yes	8	32
No	0	0
Not college faculty	17	68

## STANDARD-SETTING JUDGMENTS

Table 3 summarizes the standard-setting judgments (Round 2) of panelists. The table also includes estimates of the measurement error associated with the judgments: the standard deviation of the mean and the standard error of judgment (SEJ). The SEJ is one way of estimating the reliability or

consistency of a panel’s standard-setting judgments.<sup>7</sup> It indicates how likely it would be for several other panels of educators similar in makeup, experience, and standard-setting training to the current panel to recommend the same passing score on the same form of the test. The confidence intervals created by adding/subtracting two SEJs to each panel’s recommended passing score overlap, indicating that they may be comparable.

Panelist-level results, for Rounds 1 and 2, are presented in Appendix D (Table D2).

**Table 3**  
*Summary of Round 2 Standard-setting Judgments*

	<b>Panel 1</b>	<b>Panel 2</b>
Average	37.18	39.94
Lowest	30.40	33.95
Highest	43.70	46.10
SD	4.22	3.64
SEJ	1.17	1.05

Round 1 judgments are made without discussion among the panelists. The most variability in judgments, therefore, is typically present in the first round. Round 2 judgments, however, are informed by panel discussion; thus, it is common to see a decrease both in the standard deviation and SEJ. This decrease — indicating convergence among the panelists’ judgments — was observed for each panel (see Table D2 in Appendix D). The Round 2 average score is the panel’s recommended passing score.

The panels’ passing score recommendations for the *Praxis* Mathematics test are 37.18 for Panel 1 and 39.94 for Panel 2 (out of a possible 60 raw-score points). The values were rounded to the next highest whole number, to determine the functional recommended passing score — 38 for Panel 1 and 40 for Panel 2. The scale scores associated with 38 and 40 raw points are 157 and 161, respectively.

In addition to the recommended passing score for each panel, the average passing score across the two panels is provided to help education agencies determine an appropriate passing score. The panels’ average passing score recommendation for the *Praxis* Mathematics test is 38.56 (out of a possible 60 raw-score points). The value was rounded to 39 (next highest raw score) to determine the functional recommended passing score. The scale score associated with 39 raw points is 159.

<sup>7</sup> An SEJ assumes that panelists are randomly selected and that standard-setting judgments are independent. It is seldom the case that panelists are randomly sampled, and only the first round of judgments may be considered independent. The SEJ, therefore, likely underestimates the uncertainty of passing scores (Tannenbaum & Katz, 2013).

Table 4 presents the estimated conditional standard error of measurement (CSEM) around the recommended passing score. A standard error represents the uncertainty associated with a test score. The scale scores associated with one and two CSEM above and below the recommended passing score are provided. The conditional standard error of measurement provided is an estimate.

**Table 4**

***Passing Scores Within 1 and 2 CSEM of the Recommended Passing Score<sup>8</sup>***

Recommended passing score (CSEM)		Scale score equivalent
	39 (3.73)	159
-2 CSEM	32	143
-1 CSEM	36	152
+ 1 CSEM	43	168
+ 2 CSEM	47	177

**Note.** CSEM = conditional standard error(s) of measurement.

## FINAL EVALUATIONS

The panelists completed an evaluation at the conclusion of their standard-setting study. The evaluation asked the panelists to provide feedback about the quality of the standard-setting implementation and the factors that influenced their decisions. The responses to the evaluation provided evidence of the validity of the standard-setting process, and, as a result, evidence of the reasonableness of the recommended passing score.

Panelists were also shown the panel’s recommended passing score and asked (a) how comfortable they are with the recommended passing score and (b) if they think the score was too high, too low, or about right. A summary of the final evaluation results is presented in Appendix D.

All panelists *strongly agreed* or *agreed* that they understood the purpose of the study and that the facilitator’s instructions and explanations were clear. All panelists *strongly agreed* or *agreed* that they were prepared to make their standard-setting judgments. All panelists *strongly agreed* or *agreed* that the standard-setting process was easy to follow.

All panelists reported that the description of the just qualified candidate was at least *somewhat influential* in guiding their standard-setting judgments; 22 of the 25 panelists indicated the description was *very influential*. All of the panelists reported that between-round discussions were at least *somewhat influential* in guiding their judgments. More than half of the panelists (18 of the 25 panelists) indicated that their own professional experience was *very influential* in guiding their judgments.

<sup>8</sup> The unrounded CSEM value is added to or subtracted from the rounded passing-score recommendation. The resulting values are rounded up to the next-highest whole number and the rounded values are converted to scale scores.

All of the panelists indicated they were at least *somewhat comfortable* with the passing score they recommended; 22 of the 25 panelists were *very comfortable*. Twenty-four of the 25 panelists indicated the recommended passing score was *about right* with the remaining panelist indicating that the passing score was *too high*.

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## SUMMARY

To support the decision-making process for education agencies establishing a passing score (cut score) for the *Praxis* Mathematics test, research staff from ETS designed and conducted a multistate standard-setting study.

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* Mathematics test, the recommended passing score<sup>9</sup> is 39 out of a possible 60 raw-score points. The scale score associated with a raw score of 39 is 159 on a 100–200 scale.

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<sup>9</sup> Results from the two panels participating in the study were averaged to produce the recommended passing score.

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## REFERENCES

- Brandon, P. R. (2004). Conclusions about frequently studied modified Angoff standard-setting topics. *Applied Measurement in Education, 17*, 59–88.
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## APPENDIX A

# PANELISTS' NAMES & AFFILIATIONS

***Participating Panelists With Affiliation***

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<b><u>Panelist</u></b>	<b><u>Affiliation</u></b>
Jodi Albers	Red Clay Consolidated School District (DE)
Holly Anthony	Tennessee Tech University (TN)
David Barnes II	Kansas State Department of Education (KS)
Stephen Bismarck	University of South Carolina Upstate (SC)
Sheila Blackmore	Bethany College (WV)
Tyesha Deas	A.C. Flora High School (SC)
Lacey Eckert	Sussex Technical High School (DE)
Ella Harris	Olathe Northwest High School (KS)
Amanda Huffman	Pike High School (IN)
Paul Johanson	Brigham Young University - Idaho (ID)
Samantha Junkin	Auburn University at Montgomery (AL)
Melike Kara	Towson University (MD)
Ashley Kearney	Office of State Superintendent (DC)
Cindy Kroon	Montrose High School (SD)
Mary Martin	Middle Tennessee State University (TN)
Stephanie Marvel	Anne Arundel County Public Schools (MD)
Erin McCain	NW Arkansas Education Service Cooperative (AR)
Amanda Pendergrass	University of West Alabama (AL)
Adam Riazi	Cabell Midland High School (WV)
Amy Schander	Gayville-Volin High School (SD)
Thomas Schutt	DC Public Schools (DC)

*(table continues)*



*Participating Panelists With Affiliation (continued)*

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<b><u>Panelist</u></b>	<b><u>Affiliation</u></b>
Sherra Shearer	Brandon High School (MS)
Douglas Speck	Southern Nevada Regional Professional Development Program (NV)
Rusty Young	Arkansas State University (AR)
Lauren Zarandona	Mississippi School for Math and Science (MS)

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**APPENDIX B**  
**STUDY AGENDA**

# AGENDA

## ***Praxis*<sup>®</sup> Mathematics (5165) Standard-Setting Study**

### Day 1

Welcome and Introduction

Overview of Standard Setting and the *Praxis* Mathematics Test

Review the *Praxis* Mathematics Test

Discuss the *Praxis* Mathematics Test

Lunch

Define the Knowledge/Skills of a Just Qualified Candidate

Break

Define the Just Qualified Candidate (*continued*)

End of Day 1

# AGENDA

## ***Praxis*<sup>®</sup> Mathematics (5165) Standard-Setting Study**

### Day 2

Overview of Day 2

Define the Just Qualified Candidate (*continued*)

Standard-setting training presentation

Practice Round: Selected-response standard-setting judgments

Break

Practice Round: Data Discussion

Lunch Break

Round 1: Selected-response standard-setting judgments

Break

Round 1: Selected-response standard-setting judgments (*continued*)

End of Day 2

# AGENDA

## ***Praxis*<sup>®</sup> Mathematics (5165) Standard-Setting Study**

Day 3

Overview of Day 3

Round 1 Feedback and Round 2 Judgments

Break

Round 1 Feedback and Round 2 Judgments (*continued*)

Break

Feedback on Round 2 Recommended Cut Score

Complete Final Evaluation

End of Study

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## APPENDIX C

### JUST QUALIFIED CANDIDATE DESCRIPTION

## Description of the Just Qualified Candidate<sup>10</sup>

### A just qualified candidate...

#### *Tasks of teaching mathematics across mathematical content areas*

- Knows how to identify and reason about common mathematical misconceptions in student work
- Is familiar with identifying instructional items and examples that address a mathematical learning objective

#### *Numbers & Quantity*

1. Knows the structure and the basic operations and properties of the real and complex number systems.
2. Understands and is fluent with operations involving rational numbers
3. Understands how to determine the reasonableness of solutions within the context of a given problem
4. Understands ratios and proportions, especially in the context of dimensional analysis and estimation.
5. Knows properties of rational exponents and radicals as applied to number sets.

#### *Algebra*

6. Understands how to solve equations and inequalities using a variety of techniques such as graphical, algebraic, and tabular and understands how to justify the reasoning processes used.
7. Knows how varied techniques (e.g. graphical, algebraic, tabular) are used to solve systems of equations and inequalities
8. Knows how to find real and imaginary roots of common polynomials
9. Understands how to find and interpret the real and imaginary roots of quadratics
10. Understands how to rewrite algebraic expressions for specific purposes (e.g. factored form to find zeros, vertex form to find maxima or minima, point slope to slope intercept)
11. Knows how to model real world scenarios with algebraic expressions, including average rate of change

#### *Functions*

12. Understands how new functions are obtained from existing functions (e.g., compositions, transformations, and inverses)
13. Understands and can identify key characteristics of functions (e.g., domain, range, end behavior, increasing/decreasing/constant)
14. Understands how function behavior is analyzed using non-algebraic representations (e.g., graphs, mapping, and tables)
15. Understands how to solve basic trigonometric, logarithmic, and exponential equations  
Knows how to use basic trigonometric, logarithmic, and exponential expressions for modeling contextual situations.

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<sup>10</sup> Description of the just qualified candidate focuses on the knowledge/skills that differentiate a *just* from a *not quite* qualified candidate.

## Description of the Just Qualified Candidate (continued)

### A just qualified candidate...

#### *Calculus*

16. Knows how to find the limit of a function numerically, algebraically or graphically.
17. Knows the derivative as a slope of a tangent line and as a rate of change
18. Is familiar with continuity and differentiability of functions.
19. Knows how and when to use standard differentiation and integration concepts

#### *Geometry*

20. Understands how trigonometry is applied to right triangles
21. Understands angle measurement in terms of radians and degrees.
22. Understands means for proving geometric properties (e.g., lines, angles, polygons, and their operations) using geometric and algebraic methods
23. Knows means for visualizing and reasoning algebraically among common 2D and 3D figures

#### *Probability & Stats*

24. Understands how to interpret a linear regression model (e.g., rate of change, intercepts, and correlation coefficient) in the context of the data
25. Understands and compute the concepts of interdependence and conditional probability (such as simple events, probabilities of compound events, conditional probabilities) and how to apply those concepts to data
26. Understands how to summarize, represent, and interpret common representations of qualitative and quantitative data
27. Knows how to use basic statistics to make inferences and informed decisions.
28. Is familiar with counting techniques such as permutations and combinations.



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# APPENDIX D

## RESULTS

**Table D1**  
**Panel Member Demographics (by Panel)**

	Panel 1		Panel 2	
	<i>N</i>	%	<i>N</i>	%
<b>Current position</b>				
Teacher	6	46	6	50
College faculty	4	31	4	33
Mathematics Specialist	1	8	1	8
Other	2	15	1	8
<b>Race</b>				
White	12	92	11	92
Black or African American	1	8	1	8
<b>Gender</b>				
Female	10	77	8	67
Male	3	23	4	33
<b>Are you currently certified to teach mathematics in your state?</b>				
Yes	12	92	10	83
No	1	8	2	17
<b>Are you currently teaching mathematics in your state?</b>				
Yes	11	85	8	67
No	2	15	4	33
<b>Are you currently supervising or mentoring other mathematics teachers?</b>				
Yes	12	92	11	92
No	1	8	1	8
<b>At what K–12 grade level are you currently teaching this subject?</b>				
Elementary (K–5 or K–6)	0	0	1	8
Middle school (6–8 or 7–9)	1	8	0	0
Middle and High school	0	0	1	8
High school (9–12 or 10–12)	6	46	4	33
All Grades	1	8	0	0
Not currently teaching at the K–12 level	5	38	6	50
<b>Including this year, how many years of experience do you have teaching mathematics?</b>				
3 years or less	0	0	0	0
4–7 years	0	0	0	0
8–11 years	3	23	4	33
12–15 years	1	8	2	17
16 years or more	9	69	6	50

*(continued on next page)*

**Table D1 (continued)*****Panel Member Demographics (by Panel)***

	<b>Panel 1</b>		<b>Panel 2</b>	
	<i>N</i>	%	<i>N</i>	%
<b>Which best describes the location of your K–12 school?</b>				
Urban	2	15	1	8
Suburban	5	38	2	17
Rural	1	8	3	25
Not currently working at the K–12 level	5	38	6	50
<b>If you are college faculty, are you currently involved in the training/preparation of teacher candidates in mathematics?</b>				
Yes	4	31	4	33
No	0	0	0	0
Not college faculty	9	69	8	67

**Table D2**  
*Passing Score Summary by Round of Judgments*

<b>Panelist</b>	<b>Panel 1</b>		<b>Panel 2</b>	
	<b>Round 1</b>	<b>Round 2</b>	<b>Round 1</b>	<b>Round 2</b>
1	33.90	33.80	42.45	42.20
2	38.70	37.25	35.80	37.55
3	35.50	35.35	39.15	40.90
4	41.40	39.30	44.75	43.50
5	43.40	42.75	44.80	42.30
6	40.50	38.50	40.35	40.35
7	33.55	34.25	33.05	33.95
8	30.00	33.80	38.15	38.70
9	28.60	30.40	36.45	38.05
10	30.10	32.30	32.90	34.10
11	40.70	40.30	40.65	41.55
12	42.75	41.65	51.45	46.10
13	45.20	43.70		
<b>Average</b>	37.25	37.18	40.00	39.94
<b>Lowest</b>	28.60	30.40	32.90	33.95
<b>Highest</b>	45.20	43.70	51.45	46.10
<b>SD</b>	5.62	4.22	5.36	3.64
<b>SEJ</b>	1.56	1.17	1.55	1.05

**Table D3*****Final Evaluation: Panel 1***

	<b>Strongly agree</b>		<b>Agree</b>		<b>Disagree</b>		<b>Strongly disagree</b>	
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
• I understood the purpose of this study.	12	92	1	8	0	0	0	0
• The instructions and explanations provided by the facilitators were clear.	12	92	1	8	0	0	0	0
• The training in the standard-setting method was adequate to give me the information I needed to complete my assignment.	11	85	2	15	0	0	0	0
• The explanation of how the recommended passing score is computed was clear.	11	85	2	15	0	0	0	0
• The opportunity for feedback and discussion between rounds was helpful.	12	92	1	8	0	0	0	0
• The process of making the standard-setting judgments was easy to follow.	10	77	3	23	0	0	0	0

**Table D3 (continued)**  
**Final Evaluation: Panel 1**

How influential was each of the following factors in guiding your standard-setting judgments?	Very influential		Somewhat influential		Not influential			
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%		
• The description of the just qualified candidate	12	92	1	8	0	0		
• The between-round discussions	10	77	3	23	0	0		
• The knowledge/skills required to answer each test item	11	85	2	15	0	0		
• The passing scores of other panel members	7	54	4	31	2	15		
• My own professional experience	10	77	3	23	0	0		
	Very comfortable		Somewhat comfortable		Somewhat uncomfortable		Very uncomfortable	
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
• Overall, how comfortable are you with the panel's recommended passing score?	11	85	2	15	0	0	0	0
	Too low		About right		Too high			
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%		
• Overall, the recommended passing score is:	0	0	12	92	1	8		

**Table D4*****Final Evaluation: Panel 2***

	<b>Strongly agree</b>		<b>Agree</b>		<b>Disagree</b>		<b>Strongly disagree</b>	
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
• I understood the purpose of this study.	12	100	0	0	0	0	0	0
• The instructions and explanations provided by the facilitators were clear.	12	100	0	0	0	0	0	0
• The training in the standard-setting method was adequate to give me the information I needed to complete my assignment.	12	100	0	0	0	0	0	0
• The explanation of how the recommended passing score is computed was clear.	12	100	0	0	0	0	0	0
• The opportunity for feedback and discussion between rounds was helpful.	10	83	2	17	0	0	0	0
• The process of making the standard-setting judgments was easy to follow.	12	100	0	0	0	0	0	0

**Table D4 (continued)**  
**Final Evaluation: Panel 2**

How influential was each of the following factors in guiding your standard-setting judgments?	Very influential		Somewhat influential		Not influential			
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%		
• The description of the just qualified candidate	10	83	2	17	0	0		
• The between-round discussions	8	67	4	33	0	0		
• The knowledge/skills required to answer each test item	11	92	1	8	0	0		
• The passing scores of other panel members	5	42	6	50	1	8		
• My own professional experience	8	67	4	33	0	0		
	Very comfortable		Somewhat comfortable		Somewhat uncomfortable		Very uncomfortable	
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
• Overall, how comfortable are you with the panel's recommended passing score?	11	92	1	8	0	0	0	0
	Too low		About right		Too high			
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%		
• Overall, the recommended passing score is:	0	0	12	100	0	0		





Multistate Standard-Setting Technical Report

**PRAXIS<sup>®</sup> MIDDLE SCHOOL MATHEMATICS (5164)**

Licensure and Credentialing Research

ETS

Princeton, New Jersey

February 2021

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# EXECUTIVE SUMMARY

To support the decision-making process of education agencies establishing a passing score (cut score) for the *Praxis*<sup>®</sup> Middle School Mathematics (5164) test, research staff from Educational Testing Service (ETS) designed and conducted a distance-based multistate standard-setting study.

## PARTICIPATING STATES

Panelists from 12 states and Washington, D.C., were recommended by their respective education agencies. The education agencies recommended panelists with (a) experience as either 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<sup>1</sup> is 38 out of a possible 60 raw-score points. The scale score associated with a raw score of 38 is 157 on a 100–200 scale.

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<sup>1</sup> Results from the two panels participating in the study were averaged to produce the recommended passing score.

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# INTRODUCTION

To support the decision-making process for education agencies establishing a passing score (cut score) for the *Praxis*<sup>®</sup> Middle School Mathematics (5164) test, research staff from ETS designed and conducted a distance-based multistate standard-setting study in January 2021. Education agencies<sup>2</sup> recommended panelists with (a) experience as either 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. Twelve states and Washington, D.C., were represented by 29 panelists, as listed in Table 1. (See Appendix A for the names and affiliations of the panelists.)

**Table 1**  
***Participating States, Washington, D.C., and Number of Panelists***

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Alabama (2 panelists)	Rhode Island (3 panelists)
Delaware (3 panelists)	South Carolina (2 panelists)
Idaho (3 panelists)	South Dakota (2 panelists)
Indiana (2 panelists)	Tennessee (2 panelists)
Kansas (2 panelists)	Washington, D.C. (2 panelists)
Kentucky (1 panelist)	West Virginia (2 panelists)
Mississippi (3 panelists)	

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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 state and D.C., 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,<sup>3</sup> which represents the combined judgments of two panels of experienced educators. Each state and D.C., may want 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 state and

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<sup>2</sup> States and jurisdictions that currently use *Praxis* tests were invited to participate in the multistate standard-setting study.

<sup>3</sup> In addition to the recommended passing score averaged across the two panels, the passing scores for each panel are presented.

D.C., 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 state and D.C.'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 state and D.C., 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 state and D.C. 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 state and D.C. should consider the likelihood of classification errors. 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 that 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 state and D.C. need to consider which decision error is more important to minimize.

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# OVERVIEW OF THE *PRAXIS*<sup>®</sup> MIDDLE SCHOOL MATHEMATICS TEST

The Praxis<sup>®</sup> Middle School Mathematics *Study Companion* document (ETS, in press) describes the purpose and structure of the test. In brief, the test measures knowledge and competencies that are important for safe and effective beginning practice as a middle school mathematics teacher.

The three-hour assessment contains 66 selected-response items<sup>4</sup> covering five content areas: *Numbers and Operations* (approximately 16 items), *Algebra* (approximately 15 items), *Functions* (approximately 11 items), *Geometry and Measurement* (approximately 13 items), and *Statistics and Probability* (approximately 11 items).<sup>5</sup> The reporting scale for the *Praxis* Middle School Mathematics test ranges from 100 to 200 scale-score points.

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## PROCESSES AND METHODS

The design of the standard-setting study included two, independent expert panels of educators with experience with the test content and with new teachers or teacher candidates. Before the study, panelists received an email explaining the purpose of the standard-setting study and requesting that they review materials for the study, such as the test specifications and an overview presentation. This review helped familiarize the panelists with the general structure and content of the test. Additionally, panelists were asked to attend a brief, technology check meeting, to ensure that everyone could access the technology needed for the study.

For each panel, the first day of the standard-setting study began with a welcome by the meeting facilitator. After introductions of the panelists and ETS staff, the facilitator engaged the panel in a question and answer period about the overview presentation. Appendix B shows the agenda for the panel meeting.

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<sup>4</sup> Six of the 66 selected-response items are pretest items and do not contribute to a candidate's score.

<sup>5</sup> The number of items for each content area may vary slightly from form to form of the test.

## REVIEWING THE TEST

Test familiarization was the first activity for the panel. The purpose of test familiarization is for the panelists to review the test and become familiar with the manner in which a candidate would take the test. After the facilitator described the purpose of the review and how to access the test<sup>6</sup>, the standard-setting panelists took the test and had a discussion of the content measured. This discussion helped bring the panelists to a shared understanding of what the test measures.

The test discussion covered the major content areas being addressed by the test. Panelists were asked to remark on any content areas that would be particularly challenging for entry-level teachers or areas that address content particularly important for entry-level teachers. Overall, this discussion serves to reduce potential judgment errors later in the standard-setting process.

## DEFINING THE JUST QUALIFIED CANDIDATE

Following the review of the test, panelists described the just qualified candidate. The *just qualified candidate description* plays a central role in standard setting (Perie, 2008); the goal of the standard-setting process is to identify the test score that aligns with this description.

Both panels worked together to create the final description of the just qualified candidate — the knowledge/skills that differentiate a *just* from a *not quite* qualified candidate. Each panel first worked separately by working in smaller and then a large group. Then both panels convened and, through whole-group discussion, combined the two descriptions in to the final version of the just qualified candidate to use for the remainder of the study.

The written description of the just qualified candidate summarized the panel discussion in a bulleted format. The description was not intended to describe all the knowledge and skills of the just qualified candidate but only highlight those that differentiate a *just* qualified candidate from a *not quite* qualified candidate. The written description was distributed to panelists to use during later phases of the study (see Appendix C for the just qualified candidate description).

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<sup>6</sup> The computer-administered test items were available through the ETS IBIS Content Review Tool.

## PANELISTS' JUDGMENTS

The standard-setting process for the *Praxis* Middle School Mathematics test was a probability-based Modified Angoff method (Brandon, 2004; Hambleton & Pitoniak, 2006). In this study, each panelist judged each item on the likelihood (probability or chance) that the just qualified candidate would answer the item correctly. Panelists made their judgments using the following rating scale: 0, .05, .10, .20, .30, .40, .50, .60, .70, .80, .90, .95, 1. The lower the value, the less likely it is that the just qualified candidate would answer the item correctly because the item is difficult for the just qualified candidate. The higher the value, the more likely it is that the just qualified candidate would answer the item correctly.

Panelists were asked to approach the judgment process in two stages. First, they reviewed both the description of the just qualified candidate and the item and determined what was the probability that the just qualified candidate would answer the question correctly. The facilitator encouraged the panelists to consider the following rules of thumb to guide their decision:

- Items in the 0 to .30 range were those the just qualified candidate would have a low chance of answering correctly.
- Items in the .40 to .60 range were those the just qualified candidate would have a moderate chance of answering correctly.
- Items in the .70 to 1 range were those that the just qualified candidate would have a high chance of answering correctly.

Next, panelists decided how to refine their judgment within the range. For example, if a panelist thought that there was a high chance that the just qualified candidate would answer the question correctly, the initial decision would be in the .70 to 1 range. The second decision for the panelist was to judge if the likelihood of answering it correctly is .70, .80, .90, .95 or 1.

After the training, panelists made practice judgments and discussed those judgments and their rationales. All panelists completed a post-training evaluation to confirm that they had received adequate training and felt prepared to continue; the standard-setting process continued only if all panelists confirmed their readiness.

Following this first round of judgments (*Round 1*), item-level feedback was provided to the panel. The panelists' judgments were displayed for each item and summarized across panelists. Items were highlighted to show when panelists converged in their judgments (at least two-thirds of the panelists located an item in the same difficulty range) or diverged in their judgments.

The panelists discussed their item-level judgments. These discussions helped panelists maintain a shared understanding of the knowledge/skills of the just qualified candidate and helped to clarify aspects of items that might not have been clear to all panelists during the Round 1 judgments. The purpose of the discussion was not to encourage panelists to conform to another's judgment, but to understand the different relevant perspectives among the panelists.

In Round 2, panelists discussed their Round 1 judgments and were encouraged by the facilitator (a) to share the rationales for their judgments and (b) to consider their judgments in light of the rationales provided by the other panelists. Panelists recorded their Round 2 judgments only for items when they wished to change a Round 1 judgment. Panelists' final judgments for the study, therefore, consist of their Round 1 judgments and any adjusted judgments made during Round 2.

Other than the description of the just qualified candidate, results from Panel 1 were not shared with Panel 2. The item-level judgments and resulting discussions for Panel 2 were independent of judgments and discussions that occurred with Panel 1.

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## RESULTS

### EXPERT PANELS

Table 2 presents a summary of the panelists' demographic information. The panel included 29 educators representing 12 states and D.C. (See Appendix A for a listing of panelists.) Fourteen panelists were teachers, two were mathematics instructional coaches, ten were college faculty, two were administrators or department heads, and two held other positions. All of the faculty members' job responsibilities included the training, supervising, or mentoring of middle school mathematics teachers.

The number of experts by panel and their demographic information are presented in Appendix D (Table D1). One panelist was college faculty and a department head. Another panelist was college faculty and a coach (though not specifically described as a mathematics instructional coach). As such, those numbers will not sum to 29 and the percentages will exceed 100.



**Table 2**  
**Panel Member Demographics (Across Panels)**

	<i>N</i>	<i>%</i>
<b>Current position</b>		
Teacher	14	48
Mathematics Instructional Coach	2	7
Administrator/Department head	2	7
College faculty	10	34
Other	2	7
<b>Race</b>		
White	24	83
Black or African American	3	10
American Indian or Alaskan Native	1	3
Middle Eastern	1	3
<b>Gender</b>		
Female	23	79
Male	6	21
<b>Are you currently certified to teach middle school mathematics in your state?</b>		
Yes	24	83
No	5	17
<b>Are you currently teaching middle school mathematics in your state?</b>		
Yes	14	48
No	15	52
<b>Are you currently supervising or mentoring other teachers of middle school mathematics?</b>		
Yes	15	52
No	14	48
<b>At what K–12 grade level are you currently teaching middle school mathematics?</b>		
Elementary and Middle school	1	3
Middle school (6–8 or 7–9)	11	38
Middle and High school	1	3
High school (9–12 or 10–12)	1	3
All Grades	1	3
Other	1	3
Not currently teaching at the K–12 level	13	45

*(continues on next page)*

**Table 2 (continued)****Panel Member Demographics (Across Panels)**

	<i>N</i>	<i>%</i>
<b>Including this year, how many years of experience do you have teaching middle school mathematics?</b>		
3 years or less	4	14
4–7 years	4	14
8–11 years	10	34
12–15 years	4	14
16 years or more	7	24
<b>Which best describes the location of your K–12 school?</b>		
Urban	6	21
Suburban	5	17
Rural	5	17
Not currently working at the K–12 level	13	45
<b>If you are college faculty, are you currently involved in the training/preparation of teacher candidates in this subject?</b>		
Yes	8	28
No	2	7
Not college faculty	19	66

**STANDARD-SETTING JUDGMENTS**

Table 3 summarizes the standard-setting judgments (Round 2) of panelists. The table also includes estimates of the measurement error associated with the judgments: the standard deviation of the mean and the standard error of judgment (SEJ). The SEJ is one way of estimating the reliability or consistency of a panel’s standard-setting judgments.<sup>7</sup> It indicates how likely it would be for several other panels of educators similar in makeup, experience, and standard-setting training to the current panel to recommend the same passing score on the same form of the test. The confidence intervals created by adding/subtracting two SEJs to each panel’s recommended passing score overlap, indicating that they may be comparable.

Panelist-level results, for Rounds 1 and 2, are presented in Appendix D (Table D2).

<sup>7</sup> An SEJ assumes that panelists are randomly selected and that standard-setting judgments are independent. It is seldom the case that panelists are randomly sampled, and only the first round of judgments may be considered independent. The SEJ, therefore, likely underestimates the uncertainty of passing scores (Tannenbaum & Katz, 2013).

**Table 3**  
***Summary of Round 2 Standard-setting Judgments***

	<b>Panel 1</b>	<b>Panel 2</b>
Average	37.96	36.28
Lowest	33.65	28.10
Highest	43.85	40.45
SD	3.57	3.06
SEJ	0.92	0.82

Round 1 judgments are made without discussion among the panelists. The most variability in judgments, therefore, is typically present in the first round. Round 2 judgments, however, are informed by panel discussion; thus, it is common to see a decrease both in the standard deviation and SEJ. The Round 2 average score is the panel’s recommended passing score.

The panels’ passing score recommendations for the *Praxis* Middle School Mathematics test are 37.96 for Panel 1 and 36.28 for Panel 2 (out of a possible 60 raw-score points). The values were rounded to the next highest whole number, to determine the functional recommended passing score — 38 for Panel 1 and 37 for Panel 2. The scale scores associated with 38 and 37 raw points are 157 and 155, respectively.

In addition to the recommended passing score for each panel, the average passing score across the two panels is provided to help education agencies determine an appropriate passing score. The panels’ average passing score recommendation for the *Praxis* Middle School Mathematics test is 37.12 (out of a possible 60 raw-score points). The value was rounded to 38 (next highest raw score) to determine the functional recommended passing score. The scale score associated with 38 raw points is 157.

Table 4 presents the estimated conditional standard error of measurement (CSEM) around the recommended passing score. A standard error represents the uncertainty associated with a test score. The scale scores associated with one and two CSEM above and below the recommended passing score are provided. The conditional standard error of measurement provided is an estimate.

**Table 4*****Passing Scores Within 1 and 2 CSEM of the Recommended Passing Score<sup>8</sup>***

<b>Recommended passing score (CSEM)</b>		<b>Scale score equivalent</b>
	38 (3.76)	157
-2 CSEM	31	141
-1 CSEM	35	150
+ 1 CSEM	42	166
+ 2 CSEM	46	175

**Note.** CSEM = conditional standard error(s) of measurement.

## FINAL EVALUATIONS

The panelists completed an evaluation at the conclusion of their standard-setting study. The evaluation asked the panelists to provide feedback about the quality of the standard-setting implementation and the factors that influenced their decisions. The responses to the evaluation provided evidence of the validity of the standard-setting process, and, as a result, evidence of the reasonableness of the recommended passing score.

Panelists were also shown the panel's recommended passing score and asked (a) how comfortable they are with the recommended passing score and (b) if they think the score was too high, too low, or about right. A summary of the final evaluation results is presented in Appendix D.

All panelists *strongly agreed* or *agreed* that they understood the purpose of the study and that the facilitator's instructions and explanations were clear. All panelists *strongly agreed* or *agreed* that they were prepared to make their standard-setting judgments. All panelists *strongly agreed* or *agreed* that the standard-setting process was easy to follow.

All panelists reported that the description of the just qualified candidate was at least *somewhat influential* in guiding their standard-setting judgments; 27 of the 29 panelists indicated the description was *very influential*. All of the panelists reported that between-round discussions were at least *somewhat influential* in guiding their judgments. More than half of the panelists (25 of the 29 panelists) indicated that their own professional experience was *very influential* in guiding their judgments.

All of the panelists indicated they were at least *somewhat comfortable* with the passing score they recommended; 24 of the 29 panelists were *very comfortable*. Twenty-seven of the 29 panelists indicated the recommended passing score was *about right* and two indicated that the passing score was *too low*.

<sup>8</sup> The unrounded CSEM value is added to or subtracted from the rounded passing-score recommendation. The resulting values are rounded up to the next-highest whole number and the rounded values are converted to scale scores.

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## SUMMARY

To support the decision-making process for education agencies establishing a passing score (cut score) for the *Praxis* Middle School Mathematics test, research staff from ETS designed and conducted a distance-based multistate standard-setting study.

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<sup>9</sup> is 38 out of a possible 60 raw-score points. The scale score associated with a raw score of 38 is 157 on a 100–200 scale.

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<sup>9</sup> Results from the two panels participating in the study were averaged to produce the recommended passing score.

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## APPENDIX A

# PANELISTS' NAMES & AFFILIATIONS

***Participating Panelists With Affiliation***

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<b><u>Panelist</u></b>	<b><u>Affiliation</u></b>
Ahmad Alhammouri	Jacksonville State University (AL)
Sandra Ammons	South Carolina Department of Education (SC)
Cathy Boutin	RI Math Teachers Association; Association of Teachers of Mathematics in New England (RI)
Nichole Bowman	Georgia Morse Middle School (SD)
Jeneva Clark	University of Tennessee (TN)
Beth Costner	Winthrop University (SC)
Darin DeNeal	Pendleton Heights Middle School (IN)
Ashley Digmann	Dakota Wesleyan University (SD)
Sherita Flake	Urban Teachers (DC)
Tekeeta Funchess	Hinds County Schools (MS)
Tracy Graham	North Providence School Department (RI)
Tiffany Hackendorn	Indian River School District (DE)
Shauna Hedgepeth	Purvis Middle School (MS)
Jennifer Heitman	Kamiah Middle School (ID)
Shannon Henderson	Putnam County Schools (WV)
Paul Johanson	Brigham young University - Idaho (ID)
Karen Lindsey	Germantown Middle School (MS)
Robin Magruder	Campbellsville University (KY)
Michelle Northshield	Red Clay Consolidated School District (DE)
William Reaves Jr.	Capital School District (DE)

*(table continues)*



*Participating Panelists With Affiliation (continued)*

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<b><u>Panelist</u></b>	<b><u>Affiliation</u></b>
Terry Reed	West Virginia State University (WV)
Keri Richburg	Troy University (AL)
Diane Rodriguez	Bloomfield Jr./Sr. High School (IN)
Debra Scarpelli	Rhode Island Department of Education/Pawtucket School Department (RI)
Janet Stramel	Fort Hays State University (KS)
Jackie Vogel	Austin Peay State University (TN)
Kristopher Wallaert	Idaho State Department of Education (ID)
Katherine Wiechman	Maize Middle School (KS)

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\*One panelist did not wish to be listed in the final report.

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**APPENDIX B**  
**STUDY AGENDA**

# AGENDA

## ***Praxis*<sup>®</sup> Middle School Mathematics (5164) Standard-Setting Study**

Day 1

Welcome and Introduction

Overview of Standard Setting and the *Praxis* Middle School Mathematics Test

Review the *Praxis* Middle School Mathematics Test

Discuss the *Praxis* Middle School Mathematics Test

Lunch

Define the Knowledge/Skills of a Just Qualified Candidate

Break

Define the Just Qualified Candidate (*continued*)

End of Day 1

# AGENDA

## ***Praxis*<sup>®</sup> Middle School Mathematics (5164) Standard-Setting Study**

### Day 2

Overview of Day 2

Define the Just Qualified Candidate (*continued*)

Standard-setting training presentation

Practice Round: Selected-response standard-setting judgments

Break

Practice Round: Data Discussion

Lunch Break

Round 1: Selected-response standard-setting judgments

Break

Round 1: Selected-response standard-setting judgments (*continued*)

End of Day 2

# AGENDA

## ***Praxis*<sup>®</sup> Middle School Mathematics (5164) Standard-Setting Study**

Day 3

Overview of Day 3

Round 1 Feedback and Round 2 Judgments

Break

Round 1 Feedback and Round 2 Judgments (*continued*)

Break

Feedback on Round 2 Recommended Cut Score

Complete Final Evaluation

End of Study

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## APPENDIX C

### JUST QUALIFIED CANDIDATE DESCRIPTION

## Description of the Just Qualified Candidate<sup>10</sup>

### A just qualified candidate ...

#### *Numbers and Operations*

1. Understands proportional reasoning and ratios relationships
2. Understands rational number operations and properties to solve problems (standard and real world)
3. Understand basic concepts of number theory (e.g., prime numbers, factors, exponential rules)
4. Knows how to recognize the reasonableness of results within the context of a given problem
5. Is familiar with evaluating student work to identify misconceptions and valid explanations of mathematical concepts

#### *Algebra*

6. Understands linear equations and systems of two linear equations (solve; represent in multiple forms)
7. Understands representations of one-variable linear inequalities
8. Is familiar with systems of linear inequalities
9. Understands linear relationships in various forms (table, graph, description, equation, etc.)
10. Is familiar with representations of quadratic equations and expressions

#### *Functions*

11. Knows how to use and evaluate basic functions that model given information in a variety of contexts through multiple representations (sequence, function notation, tables, and graphs, etc.)
12. Is familiar with absolute value, quadratic, and exponential functions that model given information through multiple representations.
13. Understands the common characteristics and shape of the graph of basic functions, including domain, range, minimum/maximum, slope, and intercepts
14. Is familiar with common characteristics and shape of graph of absolute value, quadratic, and exponential functions

#### *Geometry and Measurement*

15. Understands multi-step applications of basic geometric concepts (including area, Pythagorean Theorem, surface area, perimeter, volume, angles/lines, characteristics of shapes, etc.)
16. Knows geometric relationships (e.g., basic transformations, distance, similarity, congruence, systems of measurement)
17. Knows the basic characteristics and properties of circles, as well as triangles, quadrilaterals, and other polygons

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<sup>10</sup> Description of the just qualified candidate focuses on the knowledge/skills that differentiate a *just* from a *not quite* qualified candidate.

## Description of the Just Qualified Candidate (continued)

**A just qualified candidate ...**

### *Probability and Statistics*

18. Knows how to appropriately collect, interpret, analyze and represent data in various forms and identifies which form is most appropriate in a given situation (e.g., scatter plots, box and whisker plots, stem and leaf, etc.)
19. Understands measures of central tendency
20. Is familiar with variability and can compare two or more data sets
21. Understands how to use basic probability models including those in real world contexts



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# APPENDIX D

## RESULTS

**Table D1**  
**Panel Member Demographics (by Panel)**

	Panel 1		Panel 2	
	<i>N</i>	%	<i>N</i>	%
<b>Current position</b>				
Teacher	8	53	6	43
Mathematics Instructional Coach	2	13	0	0
Administrator/Department head	1	7	1	7
College faculty	4	27	5	36
Other	0	0	2	14
<b>Race</b>				
White	13	87	11	79
Black or African American	1	7	2	14
American Indian or Alaskan Native	0	0	1	7
Middle Eastern	1	7	0	0
<b>Gender</b>				
Female	13	87	10	71
Male	2	13	4	29
<b>Are you currently certified to teach middle school mathematics in your state?</b>				
Yes	11	73	13	93
No	4	27	1	7
<b>Are you currently teaching middle school mathematics in your state?</b>				
Yes	7	47	7	50
No	8	53	7	50
<b>Are you currently supervising or mentoring other teachers of middle school mathematics?</b>				
Yes	7	47	8	57
No	8	53	6	43
<b>At what K–12 grade level are you currently teaching middle school mathematics?</b>				
Elementary and Middle school	0	0	1	7
Middle school (6–8 or 7–9)	6	40	5	36
Middle and High school	1	7	0	0
High school (9–12 or 10–12)	1	7	0	0
All Grades	1	7	0	0
Other	1	7	0	0
Not currently teaching at the K–12 level	5	33	8	57

**Table D1 (continued)*****Panel Member Demographics (by Panel)***

	<b>Panel 1</b>		<b>Panel 2</b>	
	<i>N</i>	<i>%</i>	<i>N</i>	<i>%</i>
<b>Including this year, how many years of experience do you have teaching middle school mathematics?</b>				
3 years or less	1	7	3	21
4–7 years	4	27	0	0
8–11 years	6	40	4	29
12–15 years	2	13	2	14
16 years or more	2	13	5	36
<b>Which best describes the location of your K–12 school?</b>				
Urban	4	27	2	14
Suburban	3	20	2	14
Rural	3	20	2	14
Not currently working at the K–12 level	5	33	8	57
<b>If you are college faculty, are you currently involved in the training/preparation of teacher candidates in middle school mathematic?</b>				
Yes	4	27	4	29
No	0	0	2	14
Not college faculty	11	73	8	57

**Table D2*****Passing Score Summary by Round of Judgments***

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	<b>Panel 1</b>		<b>Panel 2</b>	
<b>Panelist</b>	<b>Round 1</b>	<b>Round 2</b>	<b>Round 1</b>	<b>Round 2</b>
1	40.15	39.80	30.05	32.70
2	35.90	35.80	38.90	37.20
3	35.20	35.00	37.70	36.50
4	36.45	36.25	33.30	36.00
5	39.20	37.70	37.30	37.90
6	45.55	42.40	40.60	40.45
7	40.00	43.15	36.00	35.95
8	31.85	33.65	38.65	38.25
9	34.60	34.90	31.90	28.10
10	31.20	35.50	38.95	38.50
11	34.05	35.85	34.00	35.00
12	36.65	34.55	36.50	36.40
13	38.80	37.90	36.00	35.50
14	41.40	43.15	38.60	39.40
15	45.35	43.85		
<b>Average</b>	37.76	37.96	36.32	36.28
<b>Lowest</b>	31.20	33.65	30.05	28.10
<b>Highest</b>	45.55	43.85	40.60	40.45
<b>SD</b>	4.31	3.57	3.03	3.06
<b>SEJ</b>	1.11	0.92	0.81	0.82

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**Table D3*****Final Evaluation: Panel 1***

	<b>Strongly agree</b>		<b>Agree</b>		<b>Disagree</b>		<b>Strongly disagree</b>	
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
• I understood the purpose of this study.	13	87	2	13	0	0	0	0
• The instructions and explanations provided by the facilitators were clear.	9	60	6	40	0	0	0	0
• The training in the standard-setting method was adequate to give me the information I needed to complete my assignment.	13	87	2	13	0	0	0	0
• The explanation of how the recommended passing score is computed was clear.	10	67	5	33	0	0	0	0
• The opportunity for feedback and discussion between rounds was helpful.	9	60	6	40	0	0	0	0
• The process of making the standard-setting judgments was easy to follow.	8	53	7	47	0	0	0	0

**Table D3 (continued)**  
**Final Evaluation: Panel 1**

How influential was each of the following factors in guiding your standard-setting judgments?	Very influential		Somewhat influential		Not influential			
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%		
• The description of the just qualified candidate	14	93	1	7	0	0		
• The between-round discussions	8	53	7	47	0	0		
• The knowledge/skills required to answer each test item	12	80	3	20	0	0		
• The passing scores of other panel members	5	33	8	53	2	13		
• My own professional experience	14	93	1	7	0	0		
	Very comfortable		Somewhat comfortable		Somewhat uncomfortable		Very uncomfortable	
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
• Overall, how comfortable are you with the panel's recommended passing score?	11	73	4	27	0	0	0	0
	Too low		About right		Too high			
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%		
• Overall, the recommended passing score is:	2	13	13	87	0	0		

**Table D4*****Final Evaluation: Panel 2***

	<b>Strongly agree</b>		<b>Agree</b>		<b>Disagree</b>		<b>Strongly disagree</b>	
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
• I understood the purpose of this study.	14	100	0	0	0	0	0	0
• The instructions and explanations provided by the facilitators were clear.	13	93	1	7	0	0	0	0
• The training in the standard-setting method was adequate to give me the information I needed to complete my assignment.	13	93	1	7	0	0	0	0
• The explanation of how the recommended passing score is computed was clear.	13	93	1	7	0	0	0	0
• The opportunity for feedback and discussion between rounds was helpful.	14	100	0	0	0	0	0	0
• The process of making the standard-setting judgments was easy to follow.	12	86	2	14	0	0	0	0

**Table D4 (continued)**  
**Final Evaluation: Panel 2**

How influential was each of the following factors in guiding your standard-setting judgments?	Very influential		Somewhat influential		Not influential			
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%		
• The description of the just qualified candidate	13	93	1	7	0	0		
• The between-round discussions	9	64	5	36	0	0		
• The knowledge/skills required to answer each test item	11	79	3	21	0	0		
• The passing scores of other panel members	4	29	9	64	1	7		
• My own professional experience	11	79	3	21	0	0		
	Very comfortable		Somewhat comfortable		Somewhat uncomfortable		Very uncomfortable	
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
• Overall, how comfortable are you with the panel's recommended passing score?	13	93	1	7	0	0	0	0
	Too low		About right		Too high			
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%		
• Overall, the recommended passing score is:	0	0	14	100	0	0		



## Multistate Standard-Setting Technical Report

### **PRAXIS<sup>®</sup> MIDDLE SCHOOL SCIENCE (5442)**

Licensure and Credentialing Research

ETS

Princeton, New Jersey

January 2020

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# EXECUTIVE SUMMARY

To support the decision-making process of education agencies establishing a passing score (cut score) for the *Praxis*<sup>®</sup> Middle School Science (5442) test, research staff from Educational Testing Service (ETS) designed and conducted a multistate standard-setting study.

## PARTICIPATING STATES

Panelists from 17 states and Washington, D.C. were recommended by their respective education agencies. The education agencies recommended panelists with (a) experience as either middle school science teachers or college faculty who prepare middle school science teachers and (b) familiarity with the knowledge and skills required of beginning middle school science 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 Science test, the recommended passing score<sup>1</sup> is 61 out of a possible 100 raw-score points. The scale score associated with a raw score of 61 is 152 on a 100–200 scale.

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<sup>1</sup> 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*<sup>®</sup> Middle School Science (5442) test, research staff from ETS designed and conducted a multistate standard-setting study in December 2019 in Princeton, New Jersey. Education agencies<sup>2</sup> recommended panelists with (a) experience as either middle school science teachers or college faculty who prepare middle school science teachers and (b) familiarity with the knowledge and skills required of beginning middle school science teachers. Seventeen states and Washington, D.C. (Table 1) were represented by 31 panelists. (See Appendix A for the names and affiliations of the panelists.)

**Table 1**  
***Participating States and Washington, D.C. and Number of Panelists***

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Arkansas (1 panelist)	New Jersey (2 panelists)
Hawaii (1 panelist)	New Mexico (1 panelist)
Idaho (2 panelists)	Rhode Island (2 panelists)
Indiana (3 panelists)	South Carolina (1 panelist)
Kentucky (2 panelists)	South Dakota (2 panelists)
Louisiana (1 panelist)	Utah (2 panelists)
Maryland (1 panelist)	Virginia (2 panelists)
North Carolina (2 panelists)	Washington, D.C. (2 panelists)
Nebraska (2 panelists)	West Virginia (2 panelists)

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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 state and D.C., 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,<sup>3</sup> which represents the combined judgments of two panels of experienced educators. Each state, or D.C., may want to consider the recommended passing score but also other sources of information when setting the final *Praxis* Middle School Science passing score (see Geisinger & McCormick, 2010). A state, or D.C., may accept the recommended passing score, adjust the score upward to reflect more stringent

<sup>2</sup> States and jurisdictions that currently use *Praxis* tests were invited to participate in the multistate standard-setting study.

<sup>3</sup> In addition to the recommended passing score averaged across the two panels, the recommended passing scores for each panel are presented.

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 state's, or D.C.'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 Science test score and the latter, the reliability of panelists' passing-score recommendation. The SEM allows states, and D.C., to recognize that any test score on any standardized test—including a *Praxis* Middle School Science 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 states, and D.C., 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 state, and D.C., should consider the likelihood of classification errors. 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 that 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 possesses the required knowledge/skills. States, and D.C., need to consider which decision error is more important to minimize.

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# OVERVIEW OF THE *PRAXIS*<sup>®</sup> MIDDLE SCHOOL SCIENCE TEST

The Praxis<sup>®</sup> Middle School Science *Study Companion* document (ETS, in press) describes the purpose and structure of the test. In brief, the test measures the knowledge and competencies necessary for a beginning teacher of middle school science.

The two and a half-hour assessment contains 125 multiple-choice items<sup>4</sup> covering four content areas: *Nature and Impact of Science and Engineering* (approximately 17 items), *Physical Science* (approximately 38 items), *Life Science* (approximately 38 items), and *Earth and Space Science* (approximately 32 items).<sup>5</sup> The reporting scale for the *Praxis* Middle School Science test ranges from 100 to 200 scale-score points.

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## PROCESSES AND METHODS

The design of the standard-setting study included two, independent expert panels. Before the study, panelists received an email explaining the purpose of the standard-setting study and requesting that they review the content specifications for the test. This review helped familiarize the panelists with the general structure and content of the test.

The standard-setting study began as a general session for both panels. The session opened with a welcome and introduction by each of the meeting facilitators. The facilitators described the test, provided an overview of standard setting, and presented the agenda for the study. Appendix B shows the standard-setting study agenda.

### REVIEWING THE TEST

While both panels were together during the general session, the standard-setting panelists took the test and then discussed the content measured. This discussion helped bring the panelists to a shared understanding of what the test does and does not cover, which serves to reduce potential judgment errors later in the standard-setting process.

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<sup>4</sup> Twenty-five of the 125 multiple-choice items are pretest items and do not contribute to a candidate's score.

<sup>5</sup> The number of items for each content area may vary slightly from form to form of the test.

The test discussion covered the major content areas being addressed by the test. Panelists were asked to remark on any content areas that would be particularly challenging for entry-level teachers or areas that address content particularly important for entry-level teachers.

## DEFINING THE JUST QUALIFIED CANDIDATE

Following the review of the test, panelists described the just qualified candidate. The *just qualified candidate description* plays a central role in standard setting (Perie, 2008); the goal of the standard-setting process is to identify the test score that aligns with this description.

Both panels worked together to create a description of the just qualified candidate — the knowledge/skills that differentiate a *just* from a *not quite* qualified candidate. To create this description, they first split into smaller groups to consider the just qualified candidate. Then they reconvened and, through whole-group discussion, created the description of the just qualified candidate to use for the remainder of the study.

The written description of the just qualified candidate summarized the panel discussion in a bulleted format. The description was not intended to describe all the knowledge and skills of the just qualified candidate but only highlight those that differentiate a *just* qualified candidate from a *not quite* qualified candidate. The written description was distributed to panelists to use during later phases of the study (see Appendix C for the just qualified candidate description).

## PANELISTS' JUDGMENTS

The standard-setting process for the *Praxis* Middle School Science test was a probability-based Modified Angoff method (Brandon, 2004; Hambleton & Pitoniak, 2006). In this study, each panelist judged each item on the likelihood (probability or chance) that the just qualified candidate would answer the item correctly. Panelists made their judgments using the following rating scale: 0, .05, .10, .20, .30, .40, .50, .60, .70, .80, .90, .95, 1. The lower the value, the less likely it is that the just qualified candidate would answer the item correctly because the item is difficult for the just qualified candidate. The higher the value, the more likely it is that the just qualified candidate would answer the item correctly.

For consistency in understanding the standard-setting judgment process, both panels remained together as they received training and practice in how to complete their standard-setting judgments. Panelists were asked to approach the judgment process in two stages. First, they reviewed both the description of the just qualified candidate and the item and determined what was the probability that the

just qualified candidate would answer the question correctly. The facilitator encouraged the panelists to consider the following rules of thumb to guide their decision:

- Items in the 0 to .30 range were those the just qualified candidate would have a low chance of answering correctly.
- Items in the .40 to .60 range were those the just qualified candidate would have a moderate chance of answering correctly.
- Items in the .70 to 1 range were those that the just qualified candidate would have a high chance of answering correctly.

Next, panelists decided how to refine their judgment within the range. For example, if a panelist thought that there was a high chance that the just qualified candidate would answer the question correctly, the initial decision would be in the .70 to 1 range. The second decision for the panelist was to judge if the likelihood of answering it correctly is .70, .80, .90, .95 or 1.

After the training, panelists made practice judgments and discussed those judgments and their rationales. All panelists completed a post-training evaluation to confirm that they had received adequate training and felt prepared to continue; the standard-setting process continued only if all panelists confirmed their readiness. After the independent judgments were completed, panelists were split into two, distinct panels that worked separately for the remainder of the study.

Following this first round of judgments (*Round 1*), item-level feedback was provided to the panel. The panelists' judgments were displayed for each item and summarized across panelists. Items were highlighted to show when panelists converged in their judgments (at least two-thirds of the panelists located an item in the same difficulty range) or diverged in their judgments.

The panelists discussed their item-level judgments. These discussions helped panelists maintain a shared understanding of the knowledge/skills of the just qualified candidate and helped to clarify aspects of items that might not have been clear to all panelists during the Round 1 judgments. The purpose of the discussion was not to encourage panelists to conform to another's judgment, but to understand the different relevant perspectives among the panelists.

In Round 2, panelists discussed their Round 1 judgments and were encouraged by the facilitator (a) to share the rationales for their judgments and (b) to consider their judgments in light of the rationales provided by the other panelists. Panelists recorded their Round 2 judgments only for items when they wished to change a Round 1 judgment. Panelists' final judgments for the study, therefore, consist of their Round 1 judgments and any adjusted judgments made during Round 2.

Other than the description of the just qualified candidate, results from Panel 1 were not shared with Panel 2. The item-level judgments and resulting discussions for Panel 2 were independent of judgments and discussions that occurred with Panel 1.

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## RESULTS

### EXPERT PANELS

Table 2 presents a summary of the panelists' demographic information. The panel included 31 educators representing 17 states and D.C. (See Appendix A for a listing of panelists.) Eighteen panelists were teachers, eight were college faculty, one was an administrator or department head, and four held another position. All eight of the faculty members' job responsibilities included the training of middle school science teachers.

The number of experts by panel and their demographic information are presented in Appendix D (Table D1).



**Table 2**  
***Panel Member Demographics (Across Panels)***

	<i>N</i>	<i>%</i>
<b>Current position</b>		
Teacher	18	58
Administrator/Department head	1	3
College faculty	8	26
Other	4	13
<b>Race</b>		
White or European American	22	71
Black or African American	4	13
Hispanic or Latino	3	10
Asian or Asian American	1	3
African American/Caucasian	1	3
<b>Gender</b>		
Female	19	61
Male	12	39
<b>Are you currently certified as a teacher of this subject in your state?</b>		
Yes	27	87
No	4	13
<b>Are you currently teaching this subject in your state?</b>		
Yes	23	74
No	8	26
<b>Are you currently supervising or mentoring other teachers of this subject?</b>		
Yes	24	77
No	7	23
<b>At what K–12 grade level are you currently teaching this subject?</b>		
Middle school (6–8 or 7–9)	12	39
High school (9–12 or 10–12)	4	13
Middle and High school	2	6
Not currently teaching at the K–12 level	13	42

**Table 2 (continued)*****Panel Member Demographics (Across Panels)***

	<i>N</i>	<i>%</i>
<b>Including this year, how many years of experience do you have teaching this subject?</b>		
3 years or less	2	6
4–7 years	2	6
8–11 years	11	35
12–15 years	5	16
16 years or more	11	35
<b>Which best describes the location of your K–12 school?</b>		
Urban	5	16
Suburban	4	13
Rural	9	29
Not currently working at the K–12 level	13	42
<b>If you are college faculty, are you currently involved in the training/preparation of teacher candidates in this subject?</b>		
Yes	8	26
No	0	0
Not college faculty	23	74

**STANDARD-SETTING JUDGMENTS**

Table 3 summarizes the standard-setting judgments (Round 2) of panelists. The table also includes estimates of the measurement error associated with the judgments: the standard deviation of the mean and the standard error of judgment (SEJ). The SEJ is one way of estimating the reliability or consistency of a panel’s standard-setting judgments.<sup>6</sup> It indicates how likely it would be for several other panels of educators similar in makeup, experience, and standard-setting training to the current panel to recommend the same passing score on the same form of the test. The confidence intervals created by adding/subtracting two SEJs to each panel’s recommended passing score overlap, indicating that they may be comparable.

Panelist-level results, for Rounds 1 and 2, are presented in Appendix D (Table D2).

<sup>6</sup> An SEJ assumes that panelists are randomly selected and that standard-setting judgments are independent. It is seldom the case that panelists are randomly sampled, and only the first round of judgments may be considered independent. The SEJ, therefore, likely underestimates the uncertainty of passing scores (Tannenbaum & Katz, 2013).

**Table 3**  
***Summary of Round 2 Standard-setting Judgments***

	<b>Panel 1</b>	<b>Panel 2</b>
Average	60.58	60.33
Lowest	48.00	55.65
Highest	73.20	67.25
SD	6.84	3.25
SEJ	1.71	0.84

Round 1 judgments are made without discussion among the panelists. The most variability in judgments, therefore, is typically present in the first round. Round 2 judgments, however, are informed by panel discussion; thus, it is common to see a decrease both in the standard deviation and SEJ. This decrease — indicating convergence among the panelists’ judgments — was observed for each panel (see Table D2 in Appendix D). The Round 2 average score is the panel’s recommended passing score.

The panels’ passing score recommendations for the *Praxis* Middle School Science test are 60.58 for Panel 1 and 60.33 for Panel 2 (out of a possible 100 raw-score points). The values were rounded to the next highest whole number, to determine the functional recommended passing score — 61 for both Panel 1 and Panel 2. The scale score associated with 61 raw points is 152.

In addition to the recommended passing score for each panel, the average passing score across the two panels is provided to help education agencies determine an appropriate passing score. The panels’ average passing score recommendation for the *Praxis* Middle School Science test is 60.46 (out of a possible 100 raw-score points). The value was rounded to 61 (next highest raw score) to determine the functional recommended passing score. The scale score associated with 61 raw points is 152.

Table 4 presents the estimated conditional standard error of measurement (CSEM) around the recommended passing score. A standard error represents the uncertainty associated with a test score. The scale scores associated with one and two CSEM above and below the recommended passing score are provided. The conditional standard error of measurement provided is an estimate.

**Table 4*****Passing Scores Within 1 and 2 CSEM of the Recommended Passing Score<sup>7</sup>***

<b>Recommended passing score (CSEM)</b>		<b>Scale score equivalent</b>
	61 (4.90)	152
- 2 CSEM	52	140
- 1 CSEM	57	147
+1 CSEM	66	159
+2 CSEM	71	166

**Note.** CSEM = conditional standard error(s) of measurement.

## FINAL EVALUATIONS

The panelists completed an evaluation at the conclusion of the standard-setting study. The evaluation asked the panelists to provide feedback about the quality of the standard-setting implementation and the factors that influenced their decisions. The responses to the evaluation provided evidence of the validity of the standard-setting process, and, as a result, evidence of the reasonableness of the recommended passing score.

Panelists were also shown the panel's recommended passing score and asked (a) how comfortable they are with the recommended passing score and (b) if they think the score was too high, too low, or about right. A summary of the final evaluation results is presented in Appendix D.

All panelists *strongly agreed* or *agreed* that they understood the purpose of the study. Thirty of the 31 panelists *strongly agreed* or *agreed* that the facilitator's instructions and explanations were clear. All panelists *strongly agreed* or *agreed* that they were prepared to make their standard-setting judgments. All panelists *strongly agreed* or *agreed* that the standard-setting process was easy to follow.

All panelists reported that the description of the just qualified candidate was at least *somewhat influential* in guiding their standard-setting judgments; 20 of the 31 panelists indicated the description was *very influential*. All of the panelists reported that between-round discussions were at least *somewhat influential* in guiding their judgments. More than half of the panelists (25 of the 31 panelists) indicated that their own professional experience was *very influential* in guiding their judgments.

All of the panelists indicated they were at least *somewhat comfortable* with the passing score they recommended; 28 of the 31 panelists were *very comfortable*. Twenty-nine of the 31 panelists

<sup>7</sup> The unrounded CSEM value is added to or subtracted from the rounded passing-score recommendation. The resulting values are rounded up to the next-highest whole number and the rounded values are converted to scale scores.

indicated the recommended passing score was *about right*; one panelist indicated that the passing score was *too low*, and one panelist indicated that the passing score was *too high*.

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## SUMMARY

To support the decision-making process for education agencies establishing a passing score (cut score) for the *Praxis* Middle School Science test, research staff from ETS designed and conducted a multistate standard-setting study.

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 Science test, the recommended passing score<sup>8</sup> is 61 out of a possible 100 raw-score points. The scale score associated with a raw score of 61 is 152 on a 100–200 scale.

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<sup>8</sup> Results from the two panels participating in the study were averaged to produce the recommended passing score.

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## APPENDIX A

# PANELISTS' NAMES & AFFILIATIONS

*Participating Panelists With Affiliation*

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<b><u>Panelist</u></b>	<b><u>Affiliation</u></b>
Mollie Craven	Elkins High School (WV)
Teresa Dobler	Washington Latin PCS (DC)
Shannon Furstenau	Lincoln Public School (NE)
Ehren Haderlie	Brigham Young University-Idaho (ID)
Breanna Hagedorn	Phillip School Middle School (Lincoln Public Schools) (NE)
Cecilia Hernandez	New Mexico State University (NM)
Shawn Hicks	Harnett County Schools/Harnett Central Middle School (NC)
Ellie Houghton	John Griffin Middle School (NC)
Belinda Jenkins	Edward W. Wyatt Middle School (VA)
Alicia Killean	Holmdel Township Public Schools (NJ)
Chantel Kornegay	District of Columbia Public Schools (DC)
John Labriola	Chariho Middle School (RI)
Daniel Levin	University of Maryland, College Park (MD)
Alvin Lin	Central District, Hawaii Department of Education (HI)
Angela Marksberry	Henderson North Middle School (KY)
Lloyd Mataka	Lewis-Clark State College (ID)
Pamela Medows	Taylor University (IN)
Lisa Nance	Caddo Parish Schools (LA)
Matthew Perkins Coppola	Purdue University-Fort Wayne (IN)
Chad Ronish	Hill City High School (SD)
Adam Scott	Archie R. Cole Middle School (RI)

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*Participating Panelists With Affiliation (continued)*

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<b><u>Panelist</u></b>	<b><u>Affiliation</u></b>
Gwendolynn Shealy	South Carolina Department of Education (SC)
Angela Stanford	Southern Arkansas University (AR)
Angela Stewart	Centennial Junior High, Davis School District (UT)
Jamaal Stiles	Marion County Public Schools (KY)
Melesa Swartz	West Liberty University (WV)
Nora Walsh	FJ Reitz High School (IN)
Pam Wells	Mobridge-Pollock School District (SD)
Cheryl Zanone	Robert R. Lazar Middle School (NJ)
Bernard Zdancewicz	Greensville County Public Schools (VA)

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\*One panelist did not wish to be listed in the final report.

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**APPENDIX B**  
**STUDY AGENDA**

# AGENDA

## ***Praxis*<sup>®</sup> Middle School Science (5442) Standard-Setting Study**

### Day 1

Welcome and Introduction

Overview of Standard Setting and the *Praxis* Middle School Science Test

Review the *Praxis* Middle School Science Test

Discuss the *Praxis* Middle School Science Test

Break

Define the Knowledge/Skills of a Just Qualified Candidate

Lunch

Define the Knowledge/Skills of a Just Qualified Candidate (continued)

Break

Standard-Setting Training

Round 1 Standard Setting Judgments

Collect Materials; End of Day 1

# AGENDA

## *Praxis*<sup>®</sup> Middle School Science (5442) Standard-Setting Study

### Day 2

Overview of Day 2

Round 1 Standard Setting Judgments (continued)

Break

Round 1 Feedback and Round 2 Judgments

Lunch

Feedback on Round 2 Recommended Cut Score

Complete Final Evaluation

Collect Materials; End of Study

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## APPENDIX C

### JUST QUALIFIED CANDIDATE DESCRIPTION

## Description of the Just Qualified Candidate<sup>9</sup>

### A just qualified candidate ...

- I. Nature and Impact of Science and Engineering
  1. Understands that science uses evidence gathered through a variety of methods as a foundation of scientific knowledge
  2. Is familiar with the similarities and difference between science and engineering practices
  3. Recognizes common safety concerns and practices for general lab procedures, equipment use, and material storage
  4. Knows science, engineering, and technology drive each other forward and impact the environment and society
- II. Physical Science
  1. Knows energy can be transferred within and between systems and is transformed from one form to another
  2. Knows that differences in structure determine properties of matter and that those properties cause differences in chemical and physical properties and changes
  3. Knows basic relationships between forces and motion
  4. Knows the difference between matter and energy
- III. Life Science
  1. Knows the structures and processes associated with cellular function and specialization (i.e., tissues, organs, systems)
  2. Knows the interactions between the abiotic and biotic components within the environment
  3. Knows the effects of genetic and environmental factors on the diversity of life
- IV. Earth and Space Science
  1. Knows predictable patterns and relationships in the Sun-Earth-Moon and effect on Earth
  2. Knows the processes of the formation and changes in rocks (e.g., due to plate tectonics, weathering, and erosion)
  3. Knows how atmospheric patterns impact weather
  4. Knows causes of climate change (natural and human)

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<sup>9</sup> Description of the just qualified candidate focuses on the knowledge/skills that differentiate a *just* from a *not quite* qualified candidate.

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## APPENDIX D

## RESULTS

**Table D1**  
**Panel Member Demographics (by Panel)**

	Panel 1		Panel 2	
	<i>N</i>	%	<i>N</i>	%
<b>Current position</b>				
Teacher	9	56	9	60
Administrator/Department head	0	0	1	7
College faculty	5	31	3	20
Other	2	13	2	13
<b>Race</b>				
White or European American	11	69	11	73
Black or African American	2	13	2	13
Hispanic or Latino	2	13	1	7
Asian or Asian American	0	0	1	7
African American/Caucasian	1	6	0	0
<b>Gender</b>				
Female	11	69	8	53
Male	5	31	7	47
<b>Are you currently certified as a teacher of this subject in your state?</b>				
Yes	14	88	13	87
No	2	13	2	13
<b>Are you currently teaching this subject in your state?</b>				
Yes	11	69	12	80
No	5	31	3	20
<b>Are you currently supervising or mentoring other teachers of this subject?</b>				
Yes	12	75	12	80
No	4	25	3	20
<b>At what K–12 grade level are you currently teaching this subject?</b>				
Middle school (6–8 or 7–9)	6	38	6	40
High school (9–12 or 10–12)	2	13	2	13
Middle and High school	1	6	1	7
Not currently teaching at the K–12 level	7	44	6	40



**Table D1 (continued)*****Panel Member Demographics (by Panel)***

	<b>Panel 1</b>		<b>Panel 2</b>	
	<i>N</i>	%	<i>N</i>	%
<b>Including this year, how many years of experience do you have teaching this subject?</b>				
3 years or less	2	13	0	0
4–7 years	0	0	2	13
8–11 years	6	38	5	33
12–15 years	3	19	2	13
16 years or more	5	31	6	40
<b>Which best describes the location of your K–12 school?</b>				
Urban	3	19	2	13
Suburban	2	13	2	13
Rural	4	25	5	33
Not currently working at the K–12 level	7	44	6	40
<b>If you are college faculty, are you currently involved in the training/preparation of teacher candidates in this subject?</b>				
Yes	5	31	3	20
No	0	0	0	0
Not college faculty	11	69	12	80

**Table D2*****Passing Score Summary by Round of Judgments***

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	<b>Panel 1</b>		<b>Panel 2</b>	
<b>Panelist</b>	<b>Round 1</b>	<b>Round 2</b>	<b>Round 1</b>	<b>Round 2</b>
1	53.55	54.15	61.90	62.60
2	72.85	73.20	60.45	61.10
3	63.35	61.95	56.10	56.80
4	63.90	64.55	55.20	56.50
5	63.35	62.45	70.90	67.25
6	60.30	62.05	61.90	60.70
7	66.05	65.55	57.05	58.95
8	73.55	71.15	59.75	62.25
9	65.00	63.80	65.30	65.65
10	45.30	48.00	58.85	59.30
11	56.70	55.00	58.30	60.50
12	54.80	55.60	60.30	61.10
13	46.00	55.35	57.55	57.55
14	52.90	51.70	55.05	55.65
15	59.25	60.75	58.70	59.10
16	64.40	63.95		
<b>Average</b>	60.08	60.58	59.82	60.33
<b>Lowest</b>	45.30	48.00	55.05	55.65
<b>Highest</b>	73.55	73.20	70.90	67.25
<b>SD</b>	8.21	6.84	4.12	3.25
<b>SEJ</b>	2.05	1.71	1.06	0.84

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**Table D3*****Final Evaluation: Panel 1***

	<b>Strongly agree</b>		<b>Agree</b>		<b>Disagree</b>		<b>Strongly disagree</b>	
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
• I understood the purpose of this study.	13	81	3	19	0	0	0	0
• The instructions and explanations provided by the facilitators were clear.	12	75	4	25	0	0	0	0
• The training in the standard-setting method was adequate to give me the information I needed to complete my assignment.	14	88	2	13	0	0	0	0
• The explanation of how the recommended passing score is computed was clear.	15	94	1	6	0	0	0	0
• The opportunity for feedback and discussion between rounds was helpful.	15	94	1	6	0	0	0	0
• The process of making the standard-setting judgments was easy to follow.	12	75	4	25	0	0	0	0
• I understood how to use the survey software.	15	94	1	6	0	0	0	0

**Table D3 (continued)**  
**Final Evaluation: Panel 1**

How influential was each of the following factors in guiding your standard-setting judgments?	Very influential		Somewhat influential		Not influential			
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%		
• The description of the just qualified candidate	12	75	4	25	0	0		
• The between-round discussions	12	75	4	25	0	0		
• The knowledge/skills required to answer each test item	14	88	2	13	0	0		
• The passing scores of other panel members	8	50	7	44	1	6		
• My own professional experience	14	88	2	13	0	0		
	Very comfortable		Somewhat comfortable		Somewhat uncomfortable		Very uncomfortable	
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
• Overall, how comfortable are you with the panel's recommended passing score?	13	81	3	19	0	0	0	0
	Too low		About right		Too high			
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%		
• Overall, the recommended passing score is:	1	6	14	88	1	6		

**Table D4*****Final Evaluation: Panel 2***

	<b>Strongly agree</b>		<b>Agree</b>		<b>Disagree</b>		<b>Strongly disagree</b>	
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
• I understood the purpose of this study.	12	80	3	20	0	0	0	0
• The instructions and explanations provided by the facilitators were clear.	11	73	3	20	1	7	0	0
• The training in the standard-setting method was adequate to give me the information I needed to complete my assignment.	12	80	3	20	0	0	0	0
• The explanation of how the recommended passing score is computed was clear.	13	87	2	13	0	0	0	0
• The opportunity for feedback and discussion between rounds was helpful.	15	100	0	0	0	0	0	0
• The process of making the standard-setting judgments was easy to follow.	12	80	3	20	0	0	0	0
• I understood how to use the survey software.	15	100	0	0	0	0	0	0

**Table D4 (continued)**  
**Final Evaluation: Panel 2**

How influential was each of the following factors in guiding your standard-setting judgments?	Very influential		Somewhat influential		Not influential			
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%		
• The description of the just qualified candidate	8	53	7	47	0	0		
• The between-round discussions	12	80	3	20	0	0		
• The knowledge/skills required to answer each test item	13	87	2	13	0	0		
• The passing scores of other panel members	5	33	10	67	0	0		
• My own professional experience	11	73	4	27	0	0		
	Very comfortable		Somewhat comfortable		Somewhat uncomfortable		Very uncomfortable	
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
• Overall, how comfortable are you with the panel's recommended passing score?	15	100	0	0	0	0	0	0
	Too low		About right		Too high			
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%		
• Overall, the recommended passing score is:	0	0	15	100	0	0		