Achieve

Report

American Diploma Project (ADP) End-of-Course Exams: 2009 Annual Report

September 2009

Introduction

To ensure that all high school graduates are prepared for the opportunities and challenges that await them, states have increasingly been focused on aligning their end-of-high school expectations with the demands of the real world. In 2005, no state had aligned their expectations with real world demands; now 29 states have adopted college- and career-ready standards in English and/or mathematics. And, as standards in mathematics have risen, so too have graduation requirements. Currently 19 states and District of Columbia[1] require students to study mathematics through Algebra II or its equivalent in order to earn a high school diploma. These policies are well grounded; advanced mathematics courses, such as Algebra II, improve access to postsecondary education, reduce the need for remediation and significantly increase the odds that a student will earn a degree. Particularly for disadvantaged students, advanced mathematics coursework in high school significantly narrows the equity gap, improving access to and success in college and in future economic opportunities.[2]

To assess these raised expectations, a group of American Diploma Project (ADP) network states formed the ADP Assessment Consortium. The Consortium created Algebra I and II end-of-course exams that provide an honest assessment of whether a student has mastered the content in the course they have just completed and is prepared for higher-level mathematics coursework. By design, the tests are challenging. States in the Consortium knew that what they were undertaking wouldn't be easy and that early results would be disappointing. But they believed that by setting the bar appropriately high, they could collectively challenge themselves, their systems and their schools to improve secondary mathematics education for the benefit of all students.

The ADP Assessment Consortium states have shown that multistate partnerships are not just possible, but that they can be a vehicle for driving change. The states have, in fact, been engaged in a voluntary race to the top. Even in the face of disappointing first-year results for the ADP Algebra II exam and an economic recession that severely impacted state budgets, these states have stayed the course, giving more exams this year than last and willingly disclosing the results and the challenges they face. No state alone could do what the 15 Consortium states have managed together. While there is plenty of hard work ahead, the ADP Assessment Consortium states have already demonstrated that they can move faster—and more economically—together than they ever could have going it alone.

Background

The ADP Assessment Consortium is a group of fifteen states that are part of the American Diploma Project[3] network—Arizona, Arkansas, Florida, Hawaii, Indiana, Kentucky, Maryland, Massachusetts, Minnesota, New Jersey, North Carolina, Ohio, Pennsylvania, Rhode Island and Washington. These states voluntarily banded together with the goal of creating high-quality, rigorous mathematics assessments aligned to increased expectations, including an assessment that could serve as an indication of readiness for college mathematics.[4] The resulting end-of-course exams in Algebra I and II represent the largest multistate common assessment effort ever undertaken.

[1] To see a full list of the states with college- and career-ready graduation requirements in English and mathematics as well as the specific course requirements and the dates that such requirements are effective, please go to http://www.achieve.org/files/College&CareerReadyGradReqTable.pdf

[2] http://www.achieve.org/files/BuildingBlocksofSuccess.pdf

[3] For more information about Achieve's American Diploma Project, go to http://www.achieve.org/files/AboutADP.pdf

[4] A fuller description on the background of the exams and their development can be found at http://www.achieve.org/ADPAssessmentConsortium

By working together, the states also hoped to create new, high-quality assessments at a lower cost than if they were bearing all of the development costs alone. In 2006, the ADP Assessment Consortium states, with Ohio serving as the lead, participated in a joint procurement for the development of an Algebra II end-of-course assessment. Pearson, after a competitive bidding process, was chosen as the test developer. The first ADP Algebra II assessment was administered to nearly 90,000 students in the spring of 2008. Subsequently, the Consortium developed Algebra I exam standards and an aligned Algebra I exam, which was administered for the first time in 2009. Standard setting (the process of determining achievement-level cut scores) for both exams was completed in July 2009.

The ADP Assessment Consortium states anticipated that early test results would be low but recognized the importance of aiming high so that their high school graduates would be prepared for success in college and careers. In developing the exams, all participating states were guided by three main purposes:

- To develop high-quality exams that would ensure a consistent level of content and rigor in Algebra I and II courses within and across states;[5]
- To improve the quality of curriculum and instruction in Algebra I and II courses, within and across states; and
- To examine students' mastery of the content in the course they completed and to provide an indicator of students' readiness for success in mathematics at the next level. With respect to Algebra I, that means providing an indicator for readiness in a higher-level mathematics course, such as Algebra II. For students completing the Algebra II exam, the exam provides an indicator of readiness for the first credit-bearing college mathematics course, typically College Algebra.

Test Content and Design

The **ADP Algebra I exam** assesses algebra skills that will create a strong foundation for the higher-level mathematics courses students will take during the remainder of their high school careers. The content on the Algebra I exam provides a strong foundation for Algebra II and the ADP Algebra II exam. The **ADP Algebra II exam** assesses the advanced algebra content that is necessary for success in the first credit-bearing college mathematics course, typically College Algebra. In this respect, the Algebra II exam is unique and is one of only a handful of exams developed with the purpose of signaling to students their readiness for college mathematics while they are still in high school.

The ADP Algebra I and Algebra II exam standards were developed collaboratively by the partner states, based in large part on the ADP benchmarks for mathematics.[6] The Algebra I exam standards are rigorous, but fundamental in nature, and designed to provide a strong base of knowledge in the basic algebraic content necessary for higher-level courses. The Algebra I exam standards are vertically aligned with the Algebra II exam standards. The Algebra II exam standards are robust, emphasizing advanced algebra, critical thinking and problem solving. The mathematics content assessed and its associated emphasis on each exam are described in the following tables. Table 1 describes the four content standards on the Algebra I exam and Table 2 describes the five core content standards on the Algebra II exam.[7]

[5] "Algebra I" and "Algebra II" are common course titles for courses containing the beginning and advanced algebra content normally found in such courses. The content tested in the Algebra I and II exams is also covered in courses with different course titles such as integrated high school mathematics.

[6] http://www.achieve.org/files/ADPreport_7.pdf

[7] The Algebra I and II exam standards and released items can be seen at http://www.achieve.org/ADPAssessmentConsortium

Algebra I Exam Standards The emphasis a particular standard was given on the Algebra I exam is directly related to the emphasis the participating states believed that topic should receive in an Algebra I classroom. For example, in Algebra I, *Operations on Numbers and Expressions* is 25 percent of the exam because it is considered foundational material that many students will be exposed to for the first time in the course. It also serves as an important building block for advanced algebra and is, therefore, included in the Algebra II standards as well. Since the bulk of an Algebra I course should focus on *Linear Relationships*, 35 percent of the exam is dedicated to this topic. *Non-linear Relationships* is 20 percent of the Algebra I exam standards. These two standards also provide an important foundation for more advanced mathematics including the Algebra II exam standards *Equations and Inequalities* and *Polynomial and Rational Functions* (See Table 2). It was also important to the Consortium states that *Data, Statistics and Probability* be assessed on the exam since the content is often included in an Algebra I course and is critical for a well-rounded high school mathematics curriculum; 20 percent of the exam is dedicated to this content.

TABLE 1: ALGEBRA I EXAM STANDARDS

Standard	Topics Addressed	Percentage of Total Points
Operations on Numbers and Expressions	Operations with numbers and algebraic expressions, involving real numbers.	25%
Linear Relationships	Linear equations and inequalities and systems of linear equations.	35%
Non-linear Relationships	Quadratic and exponential functions and the patterns they form.	20%
Data, Statistics and Probability	Data that follow linear trends, measures of central tendency and determining probabilities.	20%

Algebra II Exam Standards Again, the emphasis a particular standard was given on the Algebra II exam is directly related to the emphasis the participating states believed the topic should receive in an Algebra II classroom. In Algebra II, *Operations on Numbers and Expressions* comprises only 15 percent of the exam because it is considered mostly introductory Algebra II material, some of which should have been covered in previous mathematics courses including Algebra I. Building on the foundation laid in Algebra I, *Equations and Inequalities* further explores these concepts at a more advanced level and comprises 20 percent of the exam. *Polynomials and Rational Functions* is the main focus of most Algebra II curricula, and as such is given the greatest emphasis on the exam at 30 percent. *Exponential Functions* was considered important enough to make up 20 percent of the test points. *Function Operations and Inverses*, only 15 percent of the total points of the Algebra II exam, is the most advanced content in the exam and stretches beyond what is covered in some Algebra II courses. The states determined that this content is important and should be included to drive curricular improvement and to better prepare students for college mathematics.

TABLE 2: ALGEBRA II EXAM STANDARDS

Standard	Topics Addressed	Percentage of Total Points
Operations on Numbers and Expressions	Operations with numbers and algebraic expressions, involving real and complex numbers.	15%
Equations and Inequalities	Linear and non-linear equations and inequalities, and systems of linear equations and inequalities.	20%
Polynomial and Rational Functions	Quadratic functions and higher-order polynomial and simple rational functions.	30%
Exponential Functions	Exponential functions and basic logarithms and their relationship to exponents.	20%
Function Operations and Inverses	Combinations and inverses of functions.	15%

Item Types Both exams include a mix of multiple-choice (worth 1 point), short-answer (worth 2 points) and extended-response questions (worth 4 points). To measure in-depth student understanding of algebraic knowledge and skills, the exams include a large number of open-response items that require students to show the steps they have taken and to justify their reasoning when solving a problem. At least 30 percent of the total points are from the short-answer and extended-response items. These problem solving and reasoning skills are critical for higher-level mathematics work, including credit-bearing coursework in college, and are highly valued by mathematics educators and postsecondary faculty.

Calculator Use In developing the content of the exams, the state mathematics experts felt it was necessary for students to demonstrate fluency in mathematics both with and without the use of technology. As a result, the exam is structured into two sections; one that allows the use of a calculator and one that does not. Although not required, the use of a graphing calculator is highly recommended for the calculator section.

2009 Changes to the Algebra II Exam The Algebra II exam was first administered in Spring 2008. Although the test was untimed, it was estimated that test administration would take 45 to 60 minutes per session. Feedback from schools and classrooms after the first administration, however, indicated that students took longer than expected to complete the test. In response to concerns regarding test length, the states decided to reduce the number of items on the Algebra II exam for the Spring 2009 administration, as well as all future administrations, and to extend the estimated time per session to 90 minutes. The test remains untimed for students.

Additional Modules The ADP Algebra II end-of-course exam content standards identify content for the core exam, as well as content for seven optional modules. The modules were developed to enable growth of the Algebra II end-of-course exam beyond the traditional Algebra II curriculum. The modules available are *Data and Statistics, Probability, Logarithmic Functions, Trigonometric Functions, Matrices, Conic Sections,* and *Sequences and Series*. The modules have been developed and field tested but, to date, have not been administered in any state.

Comparing the ADP Algebra II Assessment to other Exams and International Standards

The ADP Algebra II exam standards were developed by high school and college mathematics faculty from the participating states. The exam is challenging, but not unreasonably so. It provides an honest measure of how well students have mastered the course content, and how well prepared they are to enter and succeed in a college mathematics course.

The Algebra II exam includes far more advanced algebra than high school exit exams. In 2004, Achieve conducted a review of graduation assessments, *Do Graduation Tests Measure Up? A Closer Look at State High School Exit Exams*, which included a review of the mathematics exams required for graduation in six states, Florida, Maryland, Massachusetts, New Jersey, Ohio, and Texas. Looking across these state exams, Achieve found that nearly 60% of the mathematics items on high school graduation exams measure pre-algebra skills, whereas only 16% of the ADP Algebra II exam measures similar content. In contrast, only 15% of the items on state high school graduation tests measure advanced algebra content, while nearly 60% of the items on the ADP Algebra II exam measure this advanced content.

The Algebra II exam includes more advanced algebra than college admissions exams. The ACT and SAT are comprehensive mathematics admissions tests assessing a mix of topics. Their intended purpose is for use in admissions decisions, not to measure the mastery of specific course content, especially an advanced course such as Algebra II. While 60% of the ADP Algebra II exam measures advanced algebra content, according to ACT the content covered by the mathematics portion of the ACT exam includes the following mix: pre-algebra (23%); elementary algebra (17%); intermediate algebra (15%); coordinate geometry (15%); plane geometry (23%); and trigonometry (7%). The College Board reports that the topics covered on the math portion of the SAT exam include numbers and operations; algebra and functions; geometry; and statistics, probability and data analysis. Topics from third-year college-preparatory math courses (such as Algebra II) were first added to the SAT in 2005. For more information about what admissions and placement exams test, including an analysis of the mathematics portions of the ACT and SAT exams, go to *Aligned Expectations? A Closer Look at College Admissions and Placement Tests* at www.achieve.org/AlignedExpectations.

The Algebra II exam standards are internationally competitive. Achieve recently compared the Algebra II end-of course exam standards to upper-level secondary mathematics standards in eleven countries—Alberta (Canada), China, Chinese Taipei, Finland, Hong Kong, Japan, Korea, Malaysia, New Zealand, Singapore and Thailand. The mathematics standards from the countries Achieve analyzed are the upper-level secondary standards required for all students receiving a high school diploma or equivalent credential. The analyses show that the algebra in the standards from other countries is at least as rigorous, if not more, than the ADP Algebra II exam standards. In more than half of the countries' standards analyzed, over 50% of the algebra content focused on advanced algebra.

Administration of the Spring 2009 ADP Algebra I and Algebra II Exams

The development of the ADP Algebra I and Algebra II end-of-course exams is an important element in the college- and career-ready agenda in the ADP Consortium states. Most of the states in the Consortium are still in the process of developing and adopting policies that will govern participation in the exams and how the results will ultimately be used. Consistent with this ongoing discussion, it is important to note that there are *no stakes—no incentives or consequences*—for students, schools or districts attached to either ADP Algebra I or Algebra II exam results.

Five states participated in the first administration of the Algebra I exam: Kentucky, Minnesota, New Jersey, Ohio and Rhode Island (see Table 3, p. 11) with 33,446 students tested in total. The exam was treated by all five ADP Consortium states as an opportunity to pilot the test in a small number of school districts and schools. Some consortium states are already planning to phase in broader participation for future test administrations; for example, New Jersey is planning to have all students who take Algebra I in the 2009-10 school year take the ADP Algebra I end-of-course exam in spring 2010.

With respect to Algebra II (see Table 4, p. 11) most states, in the second administration year of the exam, decided to continue to pilot the exam in a small number of school districts and schools. The notable exceptions were three states—Arkansas, Hawaii and Indiana—that required all students taking an Algebra II course in the spring of 2009 to take the ADP Algebra II end-of-course exam. These states are all evaluating how a rigorous Algebra II assessment can reinforce their college- and career-ready policies.

For example, Arkansas is one of 19 states that require all students to complete an Algebra II course to graduate from high school, starting with the class of 2010. Hawaii, while not currently requiring all students to take Algebra II, includes the course as part of its Board Recognition Diploma and is working with both postsecondary institutions and employers to create incentives for students to complete the more rigorous, opt up curriculum. Hawaii is also, through a robust multimedia campaign, encouraging their high school students to "Step Up" to the challenge. Starting with the graduating class of 2011, Indiana's Core 40 requires at least three years of mathematics though Algebra II, or a three-year integrated course sequence covering the same curriculum, for graduation. Indiana is also moving to an end-of-course assessment system and considering how the ADP Algebra II exam may fit into that system. Again, even in these three states where all students who took Algebra II were required to take the exam, there were no stakes attached to the results of the exam for students, schools or districts.

This year, the economic recession and its impact on state budgets had a significant impact on test administration and participation for both exams. Interest in the exam remained high, but the ability for states to test as many students as they would like was limited by budget realities. For instance, Ohio tested over 33,000 students in Algebra II in 2008, but was only able to secure funding for 2,000 Algebra I exams and nearly 2,500 Algebra II exams in 2009. Many other states that were able to offer the Algebra II exam to all districts last year were forced to select districts to participate this year instead.

Despite the fiscal challenges faced by states, participation in the ADP Algebra II exam increased this year. Across the Consortium, 102,936 students took the Algebra II exam in the spring of 2009, up from 88,344 in 2008.

Standard Setting

The spring 2009 test administrations were important for both exams because results now can be reported in terms of performance levels indicating a student's mastery of the course materials and readiness for success in mathematics at the next level. The process of determining the achievement-level cut scores for the exams—known as standard setting—was completed in July 2009 and involved representatives from each of the Consortium states.

Algebra I The ADP Algebra I End-of-Course Exam used a traditional item mapping standard setting approach, commonly used in state assessment programs. In this procedure cut scores are based on the judgments of a standard setting panel, in this case state department mathematics specialists and high school mathematics teachers. During a two-day meeting involving multiple rounds of ratings and discussions, panelists made judgments to match student performance on the test to achievement level descriptions based on the ADP Algebra I exam standards. At the conclusion of the meeting, the judgments of individual panelists were combined to produce a set of recommended achievement-level cut scores for the ADP Algebra I end-of-course exam: "*Below Basic*," "*Basic*," "*Proficient*" or "*Advanced*." For a fuller description of these performance levels, see the sidebar on page 8.

Algebra II Because of its intended use as both evidence of content mastery and an indicator of readiness for a first-year credit-bearing college mathematics course, a variety of empirical and judgment-based studies conducted over the past year and a half formed the basis of the standard setting process used for the ADP Algebra II end-of-course exam. This research served as the main evidence for the panelists' judgments on the placement of the achievement level cut scores. The types of research studies used to inform the standard-setting process included the following:

- *International benchmarking analyses*, in which Achieve content specialists compared the content and rigor of the ADP Algebra II exam standards with upper-level secondary mathematics standards in eleven countries;
- *Concurrent studies*, which included analyses of the relationship between student performance on the ADP Algebra II end-of-course exam and their performance on other exams, such as a state exam, the SAT or the ACT;
- *Cross-sectional validity studies*, in which Pearson administered the ADP Algebra II end-of-course exam to college students at the beginning of their first credit-bearing mathematics course and analyzed the relationship between the students' final grades in the course and their performance on the exam;
- *Judgment studies*, in which college mathematics professors from both two- and four-year postsecondary institutions: a) rated the ADP Algebra II exam standards based on their relevancy to the courses they teach; b) determined which items on the ADP Algebra II end-of-course exam a student would need to have previously mastered in order to successfully complete their course, earning a B- or better; and c) provided descriptions of student performance that formed the basis of the achievement level definitions for the ADP Algebra II end-of-course exam. Altogether, over 125 mathematics faculty members from 79 institutions in 20 states participated in three judgment study meetings held during winter and spring 2009; and

- *College Algebra and Pre-Calculus course syllabi analysis*, in which Achieve content specialists determined the relative importance of the content in the Algebra II exam standards for preparation for credit-bearing college mathematics courses, specifically College Algebra and Pre-Calculus. In all, 71 higher education institutions and campuses, representing two- and four-year public institutions, across 18 states contributed syllabi to the analysis.

Results from all of the studies were presented to an Algebra II standard setting panel composed of representatives from the 15 Consortium states, including state education department policy, assessment and mathematics experts, as well as higher education mathematics professors from two- and four-year institutions. During a two-day meeting, the panelists engaged in rich discussions about the various pieces of research and the implications of each study's results. At the conclusion of the meeting, the judgments of individual panelists were combined to produce a set of recommended achievement level cut scores for the ADP Algebra II end-of-course exam: "*Well Prepared*," "*Prepared*" or "*Needs Preparation*." (For a fuller description of these performance levels, see the sidebar on page 9.)

ADP Algebra I Exam Performance Levels

Results for the ADP Algebra I Exam are reported according to four performance levels that indicate a student's proficiency in Algebra I and are a useful indicator of his or her preparedness for higher-level mathematics courses. The knowledge, skills, and abilities required at each performance level and the scores required to achieve each level were defined in collaboration with state department mathematics specialists and high school mathematics teachers.

ADVANCED **The student consistently applies concepts, procedures, and skills needed to show mastery of Algebra I. The student is highly effective at devising and clearly communicating a wide range of strategies to solve complex mathematical and contextual problems. The student computes accurately and uses precise mathematical and symbolic language to solve problems and communicate solutions. The student's explanations demonstrate the ability to use formal reasoning to justify solutions and evaluate the validity of solutions.**

PROFICIENT **The student usually applies concepts, procedures, and skills to show adequate progress toward the mastery of Algebra I. The student is usually effective at devising and communicating a variety of strategies to solve mathematical and contextual problems. The student is adept in computation and uses mathematical and symbolic language to solve problems and communicate solutions. The student's explanations demonstrate the ability to reason mathematically, recognizing connections between ideas in or across areas of mathematics, using formal and informal reasoning to justify solutions, and evaluating the validity of solutions.**

BASIC **The student inconsistently applies concepts, procedures, and skills to show minimal progress toward the mastery of Algebra I. The student is generally effective at recalling and using routine, easily recognized, or straightforward strategies to solve simple mathematical and some contextual problems. The student can generally compute accurately and uses limited mathematical and symbolic language to solve problems and communicate solutions. The student's explanations demonstrate limited ability to reason mathematically, using informal reasoning to justify solutions, and evaluating the validity of solutions.**

BELOW BASIC **The student is unable to apply concepts, procedures, and skills to show progress toward the mastery of Algebra I. The student is usually unsuccessful at using problem solving strategies or uses inappropriate strategies to solve problems. The student's explanations are often restatements of the problem, not related to the mathematics of the problem, or missing. The student displays limited computational accuracy.**

ADP Algebra II Exam Performance Levels

Results for the ADP Algebra II Exam are reported according to three performance levels that indicate a student's proficiency in Algebra II and are a useful indicator of his or her preparedness for first-year credit-bearing college mathematics courses. The knowledge, skills, and abilities required at each performance level and the scores required to achieve each level were defined in collaboration with higher-education mathematics professors from across the country.

WELL PREPARED **The student consistently applies concepts, procedures, and skills needed to show mastery of Algebra II. The student is highly effective at devising and clearly communicating a wide range of strategies to solve complex mathematical and contextual problems. The student computes accurately and uses precise mathematical and symbolic language to solve problems and communicate solutions. The student's explanations demonstrate the ability to reason mathematically, making appropriate connections between ideas in or across areas of mathematics, using formal reasoning to justify solutions, and evaluating the validity of solutions.**

PREPARED **The student usually applies concepts, procedures, and skills to show adequate progress toward the mastery of Algebra II. The student is usually effective at devising and communicating a variety of strategies to solve mathematical and contextual problems. The student is adept in computation and uses mathematical and symbolic language to solve problems and communicate solutions. The student's explanations demonstrate the ability to reason mathematically, recognizing connections between ideas in or across areas of mathematics, using formal and informal reasoning to justify solutions, and evaluating the validity of solutions.**

NEEDS PREPARATION **The student inconsistently applies concepts, procedures, and skills to show minimal progress toward the mastery of Algebra II. The student is generally effective at recalling and using routine, easily recognized, or straightforward strategies to solve simple mathematical and some contextual problems. The student can generally compute accurately and uses limited mathematical and symbolic language to solve problems and communicate solutions. The student's explanations demonstrate limited ability to reason mathematically, using informal reasoning to justify solutions, and evaluating the validity of solutions.**

Interpreting the 2009 Results

Beginning with the 2009 exams, reporting scales have been established for the ADP Algebra I and II end-of-course exams that will support a standards-based interpretation of exam results and also allow comparisons of exam results across years. This is a critical requirement in the use of the exams to monitor states' progress in implementing rigorous mathematics coursework and preparing their students for higher-level mathematics courses. The reports of exam results contain four key pieces of information:

- Performance levels;
- Scaled scores;
- Content standard mastery scores; and
- Number of students tested.

One important note of caution is in order. The ability to compare results across states is limited since the number and percentage of test takers varies significantly across the states (see Tables 3 and 4) and was not designed or intended by the states to be representative state samples. **Because the factors for student selection were not controlled and the number of test takers varied significantly across the states, cross-state comparisons are not valid for the spring 2009 administration of either the Algebra I or II exam.** It is expected that as states continue to expand their use of the test, the number of test takers will increase and the results will yield more comparable data.

Performance Levels The ADP Algebra exams are reported primarily in terms of performance levels that classify student performance in relation to standards-based benchmarks established for each of the exams. State and consortium-wide results are reported as the percentage of students whose performance falls within each performance level category. The goal is for students to perform at the *Proficient* or *Advanced* levels on the Algebra I exam and at the *Prepared* or *Well Prepared* levels on the Algebra II exam.

Scaled Scores In addition to performance levels, overall performance on the ADP Algebra exams is also reported as a scaled score. Each performance level category represents a range of performance, and scaled scores provide additional information describing where student performance falls within the performance level. Considered in conjunction with performance level results, scaled scores can be particularly useful in interpreting changes in exam results across years. State and Consortium scaled score results are reported as the mean and standard deviation of individual student scaled scores.

Content Standard Mastery Scores Although the ADP Algebra exams are designed to support valid and reliable inferences at the overall content level, aggregate performance on each of the major standards can also provide information that may be useful in interpreting test results and improving curriculum and instruction. On the ADP Algebra exams, results for each of the major content standards are reported as the percent of students who reached the mastery level on that standard. The mastery level for each content standard is determined through a statistical process that compares student performance on the set of items within each content standard to the *Proficient* (for the ADP Algebra I exam) or *Prepared* (for the ADP Algebra II exam) performance standard established for the overall exam. Although results at the content standard level are much less reliable than results on the overall exam, they can be very useful. Aggregate results that show large and persistent differences in performance across content standards can be an indicator of relative strengths and weaknesses in curriculum and instruction.

Number of Students Tested The total number and percentage of students tested is a critical piece of information in interpreting ADP exam results within and across states. As shown in Tables 3 and 4, the level of student participation varied greatly across the states in the Consortium. For example, in a few states, all students enrolled in an Algebra II course took the associated exam, and in others only a small subset of schools and students participated. The level of participation itself also can be an important indicator of progress in implementing the rigorous program of curriculum and instruction called for by the ADP Algebra I and II exam standards. It is expected that as states continue to align their curriculum and instruction with the exam standards, they will expand their use of the exams.

TABLE 3: STUDENTS' ENROLLMENT IN ALGEBRA I COURSES AND/OR PARTICIPATION IN ALGEBRA I EXAM BY STATE, 2008-09

State	Exam Participants	Approximate Number of Students Enrolled in Algebra I	Percent of Enrolled Students who Took the Exam	First Year Algebra I is Required for Graduation
Total	**33,446**			
KY	520	54,160	1%	Currently Required
NJ	28,470	105,000	27%	Currently Required
OH	2,031	152,190	1%	2014
RI	2,416	No State Data	No State Data	Not Required

NOTES: Data on the numbers of students enrolled in Algebra I are state reported information. Minnesota participated in the Algebra I administration but too few students took the exam to report scores.

TABLE 4: STUDENTS' ENROLLMENT IN ALGEBRA II COURSES AND/OR PARTICIPATION IN ALGEBRA II EXAM BY STATE, 2008-09

State	Exam Participants	Approximate Number of Students Enrolled in Algebra II (or its equivalent)	Percent of Enrolled Students who Took the Exam	First Year Algebra II is Required for Graduation
Total	**102,936**			
AZ	2,982	No State Data	No State Data	2013
AR	23,608	29,119	81%	2010
HI	6,291	7,266	87%	Not Required
IN	45,443	60,078	76%	2011
KY	1,384	45,350	3%	2012
MD	1,295	No State Data	No State Data	Not Required
MA	584	46,400	1%	Not Required
MN	1,164	No State Data	No State Data	2015
NJ	8,063	70,000	12%	Not Required
NC	2,551	76,079	3%	2013
OH	2,416	138,239	2%	2014
PA	6,786	135,307	5%	Not Required
RI	369	No State Data	No State Data	Not Required

NOTES: Data on the numbers of students enrolled in Algebra II are state reported information. Note that while Arkansas, Indiana and Hawaii required all students taking the Algebra II course to take the spring 2009 exam, discrepancies in numbers reported (course takers versus exam takers) are due to a variety of factors including students who completed their Algebra II course in a fall or winter semester or trimester; students who were absent during the testing window; students who enrolled in the class but did not complete it and; students repeating the course who were not retested.

ADP Algebra I and II Exam Results

Students Performance was Low Across All States for Both Exams As shown in Table 5, performance on the 2009 **Algebra I exam** was low across all states. On the Algebra I exam, only 18.0% of the 33,446 students tested performed at the *Proficient* or *Advanced* levels. Additionally, in each of the participating states more than half of the students tested performed at the *Below Basic* level on the Algebra I test.

TABLE 5: ALGEBRA I: PERCENT OF STUDENTS IN EACH PERFORMANCE LEVEL, BY STATE

	Total Students Tested	Advanced (850—575)	Proficient (574—450)	Basic (449—387)	Below Basic (386—300)	Average Scale Score (Standard Deviation)
Consortium	**33,446**	**1.6%**	**16.4%**	**26.2%**	**55.8%**	**384 (70)**
KY	520	3.9%	21.0%	20.6%	54.6%	393 (84)
NJ	28,470	1.8%	17.3%	26.2%	54.7%	386 (72)
OH	2,031	0.4%	13.0%	26.4%	60.2%	375 (61)
RI	2,416	0.2%	8.2%	27.2%	64.4%	368 (53)

NOTE: Minnesota participated in the Algebra I administration but too few students took the exam to report scores.

Table 6 shows that on the 2009 **Algebra II exam**, of the 102,936 students tested across 13 states, only 14.6% performed at the *Prepared* or *Well Prepared* levels. Consortium wide, 85.4% of students tested performed at the *Needs Preparation* level. It is significant to note that the states with the highest participation rates who tested all students who were taking an Algebra II course in the spring of 2009—Arkansas, Indiana and Hawaii—had scores that were similar to those states who had a smaller, select number of participants.

TABLE 6: ALGEBRA II: PERCENT OF STUDENTS IN EACH PERFORMANCE LEVEL, BY STATE

	Total Students Tested	Well Prepared (1650–1275)	Prepared (1274–1150)	Needs Preparation (1149–900)	Average Scale Score (Standard Deviation)
Consortium	**102,936**	**3.5%**	**11.1%**	**85.4%**	**1032 (109)**
AZ	2,982	4.2%	11.9%	83.9%	1045 (110)
AR	23,608	2.9%	9.3%	87.8%	1019 (105)
HI	6,291	2.8%	9.4%	87.8%	1021 (105)
IN	45,443	4.0%	12.8%	83.3%	1043 (110.5)
KY	1,384	3.0%	5.6%	91.4%	1000 (105)
MD	1,295	2.9%	12.4%	84.7%	1026 (112)
MA	584	4.1%	14.9%	81.1%	1045 (120)
MN	1,164	0.9%	5.2%	93.9%	1001 (82)
NJ	8,063	4.0%	9.9%	86.1%	1026 (113)
NC	2,551	4.0%	14.3%	81.7%	1055 (108)
OH	2,416	1.7%	10.0%	88.3%	1030 (94)
PA	6,786	3.4%	9.8%	86.8%	1025 (108)
RI	369	1.9%	10.8%	87.3%	1036 (97)

The ADP Algebra I and II exam results are a stark reminder of the challenges states face to improve mathematics performance. The results, however, are not surprising given the rigor of the content the states chose to include in the exams and the performance standards which, by design, measure content mastery in the course they have just completed and preparation for higher-level mathematics coursework. In this regard, the exams are unique.

The Algebra I exam, administered for the first time in 2009, is based on standards designed to ensure that students have the prerequisite content knowledge and skills needed to be prepared to perform successfully in higher-level mathematics course including an Algebra II course, aligned with the ADP Algebra II exam standards. Over the next several years of the program, as teachers and students become more familiar with the content and performance standards, and curriculum and instruction are designed to meet the higher expectations of those standards, it is expected that students will gain the necessary knowledge and skills needed to meet the standards and that will be reflected in improved exam scores.

Similarly, the Algebra II exam is designed to measure mastery of advanced Algebra content at a level necessary to indicate readiness to perform successfully in a first-year credit-bearing college mathematics course. This is significantly more rigorous than what is measured by current statewide high school exams. As curriculum and instruction are designed to meet the ADP exam standards and coursework is more closely aligned with those standards, it is also expected that performance will improve.

Moreover, as teachers and students become more familiar with the exam standards and those standards become more embedded in curriculum and instruction, student motivation—and, therefore, performance itself—on the ADP Algebra exams should increase. It is worth noting that student motivation may have played a role in this year's results for both exams. There is no question that when there are no incentives or consequences associated with test results,[8] as is the case currently for both the ADP Algebra I and II end-of-course exams in all participating states, and the demands of the exam exceed their normal coursework, high school students may not be motivated to put forth their best effort. This does not fully explain low performance, but it is likely a contributing factor.

Content Standard Mastery Results: Performance is Low Across All Content Standards in Both Exams, in All States Content standard mastery results provided in Tables 7 and 8 show that performance is consistently low across all of the major content standards. On the Algebra I test, the mastery level results ranged from 18.9% in *Data, Statistics and Probability* to 26.5% in *Non-linear Relationships*. At the Consortium level, the percentage of students reaching the mastery level on the Algebra II content standards ranged only from 18.8% in *Polynomials and Rational Functions* to 24.3% in *Exponential Functions*. Although patterns of performance varied somewhat across states, results were consistently low across the content standards. The results may suggest some content standards where performance was relatively stronger than others, but no content standard could be labeled a strength based on these initial results. And, as described in the previous section, these content standard mastery results based on small numbers of items are less reliable than the overall exam results and must be interpreted cautiously—particularly in states with non-representative samples of students tested.

[8] Brophy, J., and Ames, C. (2005). *NAEP Testing for Twelfth Graders: Motivational Issues*. Washington, DC: National Assessment Governing Board. http://www.eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/3d/5f/2c.pdf

TABLE 7: ALGEBRA I: PERCENT OF STUDENTS AT MASTERY LEVEL,* BY STATE AND CONTENT STANDARD

	Total Tested	Operations on Numbers and Expressions	Linear Relationships	Non-linear Relationships	Data, Statistics and Probability
Consortium	**33,446**	**22.5%**	**24.6%**	**26.5%**	**18.9%**
KY	520	23.9%	27.1%	32.1%	25.2%
NJ	28,470	23.8%	25.3%	27.7%	19.5%
OH	2,031	18.6%	20.9%	23.6%	12.5%
RI	2,416	10.0%	18.8%	14.3%	14.7%

NOTE: Although Minnesota administered the 2009 ADP Algebra I Exam, state level data is not reported when too few students took the exam to report scores.

TABLE 8: ALGEBRA II: PERCENT OF STUDENTS AT MASTERY LEVEL,* BY STATE AND CONTENT STANDARD

	Total Tested	Operations on Numbers and Expressions	Equations and Inequalities	Polynomial and Rational Functions	Exponential Functions	Function Operations and Inverses
Consortium	**102,936**	**20.2%**	**21.8%**	**18.8%**	**24.3%**	**22.7%**
AZ	2,982	22.9%	22.9%	22.5%	25.1%	26.9%
AR	23,608	13.9%	18.9%	17.9%	22.4%	21.3%
HI	6,291	18.9%	16.8%	17.0%	21.8%	21.6%
IN	45,443	24.8%	24.6%	19.7%	26.3%	23.2%
KY	1,384	13.2%	15.2%	11.9%	18.9%	15.3%
MD	1,295	16.3%	20.3%	18.8%	27.2%	25.4%
MA	584	19.9%	21.6%	26.4%	23.5%	24.5%
MN	1,164	7.9%	12.4%	12.6%	18.9%	16.8%
NJ	8,063	19.2%	20.3%	16.9%	23.0%	22.1%
NC	2,551	23.8%	28.4%	24.0%	30.2%	27.3%
OH	2,416	16.6%	19.5%	18.1%	26.7%	23.1%
PA	6,786	16.4%	20.2%	17.9%	20.5%	23.6%
RI	369	16.0%	21.1%	20.9%	24.4%	23.3%

** The mastery level for each content standard is determined through a statistical process that compares student performance on the set of items within each content standard to the Proficient (for the ADP Algebra I exam) or Prepared (for the ADP Algebra II exam) performance standard established for the overall exam.*

Consistent Patterns from 2008 to 2009

Performance on Constructed Response Items Is Particularly Weak At least 30 percent of the points on the ADP Algebra I and II exams are derived from constructed-response items—2-point short-answer and 4-point extended-response items—that require a student to produce an answer rather than select from a set of four possible answers, as with a multiple-choice item. In general, the constructed-response format is well-suited for measuring critical higher-level knowledge and skills such as problem solving and reasoning. It is not unusual, therefore, for students to perform somewhat better overall on multiple-choice items than on the constructed-response items. However, it is not the case that all constructed-response items measure only high-level knowledge and skills or that the constructed-response items must measure more difficult content than the multiple-choice items.

Although performance on the ADP Algebra exams is low across all item types, the low level of performance on the constructed-response items is particularly striking. On both the Algebra I and Algebra II exams, students earned, on average, only 11% and 14%, respectively, of the possible points available on constructed-response items. On the Algebra I exam, one-fourth of the students earned no points on the constructed-response items. Many of these students made no attempt to answer any of those constructed-response items. On the Algebra II exam in both 2008 and 2009, nearly one-third of the students earned no points on the 2-point or 4-point constructed-response items. Further, on the 2009 Algebra II exam more than half of the students earned no points on 4-point extended response items.

Whether students performed poorly on the constructed-response items because they found the content to be too difficult or the task too demanding (relative to their motivation level, see previous discussion p. 14), remains a challenging issue for states to address. In the design of the ADP Algebra exams, the states agreed that the inclusion of constructed-response items on the tests was critical to send a clear signal that the goal was to produce curriculum and instructional programs that require students to demonstrate critical thinking and problem solving skills and communicate their reasoning and strategies.

Students Who Take Algebra I and II in Earlier Grades Perform Better on the Exams As shown in Table 9, students who completed Algebra I in 7th or 8th grade were much more likely to perform at the *Proficient* and *Advanced* performance levels than those students who completed Algebra I in grades 9-12. Consistent with results from the 2008 test, as shown in Table 10, students who take Algebra II in the 8th or 9th grade do better on the exam than those students who take the course in the 11th or 12th grade on average. Also consistent with the 2008 results, the performance gap between students who complete the course in grade 10 compared to grade 11 is much greater than the gap between students who complete the course in grade 9 compared to grade 10. This is most likely because students who are prepared to take the course in the earlier grades are the strongest and most advanced mathematics students, while those who take it toward the end of their high school career tend to struggle more in mathematics.

TABLE 9: ALGEBRA I: PERCENT OF STUDENTS IN EACH PERFORMANCE LEVEL, BY GRADE

	Total Students Tested	Advanced (850–575)	Proficient (574–450)	Basic (449–387)	Below Basic (386–300)	Average Scale Score (Standard Deviation)
Grade Seven	584	17.8%	67.1%	13.4%	1.7%	512 (66)
Grade Eight	7,542	4.9%	38.2%	31.5%	25.4%	437 (77)
Grade Nine	19,926	0.3%	9.7%	27.2%	62.8%	370 (56)
Grade Ten	4,318	0.4%	5.7%	16.4%	77.6%	351 (53)
Grade Eleven	820	0.1%	3.9%	16.8%	79.2%	348 (48)
Grade Twelve	214	0.0%	1.9%	16.8%	81.3%	343 (42)
Not Identified	40	0.0%	0.0%	17.5%	82.5%	341 (40)
Total	**33,446**	**1.6%**	**16.4%**	**26.2%**	**55.8%**	**384 (70)**

NOTE: Although there were 6th graders who took the 2009 ADP Algebra I exam, data are not reported when too few students took the exam to report scores.

TABLE 10: ALGEBRA II: PERCENT OF STUDENTS IN EACH PERFORMANCE LEVEL, BY GRADE

	Total Students Tested	Well Prepared (1650—1275)	Prepared (1274—1150)	Needs Preparation (1149—900)	Average Scale Score (Standard Deviation)
Grade Eight	212	24.5%	34.0%	41.5%	1195 (141)
Grade Nine	7,115	13.2%	22.3%	64.5%	1111 (138)
Grade Ten	32,079	6.7%	20.5%	72.8%	1080 (117)
Grade Eleven	50,017	0.7%	5.8%	93.5%	1004 (85)
Grade Twelve	13,390	0.7%	2.3%	97.0%	978 (75)
Not Identified	118	4.2%	7.6%	88.1%	1025 (111)
Total	**102,936**	**3.5%**	**11.1%**	**85.4%**	**1032 (109)**

NOTE: Although there were 6th and 7th graders who took the 2009 ADP Algebra II Exam, data are not reported when too few students took the exam to report scores.

Conclusion

The ADP Assessment Consortium has succeeded in creating rigorous, high-quality assessments in Algebra I and II that will not only inform students whether they have mastered the content of the course they have just completed but also give an indication of preparation for higher-level mathematics courses. In 2009, the participating states gave an aligned Algebra I exam for the first time and administered the Algebra II exam to more students than they did in 2008. Given the significant pressure on state budgets this year, this is a significant accomplishment that reflects the Consortium states' commitment to improving secondary mathematics so that all students graduate from high school prepared for the opportunities and challenges that await them.

Now that rigorous exams with high standards are firmly in place, the next phase of work must begin in earnest. States must now turn their attention to the other purposes they identified in creating the exams: ensuring a consistent level of content and rigor within and across states in their Algebra I and II courses and improving the quality of curriculum and instruction in Algebra I and II courses, within and across states. To do so, states must provide students and teachers with the tools they need to be successful, including improving curriculum and instruction and providing professional development for teachers. Moreover, states must make sure *all* students have access to the support they need to succeed in rigorous mathematics courses. If states can be as successful on these critical next steps as they have been in creating the assessments, they will have truly changed the prospects for their students by ensuring that student choices regarding their future college and career plans are based on having a strong foundation in mathematics that makes all paths possible.

Acknowledgements

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Because standard setting for both exams occurred this year, there are many additional people that lent their time and expertise whom we would like to acknowledge. The Algebra I standard setting panel consisted of state mathematics experts and high school mathematics teachers from the Consortium states. The Algebra II standard setting panel was comprised of state policy experts, mathematics experts and mathematics professors from two-and four-year institutions. Over 125 faculty members representing two-and four-year institutions in 20 states participated in this unprecedented effort. State commissioners of education, national

assessment experts and mathematics experts also gave invaluable guidance to Achieve regarding setting the cut scores for both exams.

As the test developer, Pearson has also been a vital partner in this project. We would like to thank the Pearson team members who have worked so hard to develop this exam and spearhead the research to support standard setting.

Throughout this project, Achieve and Pearson have received thoughtful and valuable advice and guidance from our Research Alliance, which consists of industry and academia experts in assessment, curriculum and K-12 and post secondary policy issues. It was this group, in conjunction with Pearson and Achieve, who shaped the standard setting research agenda for the Consortium.

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Michael Cohen
President
Achieve

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Created by the nation's governors and business leaders, Achieve is a bipartisan, non-profit organization that helps states raise academic standards, improve assessments and strengthen accountability to prepare all young people for postsecondary education, careers and citizenship. Achieve has helped more than half the states benchmark their academic standards, tests and accountability systems against the best examples in the United States and around the world. Achieve also serves as a significant national voice for quality in standards-based education reform and regularly convenes governors, CEOs and other influential leaders at National Education Summits to sustain support for higher standards and achievement for all of America's schoolchildren.

In 2005, Achieve co-sponsored the National Education Summit on High Schools. Forty-five governors attended the Summit along with corporate CEOs and K–12 and postsecondary leaders. The Summit was successful in making the case to the governors and business and education leaders that our schools are not adequately preparing students for college and 21st-century jobs and that aggressive action will be needed to address the preparation gap. As a result of the Summit, 35 states have since joined with Achieve to form the American Diploma Project Network—a coalition of states committed to aligning high school standards, assessments, graduation requirements and accountability systems with the demands of college and the workplace.

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