Final Report
HumRRO
FR-04-12

Item Content and Difficulty Mapping by Form and Item Type for the 2001-03 Pennsylvania System of School Assessment (PSSA)

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Prepared for:
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Contract Number S 03-12 (PSSA Valid)

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Background

In 1999, Pennsylvania adopted academic standards for Reading, Writing, Speaking and Listening, and Mathematics. These standards identify what a student should know and be able to do at varying grade levels (Appendix A--Standards). The annual Pennsylvania System of School Assessment (PSSA) is a standards-based criterion-referenced assessment used to measure a student's attainment of the academic standards while also determining the degree to which school programs enable students to attain proficiency of the standards. Pennsylvania students in Grades 5, 8 and 11 are assessed in reading and math, and students in Grades 6, 9, and 11 are assessed in writing (http://www.pde.state.pa.us). This report considers only the mathematics and reading PSSA.

The PSSA is a series of separate examinations each tailored to its own specific grade and subject. The content that may be included within each of these grade/subject combinations is specified in Pennsylvania's academic standards. The mathematics and reading tests at all grade levels consist of a set of multiple-choice items and a set of performance-task items. PSSA tests also include common and matrix items. Common items occur on all test forms and are administered to all students. Matrix items are spiraled among separate forms of the PSSA. Each student is administered a subset of the matrix items depending on the particular test form the student receives. Since the test forms are spiraled by classroom, it can be assumed that the forms are distributed randomly across all students.

Test designs that include commonly administered as well as matrix items are frequent among assessment systems created for multiple purposes. PSSA is designed as both a student-level and school-level assessment. Students' results are calculated using only the common items, while school-level results are calculated from common and matrix items. This allows for directly comparable student-level results without requiring equivalent forms. It also allows for a broader set of curricular topics to be assessed at the school level. These strengths of the design are coupled with compromises, however. First, student-level results for any particular curricular topic are based on a minimal set of items. Results at this level are subject to overinterpretation due to their large standard error. School-level results are reported with the assumption that each school has a sufficient number of students in each tested grade that all forms will be thoroughly represented. It also assumes that mean student results would be the same irrespective of which students at the school received any given form.

Given the combination of common and matrix test items for each grade/subject, a number of questions arise about the comparability of these forms and the relationships between test items and academic standards. One way to begin addressing those questions is to map content and difficulty of items by form and by item type.

Mapping Questions

The following mapping questions are addressed for each grade/subject combination (other than writing):

1. Is the content equally distributed across forms?

2. Is the content equally distributed across Below Basic, Basic, Proficient, and Advanced achievement levels?

3. How is the content distributed by type of item, multiple-choice versus open-response?

4. What is the distribution of item types across achievement levels?

Mapping Procedure

Mapping the items requires that every item be categorized by form, item type, content, and difficulty. Categorizing items by item type is straightforward. Categorizing by form, content, and difficulty requires some explanation.

Mapping items by form would be very straightforward if only student-level results were considered. All student-level information is derived from a common set of items. However, school-level results are based on the combination of common and matrix items. Matrix items differ by form. When one considers the tested academic content for schools, the common and matrix items must be combined. When considering test forms it is important to keep in mind that the common items were taken by all students, while about 1/12 of the students received each set of matrix items. In very small schools, it is possible that a particular matrix form might not be administered at all. It is also possible that a single student in a school might receive a set of matrix items that no other student at the school received. Since these items contribute to each school's accountability measure, it is important that the matrix items be considered both separately and as a part of the complete PSSA test.

Pennsylvania's academic standards include descriptions of the knowledge and skills that students are expected to acquire for each tested grade/subject combination. Content descriptions for each grade/subject combination are structured in four hierarchical levels. In order of increasing detail, the hierarchies consist of subject (in this case either mathematics or reading), grade level, specific content standards, and broadly defined applications (substandards) within each standard that identify the manner in which students at each grade level can use the knowledge implied by the standards. Some applications also contain an additional level of more specific bulleted applications within the broader category. However, because not all applications have bullets and because bullets are not consistently identified in the item documentation, this

level is not considered during mapping. All multiple-choice PSSA items are assigned codes representing this hierarchy. Performance tasks, or performance-task items, are always coded to a particular standard, but may not be coded for a specific application. All performance-task mathematics items also carry a secondary code for "Mathematical Problem Solving and Communication," or Standard 5. It seems likely that this code is included because students are required to write their responses or display their reasoning as a component of completing these items. Performance-task reading items do not include secondary content standards. For purposes of mapping the items' content, this simplifies matters considerably. Each item, whether multiple-choice or performance-task, is considered to represent only a single content and application. Since only mathematics performance-task items are also coded to secondary standards (and always to Standard 5), secondary standards need not be mapped.

Categorizing the items by difficulty is relatively straightforward for multiple-choice items. Data Recognition Corporation (DRC), the testing contractor for PSSA, produces a technical manual for each administration of the PSSA (Meade & Melby, 2002; Meade & Melby, 2003; Mead, Smith & Swanlund, 2003). Among other things, the technical manual contains item statistics, including logit numbers for each item. DRC uses Rasch item response theory (IRT) methodology to compute these logit numbers. Performance-task item statistics are estimated using the Masters partial credit model. A logit number can be conceptualized as a standardized measure of item difficulty. An item of average difficulty would have a logit number of 0. A more difficult item would have a positive logit number, while a less difficult item would have a negative logit number. Logits are similar to Z-scores, so an item with a logit number of -1 would be roughly one standard deviation below the mean difficulty of all items. These logit numbers can be converted to scale scores algebraically via a formula provided in the technical manual. Item difficulty can then be considered in relation to the reported PSSA scale. More importantly, item difficulty can be compared to the cut points along the scale that are used to sort students into performance categories. We can then count items that best discriminate performance within the Below Basic, Basic, Proficient, or Advanced categories.

Performance-task items require an additional step. While each multiple-choice item is scored either 1 or 0 (Students either select the correct answer or they do not.), students receive varying numbers of points for performance-task items based on the quality and completeness of their responses. Performance-task mathematics items are worth from 0-5 points and reading items are worth from 0-4 points. A logit number is calculated for each non-zero point for each of those items, so each mathematics item has 5 logit numbers and each reading item has 4. All of those logit numbers can also be converted to an associated PSSA scale score, but the interpretation is not as straightforward as for multiple-choice items. The logit number for 1 point on an item can be interpreted as the difficulty of getting a 1 rather than a 0 for that particular item. However, the logit number for 2 points on that same item must be interpreted as the difficulty of getting 2 points on the item, having already gotten a 1. So, if an item requires several mathematical steps and the first step is more difficult than the second, an item might have a logit for 2 points that is less than the logit for 1 point. In fact, this happens often on the PSSA performance-task mathematics items. This is an important caveat to remember when examining the mapping results for performance-task mathematics items. The logit for 2 points does not represent the difficulty associated with getting at least a 2 on the item, but the difficulty of getting a 2 once a 1 is accomplished.

Logically, however, one expects the difficulty associated with getting 2 points on an item to be greater than the difficulty associated with getting 1 point. Reading items nearly always follow a number-line progression, where the logit for receiving 4 points is greater than the logit for 3, which is greater than the logit for 2, which is greater than the logit for 1. DRC's senior psychometrician, Dr. Ronald Meade (personal communication, January 13, 2004), agreed that erratic logit numbers might signal problems with an item's scoring rubric.

Performance Categories

Mapping PSSA items by difficulty could be completed using the untransformed logit numbers. Transforming the logits to the scale score metric allows us to consider them in reference to the performance categories Below Basic, Basic, Proficient, and Advanced. While the logit numbers have a very easily understood meaning, that meaning is referenced only to the mean performance of students on a set of items. By converting to scale scores, we can compare the items to the criteria established in Pennsylvania's Academic Standards. PSSA is a "criterion-referenced" test. The term "criterion-referenced" in this case refers to the descriptions associated with the performance categories, which are in turn associated with the specific knowledge and skills listed in the academic standards. The descriptors were written in general terms so they could refer to any content area. The descriptors were drafted and then altered, based on roughly 1,700 survey responses from various groups (including educators, parents, students, and businesspersons). The adopted General Descriptors follow:

- **Advanced:** Superior academic performance indicating an in-depth understanding and exemplary display of the skills included in Pennsylvania's Academic Standards;

- **Proficient:** Satisfactory academic performance indicating a solid understanding and adequate display of the skills included in Pennsylvania's Academic Standards;

- **Basic:** Marginal academic performance, work approaching, but not yet reaching, satisfactory performance. Performance indicates a partial understanding and limited display of the skills included in the Pennsylvania's Academic Standards, and the student may need additional instructional opportunities and/or increased student academic commitment to achieve the Proficient Level;

- **Below Basic:** Inadequate academic performance that indicates little understanding and minimal display of the skills included in the Pennsylvania Academic Content Standards. There is a major need for additional instructional opportunities and/or increased student academic commitment to achieve the Proficient Level.

The general descriptors are adjectival in nature, requiring a more definitive understanding of the terms "superior, satisfactory, marginal, and inadequate" to be used operationally in relation to test scores. Standard-setting procedures were conducted in order to define the meaning of the general descriptors in relation to PSSA tests in reading and mathematics for Grades 5, 8, and 11. Once the standard-setting procedures were complete, policy decisions raised the agreed upon standards slightly (one fourth of a standard error of measurement) to reflect Pennsylvania's dedication to setting rigorous educational goals for its students and schools. The

State Board of Education endorsed the need for rigorous standards and adopted the performance levels in 2001.

Standards Setting

Standard setting was completed using both the Bookmark (Lewis, Mitzel & Green, 1996) and Borderline Groups (Livingston & Zieky, 1978) methods. These methods are commonly used to set standards for large-scale assessments. Both methods rely on the judgment of subject matter experts (primarily teachers). The methods differ in the manner in which the subject matter experts consider the performance of students in relation to the test items.

The Bookmark method requires participants to rate the abilities of students to correctly answer test items from PSSA. The items are arranged in sequence from easy to difficult. Participants literally place a bookmark at the point in the sequence that would distinguish students in one performance category from those in another. For PSSA, this required the placement of 3 bookmarks; the first to distinguish between Below Basic and Basic, the second to distinguish between Basic and Proficient, and the third to distinguish between Proficient and Advanced. Once the bookmarks are placed by the subject matter experts, individual differences are resolved, either by consensus or by averaging the results, and the point at which the bookmark is placed is converted to a scale score. Since participants refer to the Academic Standards during this process, those broad statements about student skills and abilities are linked to a particular performance event (the PSSA), and to cut points that stratify students into definable performance groups.

The Borderline Groups method provides teachers with a list of their own students who participated in the PSSA assessment and asks them to rate the classroom performance of those students in the subject area for which performance levels are being set. Teachers can refer to the performance descriptors, their knowledge of the students they teach, and the performance of those students on the PSSA while considering standards. The teachers then place their students into categories based on this knowledge. Teachers place some students in one of the four identified categories and others on the borderline between two categories. For instance, a student might be achieving at a level her teacher considers beyond Basic, but still not quite Proficient. That student would be on the borderline between those two categories. Her score would be defined as the cutpoint between Basic and Proficient. This process was completed for the three necessary cut points and then compared with results from the Bookmark method. The results were summarized and averaged to set the initial cut points that define student performance on the PSSA. The identified cut points were shifted slightly upward to meet the requisite for rigorous academic standards.

There are distinct advantages associated with using multiple standards-setting methods (Green, 2001; Green, Trimble & Lewis, 2003). Standards set with different methods often result in very different cut points (Horn, Ramos, Blumer & Madaus, 2000; Mills, 1983). Multiple methods allow comparisons and provide options for setting standards that accomplish the particular goals of the assessment system. Standards-setting methods should be selected with the purpose of the assessment clearly in mind.

For any established cutpoint on any assessment scale, there will be a portion of students misclassified into either a higher or lower category. For simplicity's sake, let us consider only the cut point between Proficient and Basic. If the standard is set purposefully high, we minimize the chances of misclassifying students who have not reached the indicated category and increase the numbers of students targeted for remediation or increased help in meeting their academic goals. This type of standards setting is usually done for assessment systems with lower stakes, but it does carry some negative consequences. Baron, Rindone and Prowda (1981) described the negative impact of such a system on students' academic self-concept, teachers' expectations for students, and peer reactions. They also describe parents' wrath and the financial cost of remediation as negatives associated with higher standards. Standards are often set lower for high stakes systems to minimize the chances of classifying a Proficient student as less than Proficient. If there are penalties associated with not meeting a standard, such as being denied a diploma or retained at grade level, it is very important that students be given the benefit of the doubt. Pennsylvania does not use the PSSA as a graduation requirement or as a condition for advancement, but allows local education agencies to hold students accountable according to their own policies. For any standard-setting procedure performance categories are based on cut points, which are based on the judgment of experts. Standards require continued scrutiny and must match the goals and use of the assessment system (Horn, Ramos, Blumer & Madaus, 2000).

The Bookmark-standards setting procedure has been used for various state testing systems. It typically produces lower standard deviations than the Angoff method (Angoff, 1971), another common standards-setting procedure (Buckendahl, Smith, Impara & Plake, 2000). Green (2001) recommends the use of multiple standards-setting methods, but when costs or time prohibits multiple methods, he recommends the Bookmark procedure because of its relationship to instruction. When Kentucky set standards using a combination of Bookmark, Contrasting Groups (Clauser & Clyman, 1994), and Jaeger-Mills (Jaeger & Mills, 1998) procedures, Bookmark cut points typically fell between cut points set using the other two methods and were nearly always closest to the arbitrated final cut point (Green, Trimble & Lewis, 2003).

In a study by Halpin and Halpin (1983) comparing 10 standards-setting procedures, the Borderline Groups method was among the 3 determined to be most reliable. Borderline Groups also results in higher standards than many other methods. Borderline Groups and Contrasting Groups methods usually have comparable results, although Borderline Groups results in higher passing scores (Livingston & Zieky, 1983). Baron, Rindone and Prowda (1981) also found that Borderline Groups resulted in higher standards than Contrasting Groups, Angoff, or Nedelsky (Nedelsky, 1954). They also found that Borderline Groups resulted in the fewest false Masters (versus non-Masters) on Connecticut's 9th Grade proficiency tests.

In addition, the Borderline Groups standards-setting method tended to be consistent across schools, where the Angoff and Nedelsky methods were school-dependent. Livingston and Zieky (1983) compared results from four standards-setting methods at four different schools. Teachers from different Connecticut schools nearly always set Borderline Groups cut points between the mean for Masters versus non-Masters. However, there was considerable variation among the scores of Borderline students. This was attributed to teachers either not knowing what skills their students did or did not possess, or to testing that was not closely aligned with the taught content.

Borderline Groups and Bookmark methods have been used to set standards for other state testing programs. Both methods require the judgment of experts and both exhibit advantages over methods further removed from instruction (such as Angoff and Nedelsky). The Bookmark procedure produced very similar cut points in Kentucky to cut points established through arbitration based on three standards-setting methods. The Borderline Groups method results in high reliability compared to other methods as well as higher standards. Borderline Groups also showed independence from school-level effects compared to other methods.

The final step in standards setting for the PSSA was writing the specific Performance Level Descriptors (Appendix A) for each tested subject. These descriptors give much more detail than the general descriptors. They describe what students in each performance category are expected to know and be able to do. The PSSA results from 1999, 2000, and 2001 were referenced during this process. All current PSSA test items are identified by specific Performance Level Descriptors. Combining a set of items under a particular heading can therefore provide subscores for particular content topics within mathematics or reading. It should be noted, however, that subscores are based only on a few items and have comparatively large errors of measurement.

Mapping Results

Mapping questions were first addressed by constructing a series of tables displaying the content of the PSSA in relation to academic standards. Table 1 contains data from the multiple-choice items included on the Grade 5 reading test administered in 2001, as an illustration. Tables with data from each grade/subject combination for PSSA administrations in 2001, 2002, and 2003 are included in Appendix B. The first several rows of the table contain data for each matrix form. Columns represent the academic content standards. The numbers in the table represent the number of items from each lettered application (substandard) under each content standard (provided as Appendix A). For example, a 1 in Column A under Standard 1 indicates that there was 1 item on that form requiring that students "Establish the purpose for reading a type of text (literature, information) before reading." Each matrix form is listed separately, followed by two rows of sums, which give a more complete picture of the breadth of the content assessed by the matrix items. The next two rows show the content of the items on Form W, the common form. These numbers represent the items administered to all students by content topic. Form W represents the content as assessed using multiple-choice items at the student level. The last two rows contain the total number of items included on the common and matrix forms combined. These numbers best represent the content assessed with multiple-choice items at the school level.

Table 1. 2001 Grade 5 Reading Multiple-Choice Items

	Standard																						
	1								2			3						7			8		
	A	B	C	D	E	F	G	H	A	B	C	A	B	C	D	E	F	A	B	C	A	B	C
Form A	1	1		1	1	1	1		6			2	2	1				2	1	1		4	
Form B	1		1	2		1			6			2	2					1	2	1		4	
Form C				3	1		1		5			3	1	1				1	2	1		3	
Form D		1	1	2	2				6			2	3	1				1	2	1		2	1
Form E		2		1	1		1		7			1	3	1				2	1			4	
Form F		1	1	2	2				5			2	2	1				2	2			2	2
Form G	1		1	2	2				5			3	2					3	1			4	
Form H	1		1	1	2	1	1		7			1	3	1				2		1		4	
Form I	1	1		1	1	1	1		6			2	2	1				2	1	1		4	
Form J	1		1	2	1	1			5			2	2					1	2	1		4	
Total	6	6	6	17	13	5	5	0	58	0	0	20	22	7	0	0	0	17	14	7	0	35	3
Matrix Total	58								58			49						38			38		
Form W	1	3	3	1	0	1	1	0	12	0	0	6	3	3	0	0	0	3	3	1	3	5	0
Common Items Total	12								12			12						7			8		
Total by Substandard	7	9	9	18	13	6	6	0	70	0	0	8	25	10	0	0	0	20	17	8	3	40	3
Final Total	70								70			61						45			46		

Table 2 contains similar information for performance-task items from the 2001 Grade 5 mathematics assessment. Again, matrix forms are represented by the first set of rows, followed by matrix totals. The next set of rows contains common items, and finally totals for all forms combined. Appendix C contains similar tables for each tested subject for PSSA tests administered in 2001, 2002, and 2003. Several caveats must be mentioned with regard to the content of performance-task items. First, all mathematics items have a secondary content standard that is not included in the tables. "Mathematical Problem Solving and Communication," or Standard 5, is coded for all mathematics performance task items in addition to the codes listed in the table. Table 2 contains data from the PSSA Grade 5 mathematics test. All reading tests are coded to Standard 3, "Reading, Analyzing and Interpreting Literature." Consequently, no tables are presented for reading performance tasks.

Table 2. 2001 Grade 5 Math Performance-Task Items

	Standard																																									
Form	1							2							3							4							6						
	A	B	E	G	I	K	L	A	B	E	G	I	K	L	A	B	E	G	I	K	L	A	B	E	G	I	K	L	A	B	E	G	I	K	L
A																								1											
B																																			
C																													1						
D																																			
E			1																																
F								1																											
G															1																				
H											1																								
I																																			
J																																			
Total			1					1			1				1									1					1						
Matrix Total	1							2							1							1							1						
W				1					1																										
Common Items Total	1							1							0							0							0						
Total by Substandard	0	0	1	1	0	0	0	1	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0
Final Total	2							3							1							1							1						

Table 2. 2001 Grade 5 Math Performance-Task Items (continued)

	Standard																											
Form	7							8							9							11						
	A	B	E	G	I	K	L	A	B	E	G	I	K	L	A	B	E	G	I	K	L	A	B	E	G	I	K	L
A																												
B									1																			
C																												
D					1																							
E																												
F																												
G																												
H																												
I																				1								
J																								1				
Total					1				1											1				1				
Matrix Total	1							1							1							1						
W																					1							
Common Items Total	0							0							1							0						
Total by Substandard	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0
Final Total	1							1							2							1						

In addition to simply mapping the content of items included on the PSSA to the academic standards, it is also informative to examine the difficulty of the items. As previously described, Pennsylvania categorizes student performance as Below Basic, Basic, Proficient, or Advanced. Students are placed in performance categories according to their scale scores on the PSSA. The categories are defined on the scale using cut points, such that scores below a cut point fall into one category while those above the cut point fall into the next higher category. It is very important that the PSSA accurately assess student performance around these cut points.

There is a certain amount of error in any measurement. If we were to measure a student's height, the measurement we took would be an estimate of the student's true height. The accuracy of our measure would depend in part on the accuracy and the precision of our measuring instrument. PSSA scale scores are estimates of students' "true" abilities. The difference between these estimates and true ability are represented by the test's standard error of measurement (SEM). The larger the SEM, the less sure we can be that the estimate is an accurate depiction of students' true ability. When student scores are applied to particular cut points along the scale for categorization, this issue is compounded. A single SEM statistic is not sufficient for making decisions about an assessment's utility for distinguishing between multiple categories of student performance along the measurement scale. The utility of such a test must be evaluated by examining the function of the test for all possible (or important) scores. This is typically done by creating SEM curves. These curves are usually U shaped, indicating that a test functions best for students at the bottom of the U, toward the middle of the distribution of score points. If the test is functioning appropriately for those students for whom it was designed, this will coincide with the distribution of students (most students will get some number of score points less than the maximum correct). No test is perfect for all populations. There is a range of performance for which a particular test functions best. If, for instance, most students missed all the items on a particular test, we would learn very little about the true ability of those students. Similarly, we would also learn very little about students' true ability if most students received a perfect score. It is important to include test items that span the range performance for most test-takers.

When cut points are set, it is important that the test function very well along the range of scores that include those cut points. If a cut point is located too high on an arm of the U shaped curve, our confidence that the student is correctly categorized is low. DRC provided SEM measures for all possible raw scores and scale scores in the 2002 and 2003 technical manuals (Meade & Melby, 2003; Mead, Smith & Swanlund, 2003). Table 3 presents the SEM at the cut points for each grade/subject and the minimum SEM for the tests. The data in Table 3 indicate that cut points are located toward the center of the distribution, near the most reliable scores on the test. However, the distribution of the SEM may indicate that, for some grade/subjects, the PSSA functions best within the Below Basic category.

Table 3. SEM at the Cut Points for PSSA 2002 and 2003

	Below Basic/ Basic		Basic/Proficient		Proficient/ Advanced		Minimum	
Mathematics	*2002*	*2003*	*2002*	*2003*	*2002*	*2003*	*2002*	*2003*
Grade 5	43	45	45	47	55	55	43	45
Grade 8	40	40	41	40	52	51	40	40
Grade 11	51	50	50	49	50	52	50	49
Reading								
Grade 5	56	58	60	60	75	71	56	57
Grade 8	59	58	60	61	69	71	58	58
Grade 11	57	57	57	60	70	72	57	57

Table 3 provides an indication of where the PSSA tests function best. The SEM at the Below Basic/Basic and Basic/Proficient cut points is near the minimum for the SEM curve. The Proficient/Advanced cut point is typically larger, however. When we look at the SEM curves plotted against the cut points in Figures 1-12, we see that the PSSA typically functions best toward the lower portion of the scale. Curves exhibit the typical U-shape, except toward the very bottom of the scale, where scale scores have been limited to a minimum of 700. An examination of these curves indicates that the area of best discrimination for some tests is in the Below Basic range.

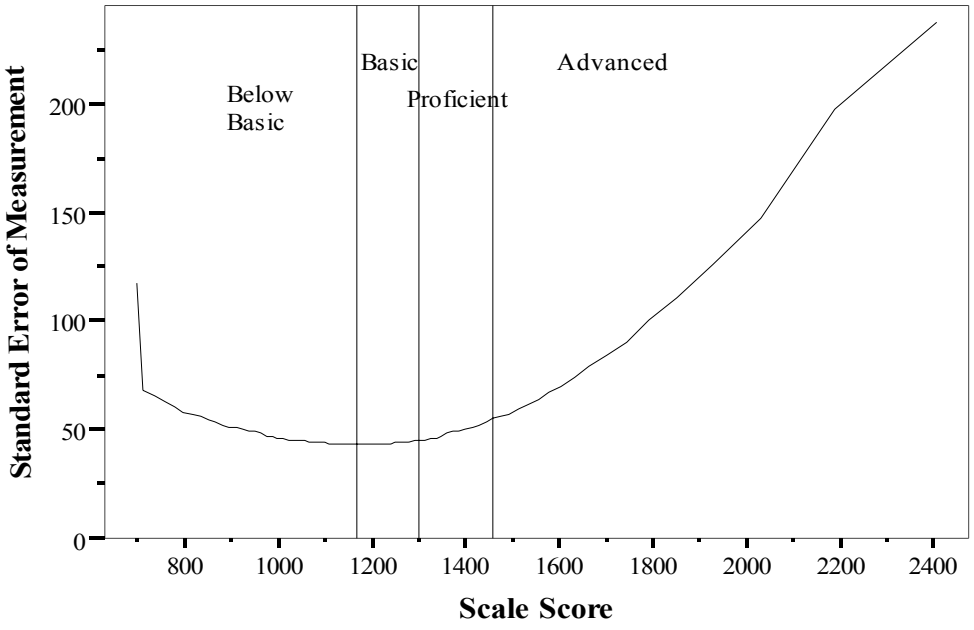

Figure 1. Standard error of measurement curve for 2002 PSSA Grade 5 Mathematics.

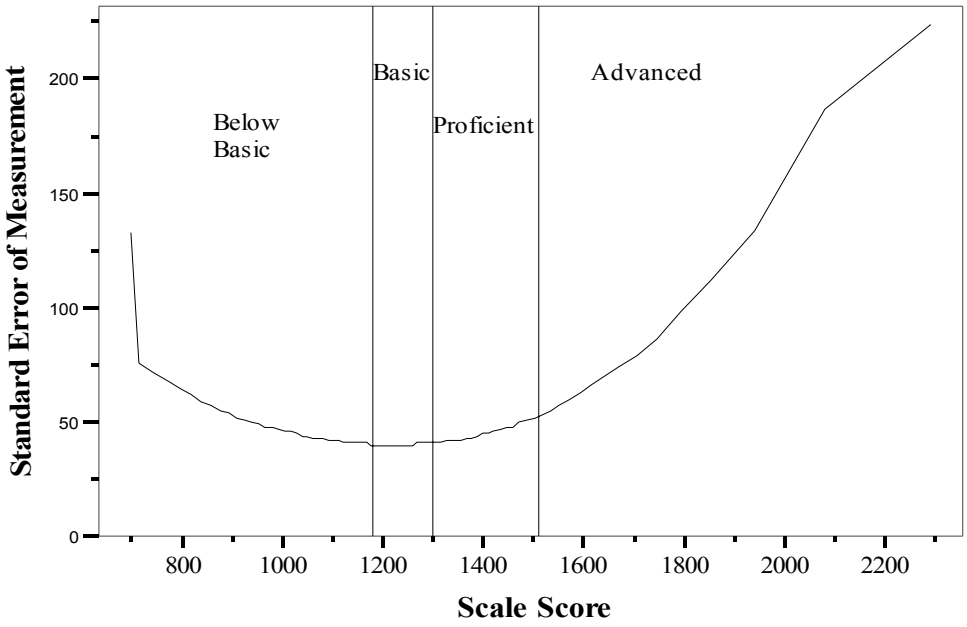

Figure 2. Standard error of measurement curve for 2002 PSSA Grade 8 Mathematics.

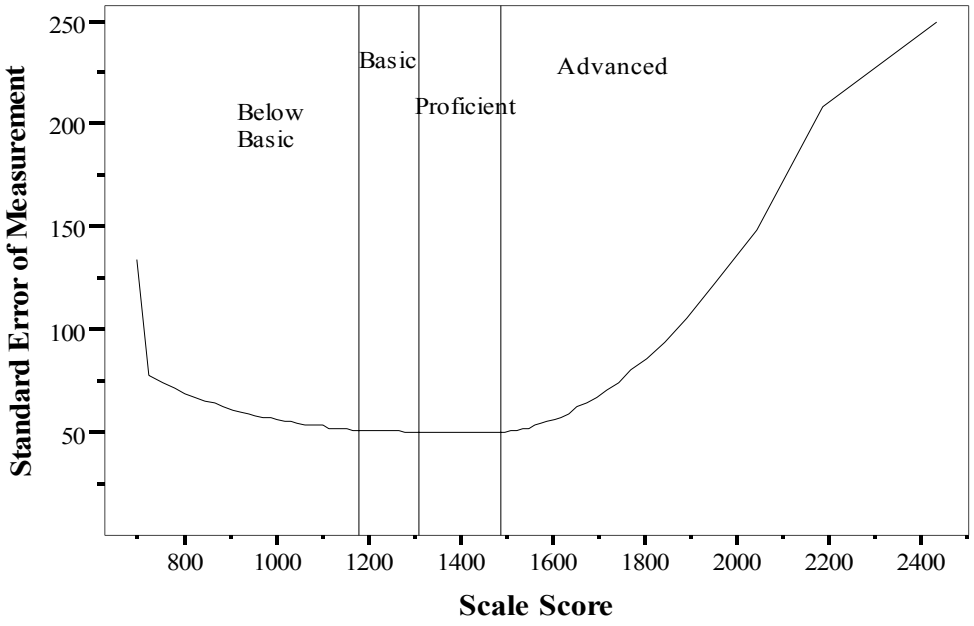

Figure 3. Standard error of measurement curve for 2002 PSSA Grade 11 Mathematics.

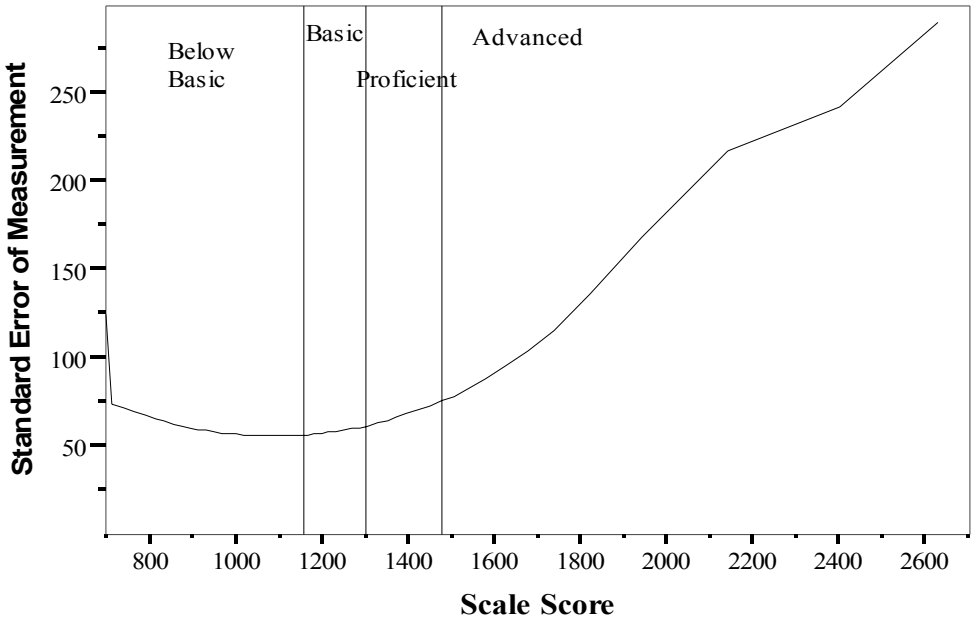

Figure 4. Standard error of measurement curve for 2002 PSSA Grade 5 Reading.

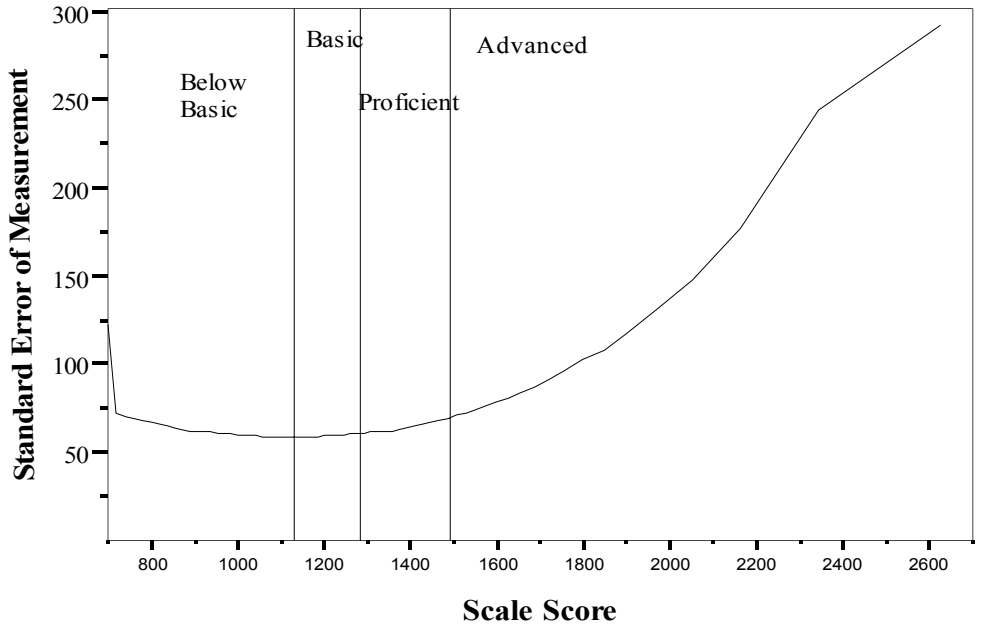

Figure 5. Standard error of measurement curve for 2002 PSSA Grade 8 Reading.

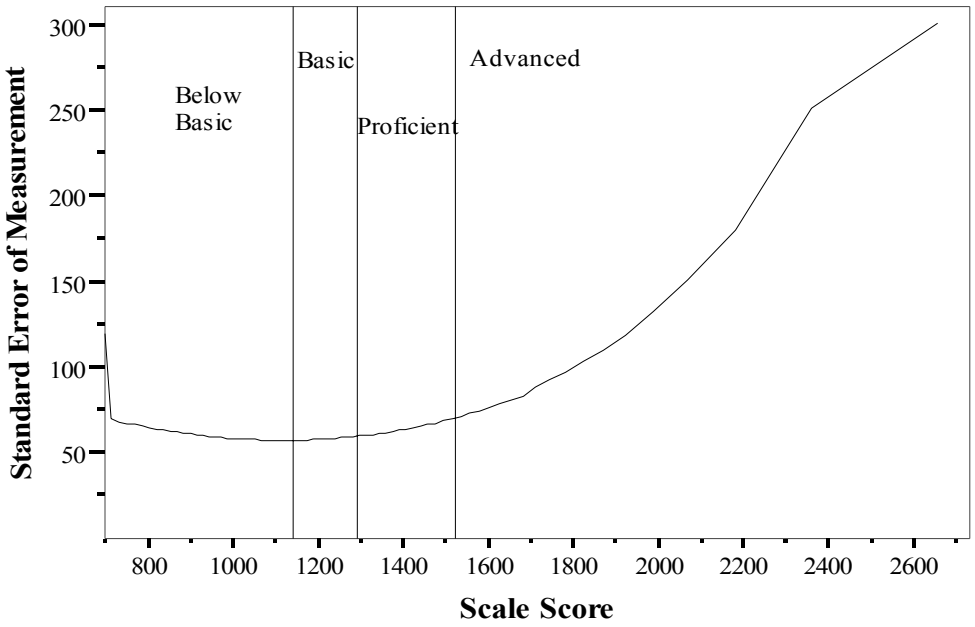

Figure 6. Standard error of measurement curve for 2002 PSSA Grade 11 Reading.

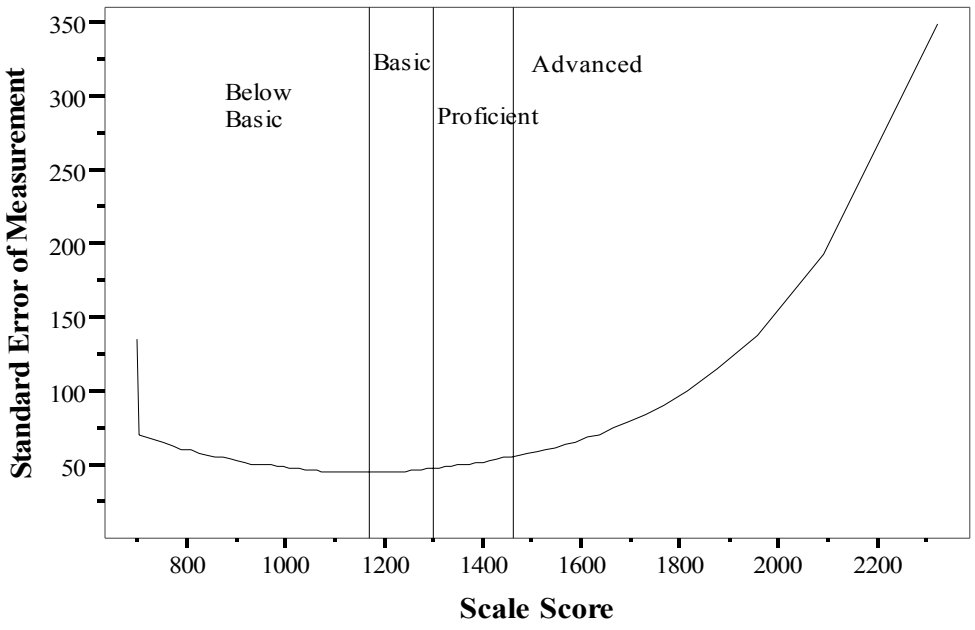

Figure 7. Standard error of measurement curve for 2003 PSSA Grade 5 Mathematics.

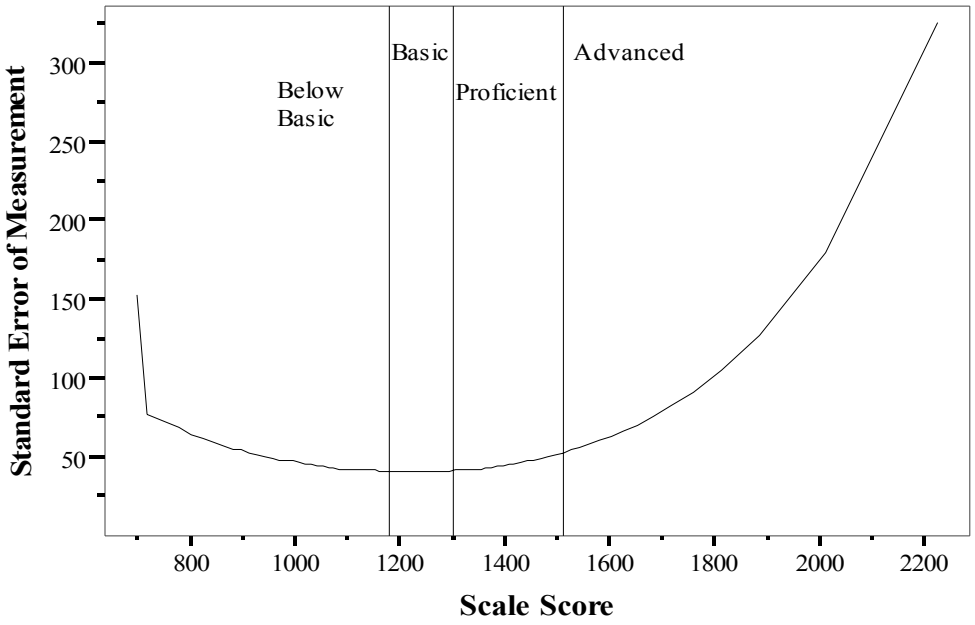

Figure 8. Standard error of measurement curve for 2003 Grade 8 Mathematics.

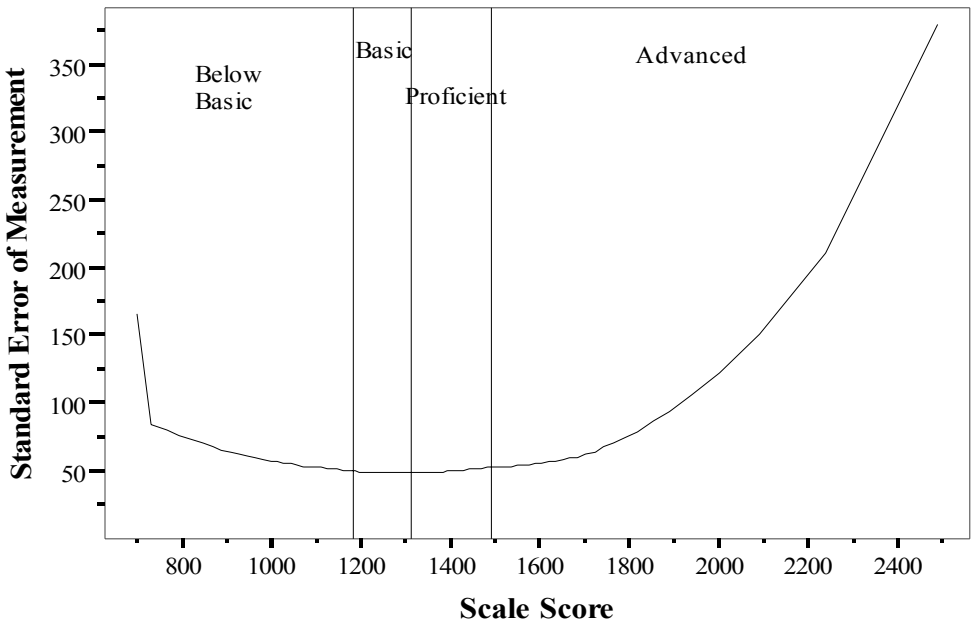

Figure 9. Standard error of measurement curve for 2003 PSSA Grade 11 Mathematics.

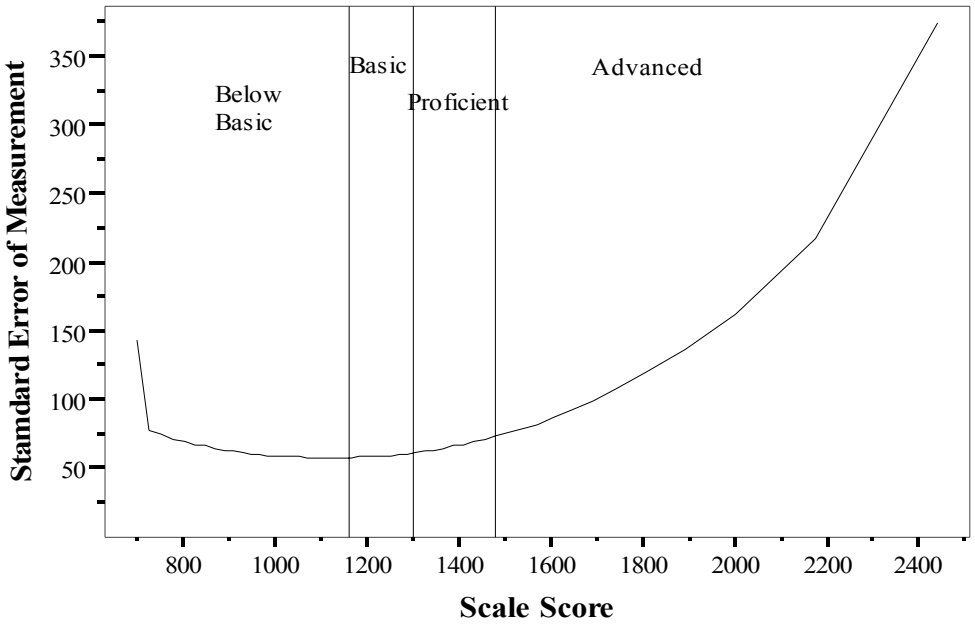

Figure 10. Standard error of measurement curve for 2003 PSSA Grade 5 Reading.

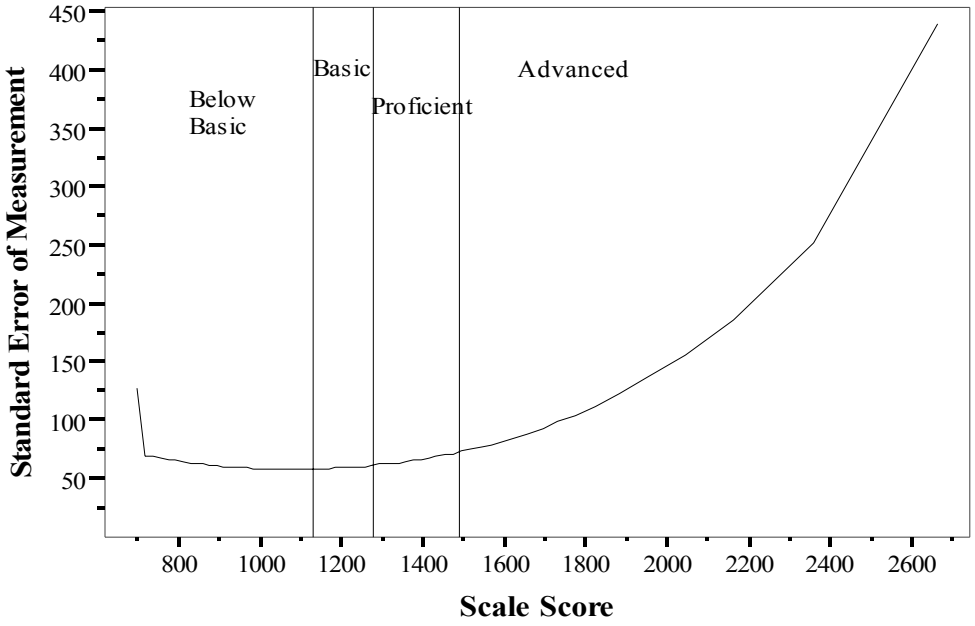

Figure 11. Standard error of measurement curve for 2003 PSSA Grade 8 Reading.

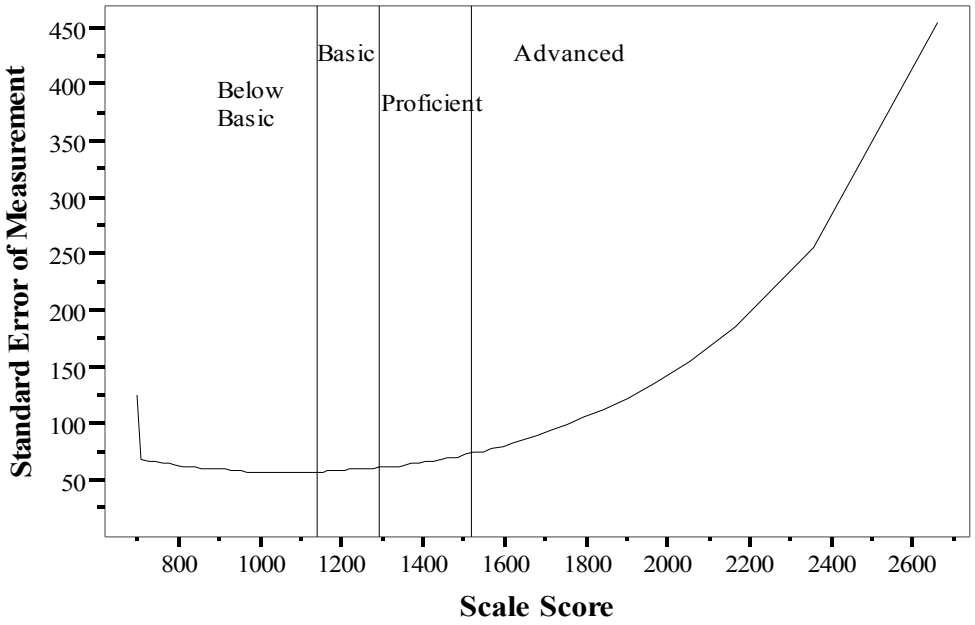

Figure 12. Standard error of measurement curve for 2003 PSSA Grade 11 Reading.

Another way of looking at this data is to actually place each item within the category at which it best functions. Figure 13 presents this data in bar graph format for common Grade 5 multiple-choice items administered as part of the 2001 PSSA. Similar figures are presented for all other grade/subjects for 2001, 2002 and 2003 in Appendix D. The first striking feature of this figure is that there are no multiple-choice items on the common portion of the test that function best within the Advanced performance category, and only 2 items that function best in the Proficient category. Also, the majority of items function best within the Below Basic category.

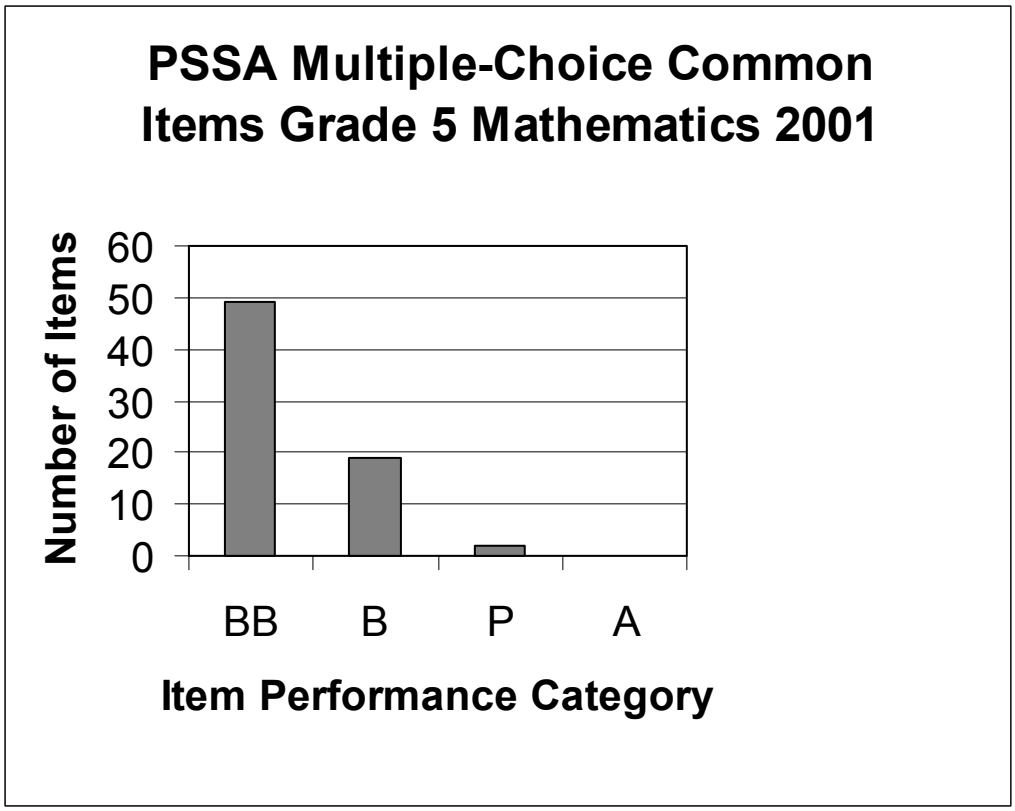

Figure 13. Multiple-choice common items Grade 5 mathematics 2001.

Figure 14 presents the same data for matrix items administered as part of the Grade 5 mathematics test in 2001. Each bar represents one matrix form. Again, there were no multiple-choice items that functioned best in the Advanced category and very few in the Proficient category. The majority of the items functioned best in the Below Basic category. Similar figures for other grade/subjects for 2001, 2002, and 2003 are presented in Appendix E.

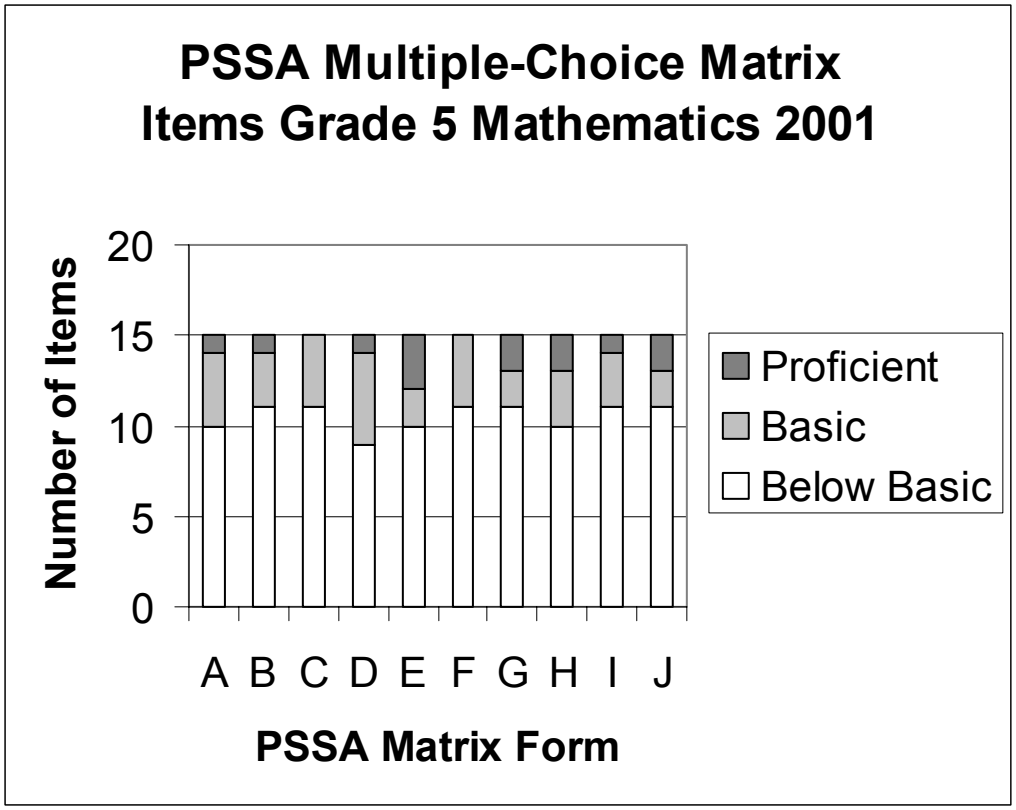

Figure 14. Multiple-choice matrix items Grade 5 mathematics 2001.

Figure 15 depicts the same information for common performance-task items from the 2001 Grade 5 mathematics test. The test included 3 common performance-task items, each of which was worth 5 raw score points. Each bar in Figure 15 represents all 3 items. The first bar includes information for the first stepwise item difficulty, or the difficulty associated with earning 1 point on the item. The second bar represents the difficulty of earning 2 points, assuming that 1 had already been achieved. As expected, the lower point scores for the item tend to function best within the lower categories, while the higher point scores tend to function best within the higher categories. This figure shows that the performance task items usually have associated point scores that best discriminate within the Advanced performance category. Bar charts for other grade/subjects for 2001, 2002, and 2003 are included in Appendix F.

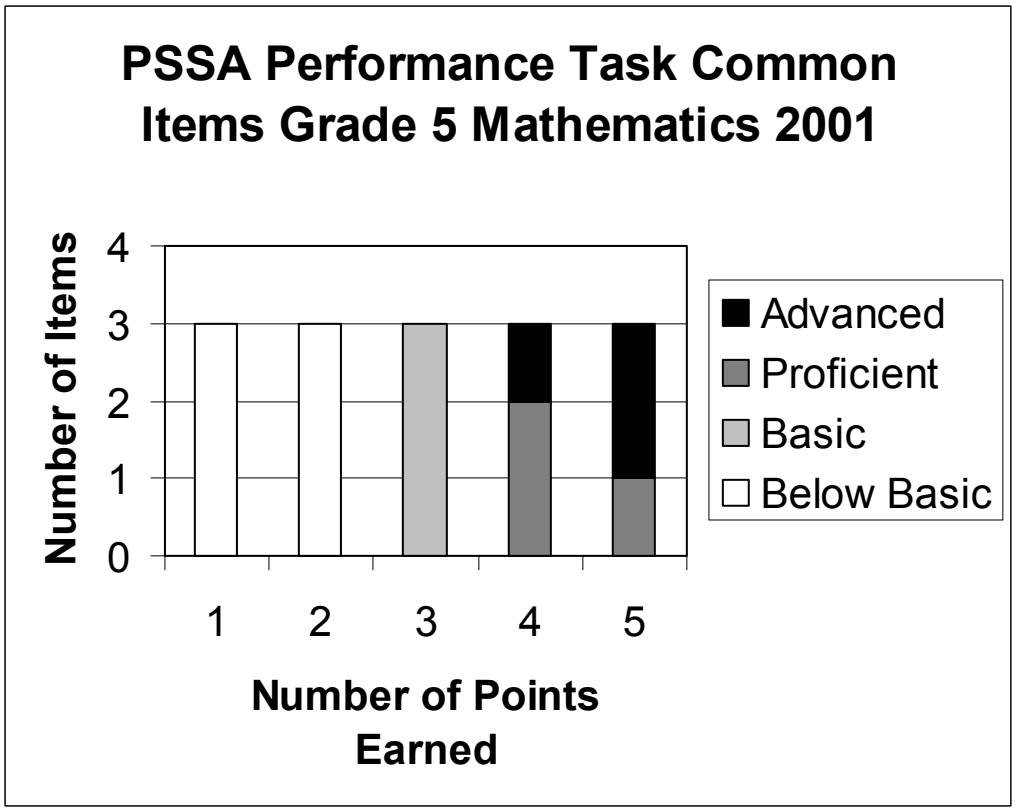

Figure 15. Performance task common items Grade 5 mathematics 2001

Figure 16 shows that this pattern holds true for the matrix items, as well. Again, each bar represents all 10 matrix items administered for the Grade 5 2001 PSSA mathematics test. Bar charts for the remaining grade/subjects for 2001, 2002 and 2003 are included in Appendix G.

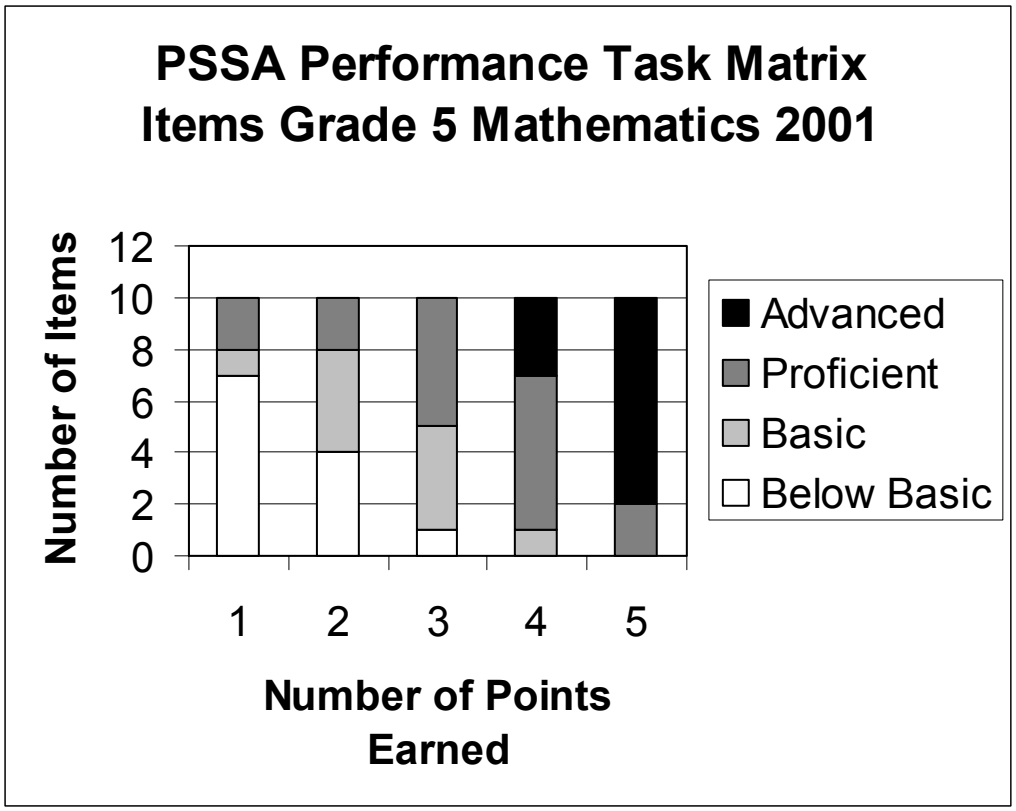

Figure 16. Performance task matrix items Grade 5 mathematics 2001.

Another way of examining the function of performance-task items is to examine the proportions of students who receive each possible score on the item. This information is included in DRC's technical manuals (Meade & Melby, 2002; Meade & Melby, 2003; Mead, Smith & Swanlund, 2003) and is not repeated here. Instead, two examples are presented as bar graphs. Both items come from the 2002 administration of Grade 11 mathematics. Figure 17 shows an item for which almost no students scored 3 points. The scoring rubric may discourage scorers to select 3 as a score for most of the student responses. Figure 18 shows a very difficult item, where nearly 60% of students received 0 points and very few students scored more than 1 point. With so few students in the upper categories, the accuracy of the difficulty estimate for those categories may not be as high as one would like. Both items had correlations of more than 0.60, indicating that scores on the items were highly related to the students' overall test scores. Both these issues may help account for the curious logit numbers mentioned previously.

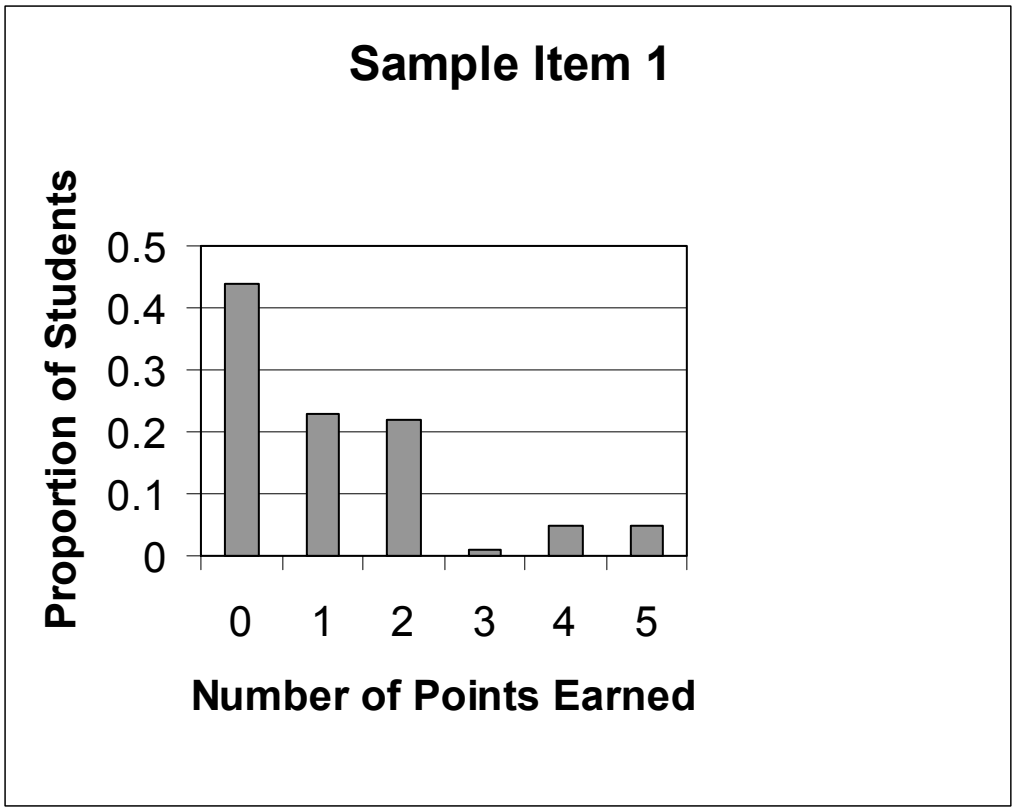

Figure 17. Proportions of students at each score point for sample mathematics item 1.

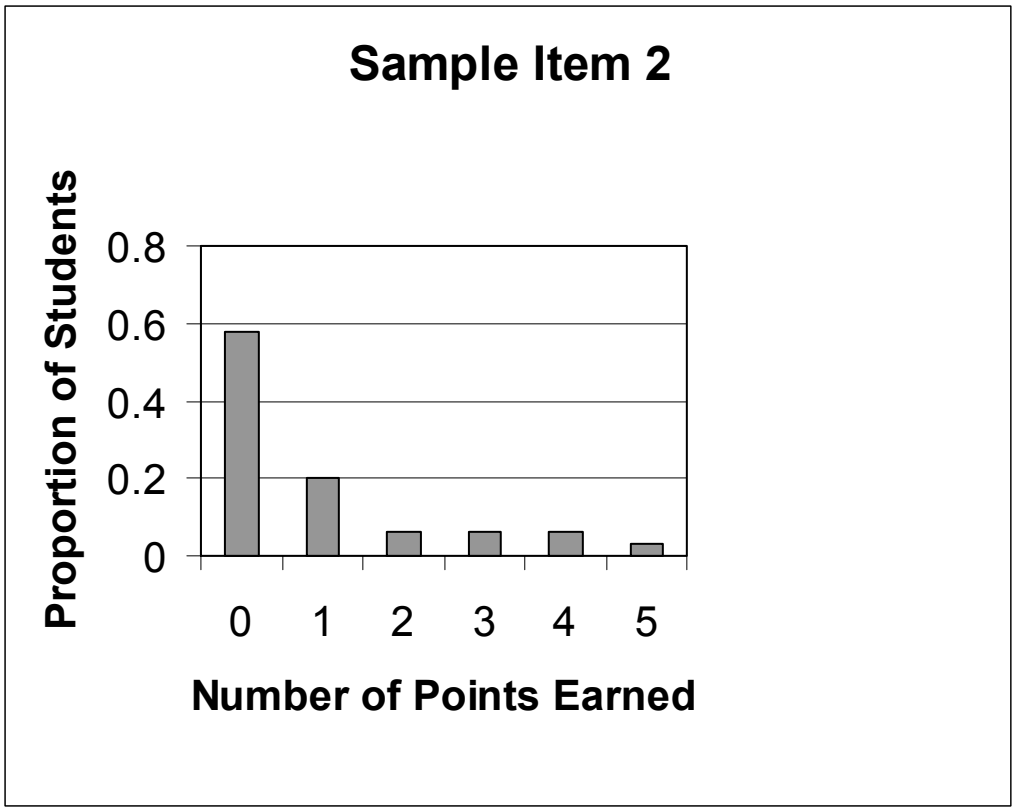

Figure 18. Proportions of students at each score point for sample mathematics item 2.

PSSA items can also be characterized by their difficulty within academic standards. Table 4 presents the mean item scale score difficulty (converted from the item logit) for both common and matrix items by academic standard for the PSSA mathematics tests administered in 2001. In addition, the number of items and the minimum and maximum item scale score is presented in the tables. Only multiple-choice items are presented in the tables because of the difficulty associated with computing a single item scale score for performance task items and because reading items are all coded to the same academic standard. This data is particularly important to consider when applying scores based on items within an academic standard.

Table 4 shows that while the mean item difficulty is not the same per standard, it is similar across all standards. No particular grade demonstrates a large discrepancy from standards to standard. One outlier among the matrix items (Standard 8, Algebra and Functions, mean of 1315), is not an outlier among the common items. Appendix H contains similar tables for PSSA math 2002 and 2003 and for all three administrations of reading.

Table 4. 2001 Math Item Difficulty by Academic Standard

		Standard									
		1	2	3	4	6	7	8	9	10	11
Matrix Items											
Grade 5	N	30	24	19	7	16	8	12	18	9	7
	Min	663.75	840.50	952.50	1001.50	833.50	779.25	725.00	936.75	1019.00	789.75
	Max	1223.75	1376.00	1367.25	1276.25	1328.75	1253.50	1386.50	1421.50	1397.00	1169.50
	Mean	1008.38	1106.79	1176.04	1102.25	1079.70	1022.72	1082.73	1115.74	1218.31	988.00
Grade 8	N	18	21	22	10	12	11	25	12	10	9
	Min	1055.60	959.60	1025.20	1028.40	1082.80	967.60	1089.20	1036.40	994.80	910.00
	Max	1345.20	1334.00	1351.60	1556.40	1327.60	1319.60	1398.00	1369.20	1377.20	1377.20
	Mean	1209.56	1180.78	1218.44	1244.24	1221.87	1183.75	1247.66	1234.40	1214.64	1196.76
Grade 11	N	13	18	14	7	18	10	35	16	12	7
	Min	1036.00	848.00	836.00	936.00	782.00	1038.00	990.00	1028.00	1154.00	1002.00
	Max	1452.00	1382.00	1480.00	1414.00	1400.00	1484.00	1578.00	1486.00	1398.00	1436.00
	Mean	1255.54	1108.67	1186.29	1165.14	1197.33	1216.00	1315.14	1269.13	1289.00	1221.71
Common Items											
Grade 5	N	9	13	9	5	7	5	7	5	5	5
	Min	754.75	898.25	1043.50	910.50	779.25	810.75	770.50	884.25	1027.75	688.25
	Max	1292.00	1400.50	1274.50	1213.25	1257.00	1040.00	1297.25	1267.50	1355.00	1202.75
	Mean	1095.03	1069.35	1154.92	1076.40	1055.00	974.55	1088.75	1082.00	1175.10	1018.30
Grade 8	N	7	10	7	4	5	5	15	9	4	4
	Min	1063.60	938.80	890.80	1017.20	1023.60	1154.80	954.80	1054.00	1054.00	1169.20
	Max	1252.40	1370.80	1393.20	1348.40	1409.20	1322.80	1292.40	1295.60	1266.80	1318.00
	Mean	1151.83	1186.80	1155.94	1173.20	1147.44	1212.72	1152.77	1197.29	1169.20	1252.40
Grade 11	N	5	10	5	5	4	6	14	11	5	5
	Min	892.00	762.00	992.00	1020.00	1088.00	804.00	894.00	932.00	1114.00	856.00
	Max	1356.00	1288.00	1356.00	1448.00	1246.00	1478.00	1346.00	1422.00	1388.00	1176.00
	Mean	1157.20	1061.20	1197.20	1232.40	1163.00	1144.67	1137.14	1163.45	1232.00	1041.60

Summary Across Grades and Subjects

Some discussion regarding the general nature of the findings from the mapping procedures is warranted. For both mathematics and reading, the number of items per academic standard is very consistent across years and across forms. The numbers of items per academic standard is not consistent from standard to standard, however. Subscores reported for individual standards will necessarily have greater standard errors than scores for the entire PSSA, but the differences in numbers of items also mean that subscores have differing standard errors depending on which academic standard is being measured. In addition, there is considerable variation between standards in terms of the difficulty of the items, meaning that subscores may be much less accurate depending on which part of the scale is considered.

There is a great deal of difference between the item types. Performance-task items are linked to academic standards that are not represented by any multiple-choice items. If there are item effects (differential performance by item type), it may not be possible to separate those effects from performance on the standards. PSSA performance-task items measure students' ability to read, analyze and interpret literature in reading, and to problem solve and communicate in mathematics. Mathematics performance tasks are also coded to another academic standard. The unidimensionality requirements for performing IRT are always at odds with having multiple academic standards within a content area, but this dilemma may be further complicated by using one type of item to measure one academic standard and another to measure the remaining content standards.

There are also academic content standards that are not represented by items on the PSSA. The academic content standards represent the knowledge and skills that students are expected to acquire at different steps during their public schooling. The PSSA is used to measure schools' and students' progress toward meeting those standards. There are often consequences for both schools and students based on their performance on the PSSA. When certain standards are not tested, the curriculum implied by those standards may not be enacted. The adage "what gets tested gets done" may cause the Pennsylvania curriculum to evolve more toward the academic standards tested on the PSSA, reducing the emphasis on non-tested standards.

The difficulty of the items by type is not similar. In nearly every case, the higher score points for the performance tasks have logit values in the Advanced performance range. Lower score points for performance-task items tend to have logit values near the very bottom of the scale. Most of the multiple-choice items fall in the Below Basic and Basic range. Performance tasks are vital for categorizing students in the upper parts of the range and help characterize very low-performing students, as well.

Item mean difficulty for PSSA increases for both math and reading with grade level. The Grade 5 tests have more "easy" items than do Grades 8 and 11. This may reflect a decision to guard against discouraging the younger students by including more difficult items. The effect of this phenomenon is that the test has a lower standard error of measurement for low ability Grade 5 students than for higher ability students.

Discussion and Recommendations for Further Study

PSSA is designed to measure two distinct aspects of performance. The common items are used to assign scores to individual students. The common items are considered in conjunction with matrix items to gauge the performance of schools. Student-level scores are considered to be free from form-level effects because those scores are based on a common set of items administered to every student. There is a possibility, however, that the matrix items may influence students' performance on the common items. Matrix items may provide contextual clues that could alter student performance on the common items. The matrix items might also affect students' attitudes toward the rest of the test. A relatively simple study could tell us if student performance is independent of the matrix forms. Difficulty estimates for the common items could be calculated by form and compared. This would give us insight into the effects the matrix items may be having on student performance. The overall mean scores vary only slightly by form for the common items, so if the matrix items are influencing student-level scores, we anticipate that their effect is small.

A second recommendation for further study arose when examining the performance-task item statistics. The logit numbers for mathematics items often do not follow a number line progression. While this phenomenon does not break Rasch IRT assumptions, it may signal cause for concern. The progression of logit numbers compared to points earned on mathematics items seems to have become more erratic since 2001. It may be necessary to reevaluate the rubrics for those items. It might also be necessary, once the rubric evaluation is complete, to edit or re-write some of the items. It may also be possible to address this issue during scorer training and/or during the selection of marker papers. A preliminary examination of the proportions of students scoring in each category shows that there are categories which are essentially eliminated for some of the mathematics items. Since the PSSA scoring system is based on a raw-score-to-scale-score conversion table, it stands to reason that increasing numbers of points on a performance-task item should be associated with greater ability.

Conclusions

This report supports the conclusion that the content distribution of items across forms is balanced at the academic standard level. There are so many substandards that often the substandards are represented by only one or two items per form. Scores are not reported at this level. The distribution of item types is constant for the common forms and is very similar, when not identical, by matrix form. The overall difficulty of the items is similar by form as well. The difficulty of the items is not similar by item type. The multiple-choice items tend to best discriminate toward the lower portion and middle of the scale. Performance-task items tend to discriminate across the scale, with very low logit numbers associated with scoring 1 point on the items and very high logit numbers associated with scoring 4 or 5 points on the items. Performance-task items are very important for discriminating between performance categories toward either end of the scale. The content is not distributed evenly by item type. Pennsylvania's academic content standards are written such that particular standards seem to fit best with particular item types. Communication and problem solving in mathematics are more readily demonstrated via performance-task items. All reading performance-task items carry a code for reading, analyzing and interpreting literature. While this standard is also assessed with multiple-

choice items, it seems clear that an aspect of this standard is tied solely to students' ability to write responses to the prompts.

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Appendix A

Pennsylvania Academic Standard

Academic Standards for Mathematics

Pennsylvania Department of Education

IV. TABLE OF CONTENTS

Introduction……. **V.**

THE ACADEMIC STANDARDS

Numbers, Number Systems and Number Relationships… **2.1.**
Types of numbers (e.g., whole, prime, irrational, complex)
Equivalent forms (e.g., fractions, decimals, percents)

Computation and Estimation…… **2.2.**
***B**asic functions* (+, -, ×, ÷)
Reasonableness of answers
Calculators

Measurement and Estimation…….……..…… **2.3.**
Types of measurement (e.g., length, time)
Units and tools of measurement
Computing and comparing measurements

Mathematical Reasoning and Connections…….…… **2.4.**
Using inductive and deductive reasoning
Validating arguments (e.g., if...then statements, proofs)

Mathematical Problem Solving and Communication..... **2.5**
Problem solving strategies
Representing problems in various ways
Interpreting results

Statistics and Data Analysis…….…… **2.6.**
Collecting and reporting Data (e.g., charts, graphs)
Analyzing data

Probability and Predictions…….…… **2.7.**
Validity of data
Calculating probability to make predictions

Algebra and Functions…… **2.8.**
Equations
Patterns and functions

Geometry…… **2.9**
Shapes and their properties
Using geometric principles to solve problems

Trigonometry…… **2.10**
Right angles
Measuring and computing with triangles
Using graphing calculators

Concepts of Calculus…… **2.11**
Comparing quantities and values
Graphing rates of change
Continuing patterns infinitely

Glossary…… VI.

Academic Standards for Mathematics

V. INTRODUCTION

This document includes Mathematics Standards:

- 2.1. Numbers, Number Systems and Number Relationships
- 2.2. Computation and Estimation
- 2.3. Measurement and Estimation
- 2.4. Mathematical Reasoning and Connections
- 2.5. Mathematical Problem Solving and Communication
- 2.6. Statistics and Data Analysis
- 2.7. Probability and Predictions
- 2.8. Algebra and Functions
- 2.9. Geometry
- 2.10. Trigonometry
- 2.11. Concepts of Calculus

The Mathematics Standards describe what students should know and be able to do at four grade levels (third, fifth, eighth and eleventh). They reflect the increasing complexity and sophistication that students are expected to achieve as they progress through school.

This document avoids repetition of learned skills, making an obvious progression across grade levels less explicit. Teachers shall expect that students know and can apply the concepts and skills expressed at the preceding level. Consequently, previous learning is reinforced but not retaught.

Students who achieve these mathematical standards will be able to communicate mathematically. Although it is an interesting and enjoyable study for its own sake, mathematics is most appropriately used as a tool to help organize and understand information from other academic disciplines. Because our capacity to deal with all things mathematical is changing rapidly, students must be able to bring the most modern and effective technology to bear on their learning of mathematical concepts and skills.

A glossary is included to assist the reader in understanding terminology contained in the standards.

Academic Standards for Mathematics

2.1. Numbers, Number Systems and Number Relationships			
2.1.3. **GRADE 3**	2.1.5. **GRADE 5**	2.1.8. **GRADE 8**	2.1.11. **GRADE 11**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:			
A. Count using whole numbers (to 10,000) and by 2's, 3's, 5's, 10's, 25's and 100's. B. Use whole numbers and fractions to represent quantities. C. Represent equivalent forms of the same number through the use of concrete objects, drawings, word names and symbols. D. Use drawings, diagrams or models to show the concept of fraction as part of a whole. E. Count, compare and make change using a collection of coins and one-dollar bills.	A. Use expanded notation to represent whole numbers or decimals. B. Apply number theory concepts to rename a number quantity (e.g., six, 6, $\frac{12}{2}$, 3×2, $10 - 4$). C. Demonstrate that mathematical operations can represent a variety of problem situations. D. Use models to represent fractions and decimals. E. Explain the concepts of prime and composite numbers.	A. Represent and use numbers in equivalent forms (e.g., integers, fractions, decimals, percents, exponents, scientific notation, square roots). B. Simplify numerical expressions involving exponents, scientific notation and using order of operations. C. Distinguish between and order rational and irrational numbers. D. Apply ratio and proportion to mathematical problem situations involving distance, rate, time and similar triangles. E. Simplify and expand algebraic expressions using exponential forms.	A. Use operations (e.g., opposite, reciprocal, absolute value, raising to a power, finding roots, finding logarithms).

Academic Standards for Mathematics

F. Apply number patterns (even and odd) and compare values of numbers on the hundred board. G. Use concrete objects to count, order and group. H. Demonstrate an understanding of one-to-one correspondence. I. Apply place-value concepts and numeration to counting, ordering and grouping. J. Estimate, approximate, round or use exact numbers as appropriate. K. Describe the inverse relationship between addition and subtraction. L. Demonstrate knowledge of basic facts in four basic operations.	F. Use simple concepts of negative numbers (e.g., on a number line, in counting, in temperature). G. Develop and apply number theory concepts (e.g., primes, factors, multiples, composites) to represent numbers in various ways.	F. Use the number line model to demonstrate integers and their applications. G. Use the inverse relationships between addition, subtraction, multiplication, division, exponentiation and root extraction to determine unknown quantities in equations.	

Academic Standards for Mathematics

2.2. Computation and Estimation			
2.2.3. **GRADE 3**	2.2.5. **GRADE 5**	2.2.8. **GRADE 8**	2.2.11. **GRADE 11**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:			
A. Apply addition and subtraction in everyday situations using concrete objects. B. Solve single- and double-digit addition and subtraction problems with regrouping in vertical form. C. Demonstrate the concept of multiplication as repeated	A. Create and solve word problems involving addition, subtraction, multiplication and division of whole numbers. B. Develop and apply algorithms to solve word problems that involve addition, subtraction, and/or multiplication with decimals with and without regrouping. C. Develop and apply algorithms to	A. Complete calculations by applying the order of operations. B. Add, subtract, multiply and divide different kinds and forms of rational numbers including integers, decimal fractions, percents and proper and improper fractions. C. Estimate the value of irrational numbers.	A. Develop and use computation concepts, operations and procedures with real numbers in problem-solving situations. B. Use estimation to solve problems for which an exact answer is not needed. C. Construct and apply

addition and arrays. D. Demonstrate the concept of division as repeated subtraction and as sharing. E. Use estimation skills to arrive at conclusions. F. Determine the reasonableness of calculated answers. G. Explain addition and subtraction algorithms with regrouping.	solve word problems that involve addition, subtraction, and/or multiplication with fractions and mixed numbers that include like and unlike denominators. D. Demonstrate the ability to round numbers. E. Determine through estimations the reasonableness of answers to problems involving addition, subtraction, multiplication and division of whole numbers. F. Demonstrate skills for using fraction calculators to verify conjectures, confirm computations and explore complex problem-solving situations. G. Apply estimation strategies to a variety of problems including time and money.	D. Estimate amount of tips and discounts using ratios, proportions and percents. E. Determine the appropriateness of overestimating or underestimating in computation. F. Identify the difference between exact value and approximation and determine which is appropriate for a given situation.	mathematical models, including lines and curves of best fit, to estimate values of related quantities. D. Describe and explain the amount of error that may exist in a computation using estimates. E. Recognize that the degree of precision needed in calculating a number depends on how the results will be used and the instruments used to generate the measure. F. Demonstrate skills for using computer spreadsheets and scientific and graphing calculators.

	H. Explain multiplication and division algorithms. I. Select a method for computation and explain why it is appropriate.		

Academic Standards for Mathematics

2.3. Measurement and Estimation			
2.3.3. **GRADE 3**	2.3.5. **GRADE 5**	2.3.8. **GRADE 8**	2.3.11. **GRADE 11**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills to:			
A. Compare measurable characteristics of different objects on the same dimensions (e.g., time, temperature, area, length, weight, capacity, perimeter). B. Determine the measurement of objects with non-standard and standard units (e.g., US customary and metric). C. Determine and compare elapsed times. D. Tell time (analog and digital) to the minute. E. Determine the appropriate unit of measure.	A. Select and use appropriate instruments and units for measuring quantities (e.g., perimeter, volume, area, weight, time, temperature). B. Select and use standard tools to measure the size of figures with specified accuracy, including length, width, perimeter and area. C. Estimate, refine and verify specified measurements of objects. D. Convert linear measurements within the same system. E. Add and subtract measurements.	A. Develop formulas and procedures for determining measurements (e.g., area, volume, distance). B. Solve rate problems (e.g., rate × time = distance, principal × interest rate = interest). C. Measure angles in degrees and determine relations of angles. D. Estimate, use and describe measures of distance, rate, perimeter, area, volume, weight, mass and angles. E. Describe how a change in linear dimension of an object affects its perimeter, area and volume.	A. Select and use appropriate units and tools to measure to the degree of accuracy required in particular measurement situations. B. Measure and compare angles in degrees and radians. C. Demonstrate the ability to produce measures with specified levels of precision.

Academic Standards for Mathematics

F. Use concrete objects to determine area and perimeter. G. Estimate and verify measurements. H. Demonstrate that a single object has different attributes that can be measured in different ways (e.g., length, mass, weight, time, area, temperature, capacity, perimeter).		F. Use scale measurements to interpret maps or drawings. G. Create and use scale models.	

Academic Standards for Mathematics

2.4. Mathematical Reasoning and Connections			
2.4.3. **GRADE 3**	2.4.5. **GRADE 5**	2.4.8. **GRADE 8**	2.4.11. **GRADE 11**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills to:			
A. Make, check and verify predictions about the quantity, size and shape of objects and groups of objects. B. Use measurements in everyday situations (e.g., determine the geography of the school building).	A. Compare quantities and magnitudes of numbers. B. Use models, number facts, properties and relationships to check and verify predictions and explain reasoning. C. Draw inductive and deductive conclusions within mathematical contexts. D. Distinguish between relevant and irrelevant information in a mathematical problem. E. Interpret statements made with precise language of logic (e.g., “all”, “or”, “every”, “none”, “some”, “or”, “many”). F. Use statistics to quantify issues	A. Make conjectures based on logical reasoning and test conjectures by using counter-examples. B. Combine numeric relationships to arrive at a conclusion. C. Use if...then statements to construct simple, valid arguments. D. Construct, use and explain algorithmic procedures for computing and estimating with whole numbers, fractions, decimals and integers. E. Distinguish between inductive and deductive reasoning.	A. Use direct proofs, indirect proofs or proof by contradiction to validate conjectures. B. Construct valid arguments from stated facts. C. Determine the validity of an argument. D. Use truth tables to reveal the logic of mathematical statements. E. Demonstrate mathematical solutions to problems (e.g., in the physical sciences).

	(e.g., in social studies, in science).	F. Use measurements and statistics to quantify issues (e.g., in family, consumer science situations).	

2.5. Mathematical Problem Solving and Communication			
2.5.3. **GRADE 3**	2.5.5. **GRADE 5**	2.5.8. **GRADE 8**	2.5.11. **GRADE 11**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills to:			
A. Use appropriate problem-solving strategies (e.g., guess and check, working backwards).	A. Develop a plan to analyze a problem, identify the information needed to solve the problem, carry out the plan, check whether an answer makes sense and explain how the problem was solved.	A. Invent, select, use and justify the appropriate methods, materials and strategies to solve problems.	A. Select and use appropriate mathematical concepts and techniques from different areas of mathematics and apply them to solving non-routine and multi-step problems.
B. Determine when sufficient information is present to solve a problem and explain how to solve a problem.	B. Use appropriate mathematical terms, vocabulary, language symbols and graphs to explain clearly and logically solutions to problems.	B. Verify and interpret results using precise mathematical language, notation and representations, including numerical tables and equations, simple algebraic equations and formulas, charts, graphs and diagrams.	B. Use symbols, mathematical terminology, standard notation, mathematical rules, graphing and other types of mathematical representations to communicate observations, predictions, concepts, procedures, generalizations, ideas and results.
C. Select and use an appropriate	C. Show ideas in a variety of ways,	C. Justify strategies and defend	

method, materials and strategy to solve problems, including mental mathematics, paper and pencil and concrete objects.	including words, numbers, symbols, pictures, charts, graphs, tables, diagrams and models. D. Connect, extend and generalize problem solutions to other concepts, problems and circumstances in mathematics. E. Select, use and justify the methods, materials and strategies used to solve problems. F. Use appropriate problem-solving strategies (e.g., solving a simpler problem, drawing a picture or diagram).	approaches used and conclusions reached. D. Determine pertinent information in problem situations and whether any further information is needed for solution.	C. Present mathematical procedures and results clearly, systematically, succinctly and correctly. D. Conclude a solution process with a summary of results and evaluate the degree to which the results obtained represent an acceptable response to the initial problem and why the reasoning is valid.

Academic Standards for Mathematics

2.6. Statistics and Data Analysis			
2.6.3. **GRADE 3**	2.6.5. **GRADE 5**	2.6.8. **GRADE 8**	2.6.11. **GRADE 11**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills to:			
A. Gather, organize and display data using pictures, tallies, charts, bar graphs and pictographs. B. Formulate and answer questions based on data shown on graphs. C. Predict the likely number of times a condition will occur based on analyzed data. D. Form and justify an opinion on whether a given statement is reasonable based on a comparison to data.	A. Organize and display data using pictures, tallies, tables, charts, bar graphs and circle graphs. B. Describe data sets using mean, median, mode and range. C. Sort data using Venn diagrams. D. Predict the likely number of times a condition will occur based on analyzed data. E. Construct and defend simple conclusions based on data.	A. Compare and contrast different plots of data using values of mean, median, mode, quartiles and range. B. Explain effects of sampling procedures and missing or incorrect information on reliability. C. Fit a line to the scatter plot of two quantities and describe any correlation of the variables. D. Design and carry out a random sampling procedure. E. Analyze and display data in	A. Design and conduct an experiment using random sampling. Describe the data as an example of a distribution using statistical measures of center and spread. Organize and represent the results with graphs. (Use standard deviation, variance and t-tests.) B. Use appropriate technology to organize and analyze data taken from the local community. C. Determine the regression equation of best fit (e.g., linear, quadratic, exponential). D. Make predictions using interpolation, extrapolation, regression and estimation using technology to verify them. E. Determine the validity of the

		stem-and-leaf and box-and-whisker plots. F. Use scientific and graphing calculators and computer spreadsheets to organize and analyze data. G. Determine the validity of the sampling method described in studies published in local or national newspapers.	sampling method described in a given study. F. Determine the degree of dependence of two quantities specified by a two-way table. G. Describe questions of experimental design, control groups, treatment groups, cluster sampling and reliability. H. Use sampling techniques to draw inferences about large populations. I. Describe the normal curve and use its properties to answer questions about sets of data that are assumed to be normally distributed.

Academic Standards for Mathematics

2.7. Probability and Predictions			
2.7.3. **GRADE 3**	2.7.5. **GRADE 5**	2.7.8. **GRADE 8**	2.7.11. **GRADE 11**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:			
A. Predict and measure the likelihood of events and recognize that the results of an experiment may not match predicted outcomes. B. Design a fair and an unfair spinner.	A. Perform simulations with concrete devices (e.g., dice, spinner) to predict the chance of an event occurring. B. Determine the fairness of the design of a spinner.	A. Determine the number of combinations and permutations for an event. B. Present the results of an experiment using visual representations (e.g., tables,	A. Compare odds and probability. B. Apply probability and statistics to perform an experiment involving a sample and generalize its results to the entire

C. List or graph the possible results of an experiment. D. Analyze data using the concepts of largest, smallest, most often, least often and middle.	C. Express probabilities as fractions and decimals. D. Compare predictions based on theoretical probability and experimental results. E. Calculate the probability of a simple event. F. Determine patterns generated as a result of an experiment. G. Determine the probability of an event involving “and”, “or” or “not”. H. Predict and determine why some outcomes are certain, more likely, less likely, equally likely or impossible. I. Find all possible combinations and arrangements involving a limited number of variables. J. Develop a tree diagram and list the elements.	charts, graphs). C. Analyze predictions (e.g., election polls). D. Compare and contrast results from observations and mathematical models. E. Make valid inferences, predictions and arguments based on probability.	population. C. Draw and justify a conclusion regarding the validity of a probability or statistical argument. D. Use experimental and theoretical probability distributions to make judgments about the likelihood of various outcomes in uncertain situations. E. Solve problems involving independent simple and compound events.

2.8. Algebra and Functions			
2.8.3. **GRADE 3**	2.8.5. **GRADE 5**	2.8.8. **GRADE 8**	2.8.11. **GRADE 11**

Academic Standards for Mathematics

Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills to:			
A. Recognize, describe, extend, create and replicate a variety of patterns including attribute, activity, number and geometric patterns.	A. Recognize, reproduce, extend, create and describe patterns, sequences and relationships verbally, numerically, symbolically and graphically, using a variety of materials.	A. Apply simple algebraic patterns to basic number theory and to spatial relations	A. Analyze a given set of data for the existence of a pattern and represent the pattern algebraically and graphically.
B. Use concrete objects and trial and error to solve number sentences and check if solutions are sensible and accurate.	B. Connect patterns to geometric relations and basic number skills.	B. Discover, describe and generalize patterns, including linear, exponential and simple quadratic relationships.	B. Give examples of patterns that occur in data from other disciplines.
C. Substitute a missing addend in a number sentence.	C. Form rules based on patterns (e.g., an equation that relates pairs in a sequence).	C. Create and interpret expressions, equations or inequalities that model problem situations.	C. Use patterns, sequences and series to solve routine and non-routine problems.
D. Create a story to match a given combination of symbols and numbers.	D. Use concrete objects and combinations of symbols and numbers to create expressions that model mathematical situations.	D. Use concrete objects to model algebraic concepts.	D. Formulate expressions, equations, inequalities, systems of equations, systems of inequalities and matrices to model routine and non-routine problem situations.
E. Use concrete objects and symbols to model the concepts of variables, expressions, equations and inequalities.	E. Explain the use of combinations of symbols and numbers in expressions, equations and inequalities.	E. Select and use a strategy to solve an equation or inequality, explain the solution and check the solution for accuracy.	E. Use equations to represent curves (e.g., lines, circles, ellipses, parabolas, hyperbolas).
F. Explain the meaning of solutions	F. Describe a realistic situation	F. Solve and graph equations and inequalities using scientific and graphing calculators and computer spreadsheets.	F. Identify whether systems of equations and inequalities are

and symbols. G. Use a table or a chart to display information. H. Describe and interpret the data shown in tables and charts. I. Demonstrate simple function rules. J. Analyze simple functions and relationships and locate points on a simple grid.	using information given in equations, inequalities, tables or graphs. G. Select and use appropriate strategies, including concrete materials, to solve number sentences and explain the method of solution. H. Locate and identify points on a coordinate system. I. Generate functions from tables of data and relate data to corresponding graphs and functions.	G. Represent relationships with tables or graphs in the coordinate plane and verbal or symbolic rules. H. Graph a linear function from a rule or table. I. Generate a table or graph from a function and use graphing calculators and computer spreadsheets to graph and analyze functions. J. Show that an equality relationship between two quantities remains the same as long as the same change is made to both quantities; explain how a change in one quantity determines another quantity in a functional relationship.	consistent or inconsistent. G. Analyze and explain systems of equations, systems of inequalities and matrices. H. Select and use an appropriate strategy to solve systems of equations and inequalities using graphing calculators, symbol manipulators, spreadsheets and other software. I. Use matrices to organize and manipulate data, including matrix addition, subtraction, multiplication and scalar multiplication. J. Demonstrate the connection between algebraic equations and inequalities and the geometry of relations in the coordinate plane. K. Select, justify and apply an appropriate technique to graph a linear function in two variables, including slope-intercept, x- and y-intercepts, graphing by transformations and the use of a

			graphing calculator. L. Write the equation of a line when given the graph of the line, two points on the line, or the slope of the line and a point on the line. M. Given a set of data points, write an equation for a line of best fit. N. Solve linear, quadratic and exponential equations both symbolically and graphically. O. Determine the domain and range of a relation, given a graph or set of ordered pairs. P. Analyze a relation to determine whether a direct or inverse variation exists and represent it algebraically and graphically. Q. Represent functional relationships in tables, charts and graphs. R. Create and interpret functional models.

			S. Analyze properties and relationships of functions (e.g., linear, polynomial, rational, trigonometric, exponential, logarithmic). T. Analyze and categorize functions by their characteristics.

2.9. Geometry			
2.9.3. **GRADE 3**	2.9.5. **GRADE 5**	2.9.8. **GRADE 8**	2.9.11. **GRADE 11**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills to:			
A. Name and label geometric shapes in two and three dimensions (e.g., circle/sphere, square/cube, triangle/pyramid, rectangle/prism).	A. Give formal definitions of geometric figures.	A. Construct figures incorporating perpendicular and parallel lines, the perpendicular bisector of a line segment and an angle bisector using computer	A. Construct geometric figures using dynamic geometry tools (e.g., Geometer's Sketchpad, Cabri Geometre).

Academic Standards for Mathematics

B. Build geometric shapes using concrete objects (e.g., manipulatives).	B. Classify and compare triangles and quadrilaterals according to sides or angles.	software. B. Draw, label, measure and list the properties of complementary, supplementary and vertical angles.	B. Prove that two triangles or two polygons are congruent or similar using algebraic, coordinate and deductive proofs.
C. Draw two- and three-dimensional geometric shapes and construct rectangles, squares and triangles on the geoboard and on graph paper satisfying specific criteria.	C. Identify and measure circles, their diameters and their radii.	C. Classify familiar polygons as regular or irregular up to a decagon.	C. Identify and prove the properties of quadrilaterals involving opposite sides and angles, consecutive sides and angles and diagonals using deductive proofs.
D. Find and describe geometric figures in real life.	D. Describe in words how geometric shapes are constructed.	D. Identify, name, draw and list all properties of squares, cubes, pyramids, parallelograms, quadrilaterals, trapezoids, polygons, rectangles, rhombi, circles, spheres, triangles, prisms and cylinders.	D. Identify corresponding parts in congruent triangles to solve problems.
E. Identify and draw lines of symmetry in geometric figures.	E. Construct two- and three-dimensional shapes and figures using manipulatives, geoboards and computer software.	E. Construct parallel lines, draw a transversal and measure and compare angles formed (e.g., alternate interior and exterior angles).	E. Solve problems involving inscribed and circumscribed polygons.
F. Identify symmetry in nature.			
G. Fold paper to demonstrate the reflections about a line.	F. Find familiar solids in the environment and describe them.		F. Use the properties of angles, arcs, chords, tangents and secants to solve problems involving circles.
H. Show relationships between and among figures using reflections.	G. Create an original tessellation.	F. Distinguish between similar and congruent polygons.	

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I. Predict how shapes can be changed by combining or dividing them.	H. Describe the relationship between the perimeter and area of triangles, quadrilaterals and circles. I. Represent and use the concepts of line, point and plane. J. Define the basic properties of squares, pyramids, parallelograms, quadrilaterals, trapezoids, polygons, rectangles, rhombi, circles, triangles, cubes, prisms, spheres and cylinders. K. Analyze simple transformations of geometric figures and rotations of line segments. L. Identify properties of geometric figures (e.g., parallel, perpendicular, similar, congruent, symmetrical).	G. Approximate the value of π (pi) through experimentation. H. Use simple geometric figures (e.g., triangles, squares) to create, through rotation, transformational figures in three dimensions. I. Generate transformations using computer software. J. Analyze geometric patterns (e.g., tessellations, sequences of shapes) and develop descriptions of the patterns. K. Analyze objects to determine whether they illustrate tessellations, symmetry, congruence, similarity and scale.	G. Solve problems using analytic geometry. H. Construct a geometric figure and its image using various transformations. I. Model situations geometrically to formulate and solve problems. J. Analyze figures in terms of the kinds of symmetries they have.

2.10. Trigonometry

Academic Standards for Mathematics

2.10.3. **GRADE 3**	2.10.5. **GRADE 5**	2.10.8. **GRADE 8**	2.10.11. **GRADE 11**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills to:			
A. Identify right angles in the environment. B. Model right angles and right triangles using concrete objects.	A. Identify and compare parts of right triangles, including right angles, acute angles, hypotenuses and legs. B. Create right triangles on a geoboard.	A. Compute measures of sides and angles using proportions, the Pythagorean Theorem and right triangle relationships. B. Solve problems requiring indirect measurement for lengths of sides of triangles.	A. Use graphing calculators to display periodic and circular functions; describe properties of the graphs. B. Identify, create and solve practical problems involving right triangles using the trigonometric functions and the Pythagorean Theorem.

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2.11. Concepts of Calculus			
2.11.3. **GRADE 3**	2.11.5. **GRADE 5**	2.11.8. **GRADE 8**	2.11.11. **GRADE 11**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills to:			
A. Identify whole number quantities and measurements from least to most and greatest value. B. Identify least and greatest values represented in bar graphs and pictographs. C. Categorize rates of change as faster and slower. D. Continue a pattern of numbers or objects that could be extended infinitely.	A. Make comparisons of numbers (e.g., more, less, same, least, most, greater than, less than). B. Identify least and greatest values represented in bar and circle graphs. C. Identify maximum and minimum. D. Describe the relationship between rates of change and time. E. Estimate areas and volumes as the sums of areas of tiles and volumes of cubes. F. Describe the relationship between the size of the unit of measurement and the estimate of	A. Analyze graphs of related quantities for minimum and maximum values and justify the findings. B. Describe the concept of unit rate, ratio and slope in the context of rate of change. C. Continue a pattern of numbers or objects that could be extended infinitely.	A. Determine maximum and minimum values of a function over a specified interval. B. Interpret maximum and minimum values in problem situations. C. Graph and interpret rates of growth/decay. D. Determine sums of finite sequences of numbers and infinite geometric series. E. Estimate areas under curves using sequences of areas.

	the areas and volumes.		

Academic Standards for Mathematics

VI. GLOSSARY

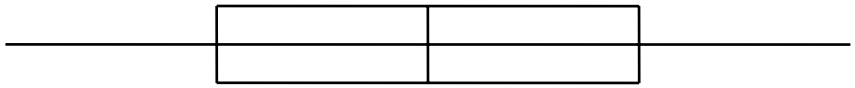
Absolute value: A number's distance from zero on a number line. The absolute value of 2 is equal to the absolute value of -2.

Algorithm: A method of performing an arithmetic operation.

Analog time: Time displayed on a timepiece having hour and minute hands.

Array: Arrangement of a series of items according to the values of the items (e.g., largest to smallest).

Box-and-whisker plot: A graphic method for showing a summary of data using median, quartiles and extremes of data.



Combination: A subset of the elements in a given set, without regard to the order in which those elements are arranged.

Composite number: Any positive integer exactly divisible by one or more positive integers other than itself and 1.

Congruent: Having the same shape and the same size.

Conjecture: A statement believed to be true but not proved.

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Coordinate system: A method of locating points in the plane or in space by means of numbers. A point in the plane is located by its distances from both a horizontal and a vertical line called the axes. The horizontal line is called the x-axis. The vertical line is called the y-axis. The pairs of numbers are called ordered pairs. The first number, called the x-coordinate, designates the distance along the horizontal axis. The second number, called the y-coordinate, designates the distance along the vertical axis. The point at which the two axes intersect has the coordinates (0,0) and is called the origin.

Correlation: A measure of the mutual relationship between two variables.

Customary system: A system of weights and measures frequently used in the United States. The basic unit of weight is the pound; the basic unit of capacity is the quart.

Deductive reasoning: The process of reasoning from statements accepted as true to reach a conclusion.

Direct variation: Two variables are so related that their ratio remains constant.

Domain: The set of all possible values for the unknown in an open sentence.

Equation: A statement of equality between two mathematical expressions (e.g., X + 5 = Y - 2).

Equivalent forms: Different forms of numbers that name the same number (e.g., fraction, decimal, percent as $\frac{1}{2}$, .5, 50%).

Expanded notation: Involves writing the number in expanded form to show the value of each digit (e.g., 15,629 = 10,000 + 5,000 + 600 + 20 + 9).

Exponential function: A function whose general equation is $y = a \times b^x$ or $y = a \times b^{kx}$, where a, b and k stand for constants.

Exponent: A numeral used to tell how many times a number or variable is used as a factor (e.g., a^2, 2^n, y^x).

Academic Standards for Mathematics

Expression: A mathematical phrase that can include operations, numerals and variables. In algebraic terms: $2l + 3x$; in numeric terms: 13.4 - 4.7.

Factor: The number or variable multiplied in a multiplication expression.

Factorial: The expression n! (n factorial) is the product of all the numbers from 1 to n for any positive integer n.

Function: A relation in which each value of an independent variable is associated with a unique value of the dependent value.

Geoboard: A board with pegs aligned in grid fashion that permits rubber bands to be wrapped around pegs to form geometric figures.

Graphing calculator: A calculator that will store and draw the graphs of several functions at once.

Independent events: Events such that the outcome of the first event has no effect on the probabilities of the outcome of the second event (e.g., two tosses of the same coin are independent events).

Inductive reasoning: Generalizations made from particular observations in a common occurrence.

Inequality: A mathematical sentence that contains a symbol (e.g., $>, <, \geq, \leq$ or $\neq$) in which the terms on either side of the symbol are unequal (e.g., $x < y$, $7 > 3$, $n \geq 4$).

Infinite: Has no end or goes on forever.

Integer: A number that is a positive whole number, a negative whole number or zero.

Inverse: A new conditional formed by negating both the antecedent and the consequent of a conditional.

Inverse operations: Operations that undo each other (e.g., addition and subtraction are inverse operations; multiplication and division are inverse operations).

Academic Standards for Mathematics

Inverse variation: When the ratio of one variable to the reciprocal of the other is constant, one of them is said to vary inversely as the other.

Irrational number: A number that cannot be written as a simple fraction. It is an infinite and non-repeating decimal.

Limit: A number to which the terms of a sequence get closer so that beyond a certain term all terms are as close as desired to that number.

Line of best fit: The line that fits a set of data points with the smallest value for the sum of the squares of the errors (vertical distances) from the data points to the line; the regression line.

Linear function: A function whose general equation is $y = mx + b$, where m and b stand for constants and $m \neq 0$.

Linear measurement: Measurement in a straight line.

Logarithm: The exponent indicating the power to which a fixed number, the base, must be raised to produce a given number. For example, if $n^x = a$, the logarithm of a, with n as the base, is x; symbolically, $\log_n a = x$. If the base is 10, the log of 100 is 2.

Manipulatives: Materials that allow students to explore mathematical concepts in a concrete mode.

Mathematical model: A representation in the mathematical world of some phenomenon in the real world. It frequently consists of a function or relation specifying how two variables are related.

Matrix: A rectangular array of numbers representing such things as the coefficients in a system of equations arranged in rows and columns.

Maximum: The greatest number in a set of data.

Mean: The sum of the set of numbers divided by n, the number of numbers in the set.

Academic Standards for Mathematics

Median: The number that lies in the middle when a set of numbers is arranged in order. If there are two middle values, the median is the mean of these values.

Metric system: A system of measurement used throughout the world based on factors of 10. It includes measures of length, weight and capacity.

Minimum: The least number in a set of data.

Missing addend: A member of an addition number sentence in which that term is missing (e.g., 5 + __ = 8).

Mode: The number(s) that occurs most often in a set of numbers (e.g., in the set 1, 2, 3, 3, 5, 8; the mode is 3).

Multiple: A number that is the product of a given integer and another integer (e.g., 6 and 9 are multiples of 3).

Normal curve: A graphical plot of a mathematical function (frequency distribution) which is unimodal and symmetrical.

***One-to-one* correspondence:** When one and only one element of a second set is assigned to an element of a first set, all elements of the second set are assigned, and every element of the first set has an assignment, the mapping is called one-to-one (e.g., in the set Bill Clinton, George Bush, Ronald Reagan, Jimmy Carter, Hillary Clinton, Barbara Bush, Nancy Reagan and Rosalynn Carter, there is a one-to-one correspondence between the pairs).

Open sentence: A statement that contains at least one unknown. It becomes true or false when a quantity is substituted for the unknown (e.g., $x + 5 = 9$, $y - 2 = 7$).

Order of operations: Rules for evaluating an expression: work first within parentheses; then calculate all powers, from left to right; then do multiplications or divisions, from left to right; then do additions and subtractions, from left to right.

Academic Standards for Mathematics

Patterns: Regularities in situations such as those in nature, events, shapes, designs and sets of numbers (e.g., spirals on pineapples, geometric designs in quilts, the number sequence 3, 6, 9, 12,…).

Permutation: An arrangement of a given number of objects from a given set in which the order of the objects is significant.

Perpendicular lines: Two lines that intersect to form right angles (e.g., ⊥, ↵, ⌈).

Plotting points: Locating points by means of coordinates, or a curve by plotted points, representing an equation by means of a curve so constructed.

Polygon: A union of segments connected end to end, such that each segment intersects exactly two others at its endpoints.

Powers: A number expressed using an exponent. The number 5^3 is read five to the third power or five cubed.

Prime: An integer greater than one whose only positive factors are 1 and itself (e.g., 2, 3, 5, 7, 11, 13, 17, and 19).

Probability: A number from 0 to 1 that indicates how likely something is to happen.

Problem-solving: Finding ways to reach a goal when no routine path is apparent.

Proof by contradiction: A proof in which, if s is to be proven, one reasons from not-s until a contradiction is deduced; from this it is concluded that not-s is false, which means that s is true.

Academic Standards for Mathematics

Proportion: An equation of the form $\frac{a}{b} = \frac{c}{d}$ that states that the two ratios are equivalent.

Quadrilateral: A four-sided polygon.

Quartiles: The three values that divide an ordered set into four subsets of approximately equal size. The second quartile is the median.

Radian: A unit of angular measure equal to $\frac{1}{2\pi}$ of a complete revolution.

Range (1) : The difference between the greatest number and the least number in a set of data.

Range (2) : The set of output values for a function.

Rate of change: The limit of the ratio of an increment of the function value at the point to that of the independent variable as the increment of the variable approaches zero.

Ratio: A comparison of two numbers by division.

Rational numbers: Any number that can be written in the form $\frac{a}{b}$ where a is any integer and b is any integer except zero.

Real numbers: The set consisting of all rational numbers and all irrational numbers.

Reasonableness: Quality of a solution such that it is not extreme or excessive.

Reciprocal: The fractional number that results from dividing one by the number.

Rectangular prism: A three-dimensional figure whose sides are all rectangles; a box.

Academic Standards for Mathematics

Reflection: A transformation that produces the mirror image of a geometric figure.

Regression: The line that represents the least deviation from the points in a scatter plot of data.

Regular polygon: A polygon in which all sides have the same measure and all angles have the same measure.

Relation: A set of ordered pairs.

Reliability: The extent to which a measuring procedure yields the same results on repeated trials.

Repeated addition: A model for multiplication (e.g., $2 + 2 + 2 = 3 \times 2$).

Rotation: A transformation that maps every point in the plane to its image by rotating the plane around a fixed point or line.

Scientific calculator: A calculator that represents very large or very small numbers in scientific notation with the powering, factorial, square root, negative and reciprocal keys.

Scientific notation: A way in writing a number of terms of an integer power of 10 multiplied by a number greater than or equal to 1 and less than 10.

Sequence: A set of ordered quantities (e.g., positive integers).

Series: The indicated sum of the terms of a sequence.

Similarity: Having the same shape but not necessarily the same size.

Simple event: An event whose probability can be obtained from consideration of a single occurrence (e.g., the tossing of a coin is a simple event).

Simulation: Modeling a real event without actually observing the event.

Academic Standards for Mathematics

Slope: The slope of a line is the ratio of the change in y to the corresponding change in x; the constant m in the linear function equation; rise/run.

Standard deviation: The square root of the variance.

Stem-and-leaf plot: A frequency distribution made by arranging data (e.g., student scores on a test were 98, 96, 85, 93, 83, 87, 85, 87, 93, 75, 77 and 83). This data is displayed in a stem-and-leaf plot below.

9	8, 6, 3, 3
8	7, 7, 5, 5, 3, 3
7	7, 5

Systems of equations: Two or more equations that are conditions imposed simultaneously on all the variables, but may or may not have common solutions (e.g., $x + y = 2$, and $3x + 2y = 5$).

Symmetry: A line of symmetry separates a figure into two congruent halves, each of which is a reflection of the other (e.g., ∅, the line through the center of the circle divides it into congruent halves).

t-test: A statistical test done to test the difference of means of two samples.

Tessellation: A repetitive pattern of polygons that covers an area with no holes and no overlaps (e.g., floor tiles).

Transformation: An operation on a geometric figure by which each point gives rise to a unique image.

Translation: A transformation that moves a geometric figure by sliding each of the points the same distance in the same direction.

Tree diagram: A diagram used to show the total number of possible outcomes in a probability experiment.

Academic Standards for Mathematics

Trigonometric functions: A function (e.g., sine, cosine, tangent, cotangent, secant, cosecant) whose independent variable is an angle measure, usually in degrees or radians.

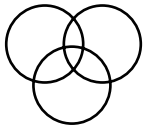
Valid argument: An argument with the property that no matter what statements are substituted in the premises, the truth value of the form is true. If the premises are true, then the conclusion is true.

Variable: A symbol used to stand for any one of a given set of numbers or other objects (e.g., in the equation $y = x + 5$, y and x are variables).

Variance: In a data set, the sum of the squared deviations divided by one less than the number of elements in the set (sample variance s^2) or by the number of elements in the set (population variance σ^2).

Vector: A quantity that has both magnitude and direction (e.g., physical quantities such as velocity and force).

Venn diagram: A display that pictures unions and intersections of sets.



Volume: The amount of space enclosed in a space (3-dimensional) figure, measured in cubic units.

Y-intercept: The y-intercept of a line is the y-coordinate of the point at which the graph of an equation crosses the y-axis.

π: pi, the ratio of the circumference of a circle to its diameter: 3.1415926535.

Academic Standards for Reading, Writing, Speaking and Listening

Pennsylvania Department of Education

Human Resources Research Organization
66 Canal Center Plaza, Suite 400 • Alexandria, VA 22314-1591

Academic Standards for Mathematics

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II. INTRODUCTION

This document includes Reading, Writing, Speaking and Listening Standards:

- ◊ 1.1. Learning to Read Independently
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The Reading, Writing, Speaking and Listening Standards describe what students should know and be able to do with the English language at four grade levels (third, fifth, eighth and eleventh). The standards provide the targets for instruction and student learning essential for success in all academic areas, not just language arts classrooms. Although the standards are not a curriculum or a prescribed series of activities, school entities will use them to develop a local school curriculum that will meet local students' needs.

The language arts—Reading, Writing, Speaking and Listening—are unique because they are processes that students use to learn and make sense of their world. Students do not read "reading"; they read about history, science, mathematics and other content areas as well as about topics for their interest and entertainment. Similarly, students do not write "writing"; they use written words to express their knowledge and ideas and to inform or entertain others.

Because of the unique nature of the language arts, all teachers in a school will use the Reading, Writing, Speaking and Listening Standards. The standards define the skills and strategies employed by effective readers and writers; therefore, all teachers will assist their students in learning them through multiple classroom situations in all the subject areas.

The Reading, Writing, Speaking and Listening Standards also provide parents and community members with information about what students should know and be able to do as they progress through the educational program and at graduation. With a clearly defined target provided by the standards, parents, students, educators and community members become partners in learning success.

A glossary is included to assist the reader in understanding terminology contained in the standards.

1.1. Learning to Read Independently			
1.1.3. **GRADE 3**	1.1.5. **GRADE 5**	1.1.8. **GRADE 8**	1.1.11. **GRADE 11**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:			
A. Identify the purposes and types of text (e.g., literature, information) before reading. B. Preview the text formats (e.g., title, headings, chapters and table of contents). C. Use knowledge of phonics, word analysis (e.g., root words, prefixes and suffixes), syllabication, picture and context clues to decode and understand new words during reading. D. Read text using self-monitoring comprehension strategies (e.g., predict, revise predictions, reread, use text organization including headings, graphics, and charts, and adjust reading	A. Establish the purpose for reading a type of text (literature, information) before reading. B. Select texts for a particular purpose using the format of the text as a guide. C. Use knowledge of phonics, syllabication, prefixes, suffixes, the dictionary or context clues to decode and understand new words during reading. Use these words accurately in writing and speaking. D. Identify the basic ideas and facts in text using strategies (e.g., prior knowledge, illustrations and headings) and information from other sources to make predictions about text.	A. Locate appropriate texts (literature, information, documents) for an assigned purpose before reading. B. Identify and use common organizational structures and graphic features to comprehend information. C. Use knowledge of root words as well as context clues and glossaries to understand specialized vocabulary in the content areas during reading. Use these words accurately in speaking and writing. D. Identify basic facts and ideas in text using specific strategies (e.g., recall genre characteristics, set a purpose for reading, generate essential	A. Locate various texts, media and traditional resources for assigned and independent projects before reading. B. Analyze the structure of informational materials explaining how authors used these to achieve their purposes. C. Use knowledge of root words and words from literary works to recognize and understand the meaning of new words during reading. Use these words accurately in speaking and writing. D. Identify, describe, evaluate and synthesize the essential ideas in text. Assess those reading strategies that were most effective in learning from a

rate). E. Acquire a reading vocabulary by identifying and correctly using words (e.g., antonyms, synonyms, categories of words). Use a dictionary when appropriate. F. Understand the meaning of and use correctly new vocabulary learned in various subject areas. G. Demonstrate after reading understanding and interpretation of both fiction and nonfiction text. • Retell or summarize the major ideas, themes or procedures of the text. • Connect the new information or ideas in the text to known information. • Clarify ideas and understandings through rereading and discussion. • Make responsible assertions about the text by citing evidence from the text.	E. Acquire a reading vocabulary by correctly identifying and using words (e.g., synonyms, homophones, homographs, words with roots, suffixes, prefixes). Use a dictionary or related reference. F. Identify, understand the meaning of and use correctly key vocabulary from various subject areas. G. Demonstrate after reading understanding and interpretation of both fiction and nonfiction text. • Summarize the major ideas, themes or procedures of the text. • Relate new information or ideas from the text to that learned through additional reading and media (e.g., film, audiotape). • Clarify ideas and understandings through rereading and discussion.	questions as aids to comprehension and clarify understanding through rereading and discussion). E. Expand a reading vocabulary by identifying and correctly using idioms and words with literal and figurative meanings. Use a dictionary or related reference. F. Understand the meaning of and apply key vocabulary across the various subject areas. G. Demonstrate after reading understanding and interpretation of both fiction and nonfiction text, including public documents. • Make, and support with evidence, assertions about texts. • Compare and contrast texts using themes, settings, characters and ideas. • Make extensions to related ideas, topics or information. • Describe the context of a document.	variety of texts. E. Establish a reading vocabulary by identifying and correctly using new words acquired through the study of their relationships to other words. Use a dictionary or related reference. F. Understand the meaning of and apply key vocabulary across the various subject areas. G. Demonstrate after reading understanding and interpretation of both fiction and nonfiction text, including public documents. • Make, and support with evidence, assertions about texts. • Compare and contrast texts using themes, settings, characters and ideas. • Make extensions to related ideas, topics or information. • Assess the validity of the

H. Demonstrate fluency and comprehension in reading. • Read familiar materials aloud with accuracy. • Self-correct mistakes. • Use appropriate rhythm, flow, meter and pronunciation. • Read a variety of genres and types of text. • Demonstrate comprehension (Standard 1.1.3.G.). (Recommend: 25 books/year)	• Make responsible assertions about the ideas from the text by citing evidence. • Extend ideas found in the text. H. Demonstrate fluency and comprehension in reading. • Read familiar materials aloud with accuracy. • Self-correct mistakes. • Use appropriate rhythm, flow, meter and pronunciation. • Read a variety of genres and types of text. • Demonstrate comprehension (Standard 1.1.5.G.). (Recommend: 25 books/year)	• Analyze the positions, arguments and evidence in public documents. H. Demonstrate fluency and comprehension in reading. • Read familiar materials aloud with accuracy. • Self-correct mistakes. • Use appropriate rhythm, flow, meter and pronunciation. • Read a variety of genres and types of text. • Demonstrate comprehension (Standard 1.1.8.G.). (Recommend: 25 books/year)	document based on context. • Analyze the positions, arguments and evidence in public documents. • Evaluate the author's strategies. • Critique public documents to identify strategies common in public discourse. H. Demonstrate fluency and comprehension in reading. • Read familiar materials aloud with accuracy. • Self-correct mistakes. • Use appropriate rhythm, flow, meter and pronunciation. • Read a variety of genres and types of text. • Demonstrate comprehension (Standard 1.1.11.G.). (Recommend: 25 books/year)
1.2. Reading Critically in All Content Areas			
1.2.3. **GRADE 3**	1.2.5. **GRADE 5**	1.2.8. **GRADE 8**	1.2.11. **GRADE 11**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:			

A. Read and understand essential content of informational texts and documents in all academic areas. • Differentiate fact from opinion within text. • Distinguish between essential and nonessential information within a text. • Make inferences from text when studying a topic (e.g., science, social studies) and draw conclusions based on text. • Analyze text organization and content to derive meaning from text using established criteria.	A. Read and understand essential content of informational texts and documents in all academic areas. • Differentiate fact from opinion across texts. • Distinguish between essential and nonessential information across a variety of texts, identifying stereotypes and exaggeration where present. • Make inferences about similar concepts in multiple texts and draw conclusions. • Evaluate text organization and content to determine the author's purpose and effectiveness.	A. Read and understand essential content of informational texts and documents in all academic areas. • Differentiate fact from opinion utilizing resources that go beyond traditional text (e.g., newspapers, magazines and periodicals) to electronic media. • Distinguish between essential and nonessential information across texts and going beyond texts to a variety of media; identify bias and propaganda where present. • Draw inferences based on a variety of information sources. • Evaluate text organization and content to determine the author's purpose and effectiveness according to the author's theses, accuracy and thoroughness.	A. Read and understand essential content of informational texts and documents in all academic areas. • Differentiate fact from opinion across a variety of texts by using complete and accurate information, coherent arguments and points of view. • Distinguish between essential and nonessential information across a variety of sources, identifying the use of proper references or authorities and propaganda techniques where present. • Use teacher and student established criteria for making decisions and drawing conclusions. • Evaluate text organization and content to determine the author's purpose and effectiveness according to the author's theses, accuracy, thoroughness, logic and reasoning.

B. Use and understand a variety of media and evaluate the quality of material produced. • Use electronic media for research. • Identify techniques used in television and use the knowledge to distinguish between facts and misleading information. • Assess the quality of media project (e.g., script, play, audiotape) that has been developed for a targeted audience. C. Produce work in at least one literary genre that follows the conventions of the genre.	B. Use and understand a variety of media and evaluate the quality of material produced. • Use a variety of media (e.g., computerized card catalogues, encyclopedias) for research. • Evaluate the role of media as a source of both entertainment and information. • Use established criteria to design and develop a media project (e.g., script, play, audiotape) for a targeted audience. C. Produce work in at least one literary genre that follows the conventions of the genre.	B. Use and understand a variety of media and evaluate the quality of material produced. • Compare and analyze how different media offer a unique perspective on the information presented. • Analyze the techniques of particular media messages and their effect on a targeted audience. • Use, design and develop a media project that expands understanding (e.g., authors and works from a particular historical period). C. Produce work in at least one literary genre that follows the conventions of the genre.	B. Use and understand a variety of media and evaluate the quality of material produced. • Select appropriate electronic media for research and evaluate the quality of the information received. • Explain how the techniques used in electronic media modify traditional forms of discourse for different purposes. • Use, design and develop a media project to demonstrate understanding (e.g., a major writer or literary period or movement). C. Produce work in at least one literary genre that follows the conventions of the genre.

1.3. Reading, Analyzing and Interpreting Literature			
1.3.3. **GRADE 3**	1.3.5. **GRADE 5**	1.3.8. **GRADE 8**	1.3.11. **GRADE 11**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:			
A. Read and understand works of literature. B. Identify literary elements in stories describing characters, setting and plot. C. Identify literary devices in	A. Read and understand works of literature. B. Compare the use of literary elements within and among texts including characters, setting, plot, theme and point of view. C. Describe how the author uses	A. Read and understand works of literature. B. Analyze the use of literary elements by an author including characterization, setting, plot, theme, point of view, tone and style. C. Analyze the effect of various	A. Read and understand works of literature. B. Analyze the relationships, uses and effectiveness of literary elements used by one or more authors in similar genres including characterization, setting, plot, theme, point of view, tone and style. C. Analyze the effectiveness, in

stories (e.g., rhyme, rhythm, personification). D. Identify the structures in poetry (e.g., pattern books, predictable books, nursery rhymes). E. Identify the structures in drama (e.g., dialogue, story enactment, acts, scenes). F. Read and respond to nonfiction and fiction including poetry and drama.	literary devices to convey meaning. • Sound techniques (e.g., rhyme, rhythm, meter, alliteration). • Figurative language (e.g., personification, simile, metaphor, hyperbole). D. Identify and respond to the effects of sound and structure in poetry (e.g., alliteration, rhyme, verse form). E. Analyze drama as information source, entertainment, persuasion or transmitter of culture. F. Read and respond to nonfiction and fiction including poetry and drama.	literary devices. • Sound techniques (e.g., rhyme, rhythm, meter, alliteration). • Figurative language (e.g., personification, simile, metaphor, hyperbole, allusion). D. Identify poetic forms (e.g., ballad, sonnet, couplet). E. Analyze drama to determine the reasons for a character's actions taking into account the situation and basic motivation of the character. F. Read and respond to nonfiction and fiction including poetry and drama.	terms of literary quality, of the author's use of literary devices. • Sound techniques (e.g., rhyme, rhythm, meter, alliteration). • Figurative language (e.g., personification, simile, metaphor, hyperbole, irony, satire). • Literary structures (e.g., foreshadowing, flashbacks, progressive and digressive time). D. Analyze and evaluate in poetry the appropriateness of diction and figurative language (e.g., irony, understatement, overstatement, paradox). E. Analyze how a scriptwriter's use of words creates tone and mood, and how choice of words advances the theme or purpose of the work. F. Read and respond to nonfiction and fiction including poetry and drama.

1.4. Types of Writing			
1.4.3. **GRADE 3**	1.4.5. **GRADE 5**	1.4.8. **GRADE 8**	1.4.11. **GRADE 11**

Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:			
A. Write narrative pieces (e.g., stories, poems**,** plays). • Include detailed descriptions of people, places and things. • Use relevant illustrations. • Include literary elements (Standard 1.3.3.B.).	A. Write poems, plays and multi-paragraph stories. • Include detailed descriptions of people, places and things. • Use relevant illustrations. • Utilize dialogue. • Apply literary conflict. • Include literary elements (Standard 1.3.5.B.). • Use literary devices (Standard 1.3.5.C.).	A. Write short stories, poems and plays. • **Apply** varying organizational methods. • Use relevant illustrations. • Utilize dialogue. • Apply literary conflict. • Include literary elements (Standard 1.3.8.B.) . • Use literary devices (Standard 1.3.8.C.).	A. Write short stories, poems and plays. • **Apply** varying organizational methods. • Use relevant illustrations. • Utilize dialogue. • Apply literary conflict. • Include varying characteristics (e.g., from limerick to epic, from whimsical to dramatic)**.** • Include literary elements (Standard 1.3.11.B.) . • Use literary devices (Standard 1.3.11.C.).
B. Write informational pieces (e.g., descriptions, letters, reports**,** instructions) using illustrations when relevant.	B. Write multi-paragraph informational pieces (e.g., essays, descriptions, letters, reports**,** instructions). • Include cause and effect. • Develop a problem and solution when appropriate to the topic. • Use relevant graphics (e.g., maps, charts, graphs, tables, illustrations**,** photographs**).**	B. Write multi-paragraph informational pieces (e.g., letters, descriptions, reports, instructions, essays, articles**,** interviews). • Include cause and effect. • Develop a problem and solution when appropriate to the topic. • Use relevant graphics (e.g., maps, charts, graphs, tables**,** illustrations**,** photographs).	B. Write complex informational pieces (e.g., research papers, analyses, evaluations, essays). • Include a variety of methods to develop the main idea. • Use precise language and specific detail. • Include cause and effect. • Use relevant graphics (e.g., maps, charts, graphs, tables,

C. Write an opinion and support it with facts.	C. Write persuasive pieces with a clearly stated position or opinion and supporting detail, citing sources when needed.	• Use primary and secondary sources. C. Write persuasive pieces. • Include a clearly stated position or opinion. • Include convincing, elaborated and properly cited evidence. • Develop reader interest. • Anticipate and counter reader concerns and arguments. D. Maintain a written record of activities, course work, experience, honors and interests.	illustrations, photographs). • Use primary and secondary sources. C. Write persuasive pieces. • Include a clearly stated position or opinion. • Include convincing, elaborated and properly cited evidence. • Develop reader interest. • Anticipate and counter reader concerns and arguments. • Include a variety of methods to advance the argument or position. D. Maintain a written record of activities, course work, experience, honors and interests. E. Write a personal resum—.

1.5. Quality of Writing			
1.5.3. **GRADE 3**	1.5.5. **GRADE 5**	1.5.8. **GRADE 8**	1.5.11. **GRADE 11**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:			
A. Write with a sharp, distinct focus identifying topic, task and audience. B. Write using well-developed content appropriate for the topic. • Gather and organize information.	A. Write with a sharp, distinct focus identifying topic, task and audience. B. Write using well-developed content appropriate for the topic. • Gather, organize and select the most effective	A. Write with a sharp, distinct focus. • Identify topic, task and audience. • Establish a single point of view. B. Write using well-developed content appropriate for the	A. Write with a sharp, distinct focus. • Identify topic, task and audience. • Establish and maintain a single point of view. B. Write using well-developed content appropriate for the topic.

• Write a series of related sentences or paragraphs with one central idea. • Incorporate details relevant and appropriate to the topic. C. Write with controlled and/or subtle organization. • Sustain a logical order. • Include a recognizable beginning, middle and end. D. Write with an awareness of the stylistic aspects of composition. • Use sentences of differing lengths and complexities. • Use descriptive words and action verbs.	information appropriate for the topic, task and audience. • Write paragraphs that have a topic sentence and supporting details. C. Write with controlled and/or subtle organization. • Sustain a logical order within sentences and between paragraphs using meaningful transitions. • Include an identifiable introduction, body and conclusion. D. Write with an understanding of the stylistic aspects of composition. • Use different types and lengths of sentences. • Use precise language including adjectives, adverbs, action verbs and specific details that convey the writer's meaning. • Develop and maintain a	topic. • Gather, determine validity and reliability of and organize information. • Employ the most effective format for purpose and audience. • Write paragraphs that have details and information specific to the topic and relevant to the focus. C. Write with controlled and/or subtle organization. • Sustain a logical order within sentences and between paragraphs using meaningful transitions. • Establish topic and purpose in the introduction. • Reiterate the topic and purpose in the conclusion. D. Write with an understanding of the stylistic aspects of composition. • Use different types and lengths of sentences. • Use tone and voice through	• Gather, determine validity and reliability of, analyze and organize information. • Employ the most effective format for purpose and audience. • Write fully developed paragraphs that have details and information specific to the topic and relevant to the focus. C. Write with controlled and/or subtle organization. • Sustain a logical order throughout the piece. • Include an effective introduction and conclusion. D. Write with a command of the stylistic aspects of composition. • Use different types and lengths of sentences. • Use precise language.

E. Revise writing to improve detail and order by identifying missing information and determining whether ideas follow logically. F. Edit writing using the conventions of language. • Spell common, frequently used words correctly. • Use capital letters correctly (first word in sentences, proper nouns, pronoun "I"). • Punctuate correctly (periods, exclamation points, question marks, commas in a series). • Use nouns, pronouns, verbs, adjectives, adverbs and conjunctions properly. • Use complete sentences (simple, compound, declarative, interrogative, exclamatory and imperative). G. Present and/or defend written work for publication when appropriate.	consistent voice. E. Revise writing to improve organization and word choice; check the logic, order of ideas and precision of vocabulary. F. Edit writing using the conventions of language. • Spell common, frequently used words correctly. • Use capital letters correctly. • Punctuate correctly (periods, exclamation points, question marks, commas, quotation marks, apostrophes). • Use nouns, pronouns, verbs, adjectives, adverbs, conjunctions, prepositions and interjections properly. • Use complete sentences (simple, compound, declarative, interrogative, exclamatory and imperative). G. Present and/or defend written work for publication when appropriate.	the use of precise language. E. Revise writing after rethinking logic of organization and rechecking central idea, content, paragraph development, level of detail, style, tone and word choice. F. Edit writing using the conventions of language. • Spell common, frequently used words correctly. • Use capital letters correctly. • Punctuate correctly (periods, exclamation points, question marks, commas, quotation marks, apostrophes, colons, semicolons, parentheses). • Use nouns, pronouns, verbs, adjectives, adverbs, conjunctions, prepositions and interjections properly. • Use complete sentences (simple, compound, complex, declarative, interrogative, exclamatory and imperative). G. Present and/or defend written work for publication when	E. Revise writing to improve style, word choice, sentence variety and subtlety of meaning after rethinking how questions of purpose, audience and genre have been addressed. F. Edit writing using the conventions of language. • Spell all words correctly. • Use capital letters correctly. • Punctuate correctly (periods, exclamation points, question marks, commas, quotation marks, apostrophes, colons, semicolons, parentheses, hyphens, brackets, ellipses). • Use nouns, pronouns, verbs, adjectives, adverbs, conjunctions, prepositions and interjections properly. • Use complete sentences (simple, compound, complex, declarative, interrogative, exclamatory and imperative). G. Present and/or defend written work for publication when appropriate.

		appropriate.	
1.6. Speaking and Listening			
1.6.3. **GRADE 3**	1.6.5. **GRADE 5**	1.6.8. **GRADE 8**	1.6.11. **GRADE 11**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:			
A. Listen to others. • Ask questions as an aid to understanding. • Distinguish fact from opinion. B. Listen to a selection of literature (fiction and/or nonfiction). • Relate it to similar experiences. • Predict what will happen next. • Retell a story in chronological order. • Recognize character and tone. • Identify and define new words and concepts.	A. Listen to others. • Ask pertinent questions. • Distinguish relevant information, ideas and opinions from those that are irrelevant. • Take notes when prompted. B. Listen to a selection of literature (fiction and/or nonfiction). • Relate it to what is known. • Predict the result of the story actions. • Retell actions of the story in sequence, explain the theme and describe the characters and setting. • Identify and define new words and concepts. • Summarize the selection.	A. Listen to others. • Ask probing questions. • Analyze information, ideas and opinions to determine relevancy. • Take notes when needed. B. Listen to selections of literature (fiction and/or nonfiction). • Relate them to previous knowledge. • Predict content/events. • Summarize events and identify the significant points. • Identify and define new words and concepts. • Analyze the selections.	A. Listen to others. • Ask clarifying questions. • Synthesize information, ideas and opinions to determine relevancy. • Take notes. B. Listen to selections of literature (fiction and/or nonfiction). • Relate them to previous knowledge. • Predict solutions to identified problems. • Summarize and reflect on what has been heard. • Identify and define new words and concepts. • Analyze and synthesize the selections relating them to other selections heard or read.

C. Speak using skills appropriate to formal speech situations. • Use appropriate volume. • Pronounce most words accurately. • Pace speech so that is understandable. • Demonstrate an awareness of audience. D. Contribute to discussions. • Ask relevant questions. • Respond with appropriate information or opinions to questions asked. • Listen to and acknowledge the contributions of others. • Display appropriate turn-taking behaviors.	C. Speak using skills appropriate to formal speech situations. • Use complete sentences. • Pronounce words correctly. • Use appropriate volume. • Pace speech so that it is understandable. • Adjust content for different audiences (e.g., fellow classmates, parents). • Speak with a purpose in mind. D. Contribute to discussions. • Ask relevant questions. • Respond with relevant information or opinions to questions asked. • Listen to and acknowledge the contributions of others. • Adjust involvement to encourage equitable participation. • Give reasons for opinions. • Summarize, when prompted.	C. Speak using skills appropriate to formal speech situations. • Use complete sentences. • Pronounce words correctly. • Adjust volume to purpose and audience. • Adjust pace to convey meaning. • Add stress (emphasis) and inflection to enhance meaning. D. Contribute to discussions. • Ask relevant, probing questions. • Respond with relevant information, ideas or reasons in support of opinions expressed. • Listen to and acknowledge the contributions of others. • Adjust tone and involvement to encourage equitable participation. • Clarify, illustrate or expand on a response when asked. • Present support for opinions.	C. Speak using skills appropriate to formal speech situations. • Use a variety of sentence structures to add interest to a presentation. • Pace the presentation according to audience and purpose. • Adjust stress, volume and inflection to provide emphasis to ideas or to influence the audience. D. Contribute to discussions. • Ask relevant, clarifying questions. • Respond with relevant information or opinions to questions asked. • Listen to and acknowledge the contributions of others. • Adjust tone and involvement to encourage equitable participation. • Facilitate total group participation. • Introduce relevant, facilitating information, ideas and opinions to enrich

		• Paraphrase and summarize, when prompted.	the discussion. • Paraphrase and summarize as needed.
E. Participate in small and large group discussions and presentations. • Participate in everyday conversation. • Present oral readings. • Deliver short reports (e.g., Show-and-Tell, field trip summary). • Conduct short interviews. • Give simple directions and explanations. • Report an emergency.	E. Participate in small and large group discussions and presentations. • Participate in everyday conversation. • Present an oral reading. • Deliver research reports. • Conduct interviews. • Plan and participate in group presentations. • Contribute to informal debates.	E. Participate in small and large group discussions and presentations. • Initiate everyday conversation. • Select a topic and present an oral reading. • Conduct interviews as part of the research process. • Organize and participate in informal debates.	E. Participate in small and large group discussions and presentations. • Initiate everyday conversation. • Select and present an oral reading on an assigned topic. • Conduct interviews. • Participate in a formal interview (e.g., for a job, college). • Organize and participate in informal debate around a specific topic. • Use evaluation guides (e.g., National Issues Forum, Toastmasters) to evaluate group discussion (e.g., of peers, on television).
F. Use media for learning purposes. • Explain the importance of television, radio, film and Internet in the lives of people.	F. Use media for learning purposes. • Compare information received on television with that received on radio or in newspapers.	F. Use media for learning purposes. • Describe how the media	F. Use media for learning purposes. • Use various forms of media

• Explain how advertising sells products. • Show or explain what was learned (e.g., audiotape, computer download).	• Access information on Internet. • Discuss the reliability of information received on Internet sources. • Explain how film can represent either accurate versions or fictional versions of the same event. • Explain the role of advertisers in the media. • Use a variety of images and sounds to create an effective presentation on a topic.	provides information that is sometimes accurate, sometimes biased based on a point of view or by the opinion or beliefs of the presenter. • Analyze the role of advertising in the media. • Create a multimedia (e.g., film, music, computer-graphic) presentation for display or transmission.	to elicit information, to make a student presentation and to complete class assignments and projects. • Evaluate the role of media in focusing attention and forming opinions. • Create a multi-media (e.g., film, music, computer-graphic) presentation for display or transmission that demonstrates an understanding of a specific topic or issue or teaches others about it.

1.7. Characteristics and Functions of the English Language

1.7.3. **GRADE 3**	1.7.5. **GRADE 5**	1.7.8. **GRADE 8**	1.7.11. **GRADE 11**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:			
A. Identify words from other languages that are commonly used English words. B. Identify variations in the dialogues of literary characters and relate them to differences in occupation or geographical location.	A. Identify words from other languages that are commonly used English words. Use a dictionary to find the meanings and origins of these words. B. Identify differences in formal and informal speech (e.g., dialect, slang, jargon). C. Identify word meanings that have changed over time (e.g., cool, mouse).	A. Describe the origins and meanings of common, learned and foreign words used frequently in English language (e.g., carte blanche, faux pas). B. Analyze the role and place of standard American English in speech, writing and literature. C. Identify new words that have been added to the English language over time.	A. Describe the influence of historical events on the English language. B. Analyze when differences in language are a source of negative or positive stereotypes among groups. C. Explain and evaluate the role and influence of the English language within and across countries.

1.8. Research			
1.8.3. **GRADE 3**	1.8.5. **GRADE 5**	1.8.8. **GRADE 8**	1.8.11. **GRADE 11**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:			
A. Select a topic for research. B. Locate information using appropriate sources and strategies. • Locate resources for a particular task (e.g., newspapers, dictionary). • Select sources (e.g., dictionaries, encyclopedias, interviews to write a family history, observations, electronic media). • Use tables of contents, key words and guide words. • Use traditional and electronic search tools.	A. Select and refine a topic for research. B. Locate information using appropriate sources and strategies. • Evaluate the usefulness and qualities of the sources. • Select appropriate sources (e.g., dictionaries, encyclopedias, other reference materials, interviews, observations, computer databases). • Use tables of contents, indices, key words, cross-references and appendices. • Use traditional and electronic search tools.	A. Select and refine a topic for research. B. Locate information using appropriate sources and strategies. • Determine valid resources for researching the topic, including primary and secondary sources. • Evaluate the importance and quality of the sources. • Select essential sources (e.g., dictionaries, encyclopedias, other reference materials, interviews, observations, computer databases). • Use tables of contents,	A. Select and refine a topic for research. B. Locate information using appropriate sources and strategies. • Determine valid resources for researching the topic, including primary and secondary sources. • Evaluate the importance and quality of the sources. • Select sources appropriate to the breadth and depth of the research (e.g., dictionaries, thesauruses, other reference materials, interviews, observations, computer databases).

C. Organize and present the main ideas from research. • Take notes from sources using a structured format. • Summarize, orally or in writing, the main ideas.	C. Organize and present the main ideas from research. • Take notes from sources using a structured format. • Present the topic using relevant information. • Credit sources using a structured format (e.g., author, title).	indices, key words, cross-references and appendices. • Use traditional and electronic search tools. C. Organize, summarize and present the main ideas from research. • Identify the steps necessary to carry out a research project. • Take relevant notes from sources. • Develop a thesis statement based on research. • Give precise, formal credit for others' ideas, images or information using a standard method of documentation. • Use formatting techniques to create an understandable presentation for a designated audience.	• Use tables of contents, indices, key words, cross-references and appendices. • Use traditional and electronic search tools. C. Organize, summarize and present the main ideas from research. • Take notes relevant to the research topic. • Develop a thesis statement based on research. • Anticipate readers' problems or misunderstandings. • Give precise, formal credit for others' ideas, images or information using a standard method of documentation. • Use formatting techniques (e.g., headings, graphics) to aid reader understanding.

III. GLOSSARY

Alliteration: The repetition of initial consonant sounds in neighboring words.

Allusion: An implied or indirect reference in literature to a familiar person, place or event.

Analysis: The process or result of identifying the parts of a whole and their relationships to one another.

Antonym: A word that is the opposite of another word.

Characterization: The method an author uses to reveal characters and their various personalities.

Compare: Place together characters, situations or ideas to show common or differing features in literary selections.

Context clues: Information from the reading that identifies a word or group of words.

Conventions of

language: Mechanics, usage and sentence completeness.

Evaluate: Examine and judge carefully.

Figurative language: Language that cannot be taken literally since it was written to create a special effect or feeling.

Fluency: The clear, easy, written or spoken expression of ideas. Freedom from word-identification problems which might hinder comprehension in silent reading or the expression of ideas in oral reading.

Focus: The center of interest or attention.

Genre: A category used to classify literary works, usually by form, technique or content (e.g., prose, poetry**)**.

Graphic organizer: A diagram or pictorial device that shows relationships.

Homophone: One of two or more words pronounced alike, but different in spelling or meaning (e.g., hair/hare, scale (fish)/scale (musical)).

Hyperbole: An exaggeration or overstatement (e.g., *I was so embarrassed I could have died*.).

Idiomatic language: An expression peculiar to itself grammatically or that cannot be understood if taken literally (e.g., *Let's get on the ball.*).

Irony: The use of a word or phrase to mean the exact opposite of its literal or usual meaning; incongruity between the actual result of a sequence of events and the expected result.

Literary conflict: The struggle that grows out of the interplay of the two opposing forces in a plot.

Literary elements: The essential techniques used in literature (e.g., characterization, setting, plot, theme).

Literary devices: Tools used by the author to enliven and provide voice to the writing (e.g., dialogue, alliteration).

Literary structures: The author's method of organizing text (e.g., foreshadowing, flashbacks).

Metaphor: The comparison of two unlike things in which no words of comparison (*like* or *as*) are used (e.g., *That new kid in class is really a squirrel.*).

Meter: The repetition of stressed and unstressed syllables in a line of poetry.

Narrative: A story, actual or fictional, expressed orally or in writing.

Paraphrase: Restate text or passage in other words, often to clarify meaning or show understanding.

Pattern book: A book with a predictable language structure and often written with predictable text; also known as predictable book.

Personification: An object or abstract idea given human qualities or human form (e.g., *Flowers danced about the lawn.*).

Phonics: The relationship between letters and sounds fundamental in beginning reading.

Point of view: The way in which an author reveals characters, events and ideas in telling a story; the vantage point from which the story is told.

Public document: A document that focuses on civic issues or matters of public policy at the community level and beyond.

Reading critically: Reading in which a questioning attitude, logical analysis and inference are used to judge the worth of text; evaluating relevancy and adequacy of what is read; the judgement of validity or worth of what is read, based on sound criteria.

Reading rate: The speed at which a person reads, usually silently.

Research: A systematic inquiry into a subject or problem in order to discover, verify or revise relevant facts or principles having to do with that subject or problem.

Satire: A literary tone used to ridicule or make fun of human vice or weakness.

Self-monitor: Know when what one is reading or writing is not making sense; adjust strategies for comprehension.

Semantics: The study of meaning in language.

Simile: A comparison of two unlike things in which a word of comparison (*like* or *as)* is used (e.g., *She eats like a bird.).*

Sources:

Primary: Text and/or artifacts that tell or show a first-hand account of an event; original works used when researching.

Secondary: Text and/or artifacts used when researching that are derived from something original.

Subject area: An organized body of knowledge; a discipline; a content area.

Style: How an author writes; an author's use of language; its effects and appropriateness to the author's intent and theme.

Synonym: One of two or more words in a language that have highly similar meanings (e.g., sorrow, grief, sadness).

Syntax: The pattern or structure of word order in sentences, clauses and phrases.

Theme: A topic of discussion or writing; a major idea broad enough to cover the entire scope of a literary work.

Thesis: The basic argument advanced by a speaker or writer who then attempts to prove it; the subject or major argument of a speech or composition.

Tone: The attitude of the author toward the audience and characters (e.g., serious or humorous).

Voice: The fluency, rhythm and liveliness in writing that makes it unique to the writer.

Appendix B

Multiple-Choice Item Tables

Table B-1. 2001 Grade 5 Reading Multiple-Choice Items

	Standard																						
	1								2			3						7			8		
	A	B	C	D	E	F	G	H	A	B	C	A	B	C	D	E	F	A	B	C	A	B	C
Form A	1	1		1	1	1	1		6			2	2	1				2	1	1		4	
Form B	1		1	2		1			6			2	2					1	2	1		4	
Form C				3	1		1		5			3	1	1				1	2	1		3	
Form D		1	1	2	2				6			2	3	1				1	2	1		2	1
Form E		2		1	1		1		7			1	3	1				2	1			4	
Form F		1	1	2	2				5			2	2	1				2	2			2	2
Form G	1		1	2	2				5			3	2					3	1			4	
Form H	1		1	1	2	1	1		7			1	3	1				2		1		4	
Form I	1	1		1	1	1	1		6			2	2	1				2	1	1		4	
Form J	1		1	2	1	1			5			2	2					1	2	1		4	
Total	6	6	6	17	13	5	5	0	58	0	0	20	22	7	0	0	0	17	14	7	0	35	3
Matrix Total	58								58			49						38			38		
Form W	1	3	3	1	0	1	1	0	12	0	0	6	3	3	0	0	0	3	3	1	3	5	0
Common Items Total	12								12			12						7			8		
Total by Substandard	7	9	9	18	13	6	6	0	70	0	0	8	25	10	0	0	0	20	17	8	3	40	3
Final Total	70								70			61						45			46		

Table B-2. 2001 Grade 5 Math Multiple-Choice Items

	Standard																																
Form	1							2									3					4						6				
	A	B	C	D	E	F	G	A	B	C	D	E	F	G	H	I	A	B	C	D	E	A	B	C	D	E	F	A	B	C	D	E
A		1		1	1			1	1								1		1						1							1
B		1		1			1	1								1	1			1			1						1	1		
C	1			1			1		1			1		1			1				1					1		1				
D				1	1		1	1	1	1									1		1								1			
E	1			1			1		1					1			1	1					1						2			
F	1	1		1				1		1							1		1									1		1		
G	1			1			1	1				1					1			1				1								1
H		1		1		1		1		1	1						1				1							1			1	
I		1				1					1			1		1	1					1									1	1
J		1			1	1				1				1			1			1					1			1	1			
Total	4	6		8	3	3	5	6	4	4	2	2		4		2	9	1	3	3	3	1	2	1	2	1		4	5	2	2	3
Matrix Total	29							24									19					7						16				
W	1	2		2	1	1	2	2	3	2		2		2	2		4	2	1	1	1	1		2	1	1		2	1	1	1	2
Common Items Total	9							13									9					5						7				
Total by Substandard	5	8	0	10	4	4	7	8	7	6	2	4	0	6	2	2	13	3	4	4	4	2	2	3	3	2	0	6	6	3	3	5
Final Total	38							37									28					12						23				

Table B-2. 2001 Grade 5 Math Multiple-Choice Items (Continued)

	Standard																																						
Form	7										8									9											10		11				
	A	B	C	D	E	F	G	H	I	J	A	B	C	D	E	F	G	H	I	A	B	C	D	E	F	G	H	I	J	K	L	A	B	A	B	C	D	E
A									1									1								1			1			1		1				
B								1			1													1					1			1						
C							1				1						1														1		1					
D			1															1										1			1	1		1				
E														1							1			1								1						1
F					1											1					1	1										1					1	
G										1	1																1			1		1		1				
H																	1								1			1				1					1	
I		1										1		1						1											1							
J				1							1																		1			1			1			
Total		1	1	1	1		1	1	1	1	4	1		2		1	2	2		1	2	1		2	1	1	1	2	3	1	3	8	1	3	1		2	1
Matrix Total	8										12									18												9		7				
W		1	1		1	1		1			2		1	1		1	1	1		1	1				1				1		1	4	1	1	1	1	1	1
Common Item Total	5										7									5												5		5				
Total by Substandard	0	2	2	1	2	1	1	2	1	1	6	1	1	3	0	1	1	3	0	2	3	1	0	2	2	1	1	2	4	1	4	12	2	4	2	1	3	2
Final Total	13										19									23												14		12				

Table B-3. 2001 Grade 8 Reading Multiple-Choice Items

	Standard																						
	1								2			3						7			8		
	A	B	C	D	E	F	G	H	A	B	C	A	B	C	D	E	F	A	B	C	A	B	C
Form A	1		1	2	1	1	2		6	1		2	2	3				1	1	3	1	3	1
Form B		1	2	1		2			6	1		4		3				3	1	1		4	1
Form C		2	1		1		3		7	1		2	2	4				3	1	1		5	
Form D	1		2		1	1	3		8	1		4	1	3				3		2	2	2	1
Form E		1	1		2		2		8			2	3	2				2	3	1		5	1
Form F		1	1	3	1	1	1		5	1		5	1	4					2	2	1	4	1
Form G		1	1	1		2	2		8	1		3	1	2				3		1		4	
Form H		1	1						7	1		2	1	4				2	1	3		4	
Form I	2		2						7	1		2	2	2				3		2	2	2	
Form J		1	2						7			3	2	2				1	3	2		5	1
Total	4	8	14	7	6	7	13		69	8		29	15	29				21	12	18	6	38	6
Matrix Total	59								77			73						51			50		
Form W	2	2	4	3	1	2	2		16			6	4	5		1		7	2	2	3	5	4
Common Items Total	16								16			16						11			12		
Total by Substandard	6	10	18	10	7	9	15	0	85	8	0	35	19	34	0	1	0	28	14	20	9	43	10
Final Total	75								93			89						62			62		

Table B-4. 2001 Grade 8 Math Multiple-Choice Items

	Standard																															
Form	1							2									3						4					6				
	A	B	C	D	E	F	G	A	B	C	D	E	F	G	H	I	A	B	C	D	E	F	A	B	C	D	E	A	B	C	D	E
A	1	1									1									1						1					1	
B	1			1					2									1		1			1									1
C	1	1							1	1							1	1				1		1								1
D		1		1		1			1	1			1					1		1						1						1
E	1			1					2										1						1							
F	1								2								1			1						1					1	1
G	2								1								1			1		1			1				1			
H								1	1	1	1								1	1				1								
I	1					1			2				1				1			1					1							
J	1		1					1				1											1						1			
Total	9	3	1	3		2		2	12	3	2	1	2				4	3	2	7		2	2	2	3	3			2		2	4
Matrix Total	18							22									18						10					8				
W	1	1	1	1		2			10				2							3		1		3	1			1	1		1	
Common Items Total	6							12									4						4					3				
Total by Substandard	10	4	2	4	0	4	0	2	22	3	2	1	4	0	0	0	4	3	2	10	0	3	2	5	4	3	0	1	3	0	3	4
Final Total	24							34									22						14					11				

Table B-4. 2001 Grade 8 Math Multiple-Choice Items (Continued)

	Standard																																					
Form	7										8										9											10		11				
	A	B	C	D	E	F	G	H	I	J	A	B	C	D	E	F	G	H	I	J	A	B	C	D	E	F	G	H	I	J	K	A	B	A	B	C	D	E
A	1												1		1												1						1			1		
B					1										1					1											1	1			1	1		
C					1												1							2								1						
D													2									1										1			1			
E					1										1		1							1									1			1		
F					1								2		1									1								1		1				
G		1			1						1											1										1				1		
H					1								1		1		1			1		1											1					
I	1												1		2							1											1	1				
J													1		1					1		1		1								1			1			
Total	2	1			6						1		8		8		3			3		5		5			1				1	6	4	2	3	4		
Matrix Total	9										23										12											10		9				
W	1		1		2						3	1	6				2	1				1		7	1							3	1		2	2		
Common Item Total	4										13										9											4		4				
Total by Substandard	3	1	1	0	8	0	0	0	0	0	4	1	14	0	8	0	5	1	0	3	0	6	0	12	1	0	1	0	0	0	1	9	5	2	5	6	0	0
Final Total	13										36										21											14		13				

Table B-5. 2001 Grade 11 Reading Multiple-Choice Items

	Standard																						
	1								2			3						7			8		
	A	B	C	D	E	F	G	H	A	B	C	A	B	C	D	E	F	A	B	C	A	B	C
Form A	2	1	1		1		1		9			1	2	3				6	4		2	4	
Form B	2	1	2	2	1		1		7				1	5		1		7	7		1	7	
Form C	2	1	2	1		1			9				3	4				6	7		1	7	
Form D		2	2	1			1		8			1	4	3				6	3	1		3	1
Form E		1	2		1		2		6			2		5				4	3	1	1	3	1
Form F	1	2	3				1		7			1	2	5				6	5		2	5	
Form G	1	2	1	1		1	1		9				1	6				7	9			9	
Form H	1	1	1	1		2			7				3	4				5	5		1	5	
Form I	2		1	1	1		1		9			1	2	3				6	4		2	4	
Form J	2	1	2	2	1		1		7				1	5		1		7	7		1	7	
Total	13	12	17	9	5	4	9		78			6	19	43		2		60	54	2	11	54	2
Matrix Total	69								78			70						116			67		
Form W		2	1	6	2	1	7		15	1		6	5	5		1	1	8	10	2	3	10	2
Common Items Total	19								16			18						20			15		
Total by Substandard	13	14	18	15	7	5	16	0	93	1	0	12	24	48	0	3	1	68	64	4	14	64	4
Final Total	88								94			88						136			82		

Table B-6. 2001 Grade 11 Math Multiple-Choice Items

	Standard																																
Form	1							2									3						4					6				
	A	B	C	D	E	F	G	A	B	C	D	E	F	G	H	I	A	B	C	D	E	F	A	B	C	D	E	A	C	D	E	I
A	2							1																					1			
B	1										1																			1		
C	1																										1					
D	2							1		1																						
E	1							2			1						1								1							
F																																
G	1																		1								1				1	1
H									2								1											1				
I								1	1								1										1					
J								2									1															
Total	8							7	3	1	2						4		1						1		3	1	1	1	1	1
Matrix Total	8							13									5						4					5				
W	1							2	2		2	1					1	1						1	1						1	
Common Items Total	1							7									2						2					1				
Total by Substandard	9	0	0	0	0	0	0	9	5	1	4	1	0	0	0	0	5	1	1	0	0	0	0	1	2	0	3	1	1	1	2	1
Final Total	9							20									7						6					6				

Table B-6. 2001 Grade 11 Math Multiple-Choice Items (Continued)

	Standard																																						
Form	7								8												9											10		11				
	A	B	C	D	E	F	G	H	A	C	D	E	F	G	I	J	L	N	O	Q	A	B	C	D	E	F	G	H	I	J	K	A	B	A	B	C	D	E
A		1										2								1																	1	
B					1					2	1																						2					
C				1	1						1																			1		1	1					1
D				1								1						1	1											1			1					
E	1													1	1																		1					
F										2		1											1			1											
G				1					1					1		1								1									1					
H		1												1			2						1							1			1					
I												2													2													
J				1								1			1																		1					1
Total	1	2		4	2				1	4	2	7		3	2	1	2	1	1	1			2	1	2	1				3		1	8				1	2
Matrix Total	9								25												9											9		3				
W	1			2				1			4			2		2		2	1			2	1	1	2	1	1			1		1	3			1	1	
Common Item Total	4								11												9											4		2				
Total by Substandard	2	2	0	6	2	0	0	1	1	4	6	7	0	5	2	3	2	3	2	1	0	2	3	2	4	2	1	0	0	4	0	2	11	0	0	1	2	2
Final Total	13								36												18											13		5				

Table B-7. 2002 Grade 5 Reading Multiple-Choice Items

	Standard																						
	1								2			3						7			8		
	A	B	C	D	E	F	G	H	A	B	C	A	B	C	D	E	F	A	B	C	A	B	C
Form A	1		1		2		2		5	1		4		2				2		2		4	
Form B	1		1	1	1		2		5			4	2					1		2		4	
Form C		2	1	1	1		1		5	1		4	1	1				1	1	2	1	3	
Form D			2		1	1	2		6			4	2					1		2		3	
Form E	1		1		1				4			3		1				1		1		2	
Form F	2		1		1		1		4			2	1	1				1		2		2	
Form G		1	1	1	2				4	1		2	1	2					1	1		2	
Form H			2		1	2	1		3			2	1	1						1		2	
Form I					1		2		3			1		3				1		1		2	
Form J	1			1			3		3			2	1	1				2				2	
Form K		1	2		1		1		5	1		2		3				1		1	1	1	
Form L			2			1	3		3			2	1	1				1		1		1	
Total	6	4	14	4	12	4	18		50	4		32	10	16				12	2	16	2	28	
Matrix Total	62								54			58						30			30		
Form W		3	3	1	2		3		5	3		5	4	3				3	3	2	2	5	1
Common Items Total	12								8			12						8			8		
Total by Substandard	6	7	17	5	14	4	21	0	55	7	0	37	14	19	0	0	0	15	5	18	4	33	1
Final Total	74								62			70						38			38		

Table B-8. 2002 Grade 5 Math Multiple-Choice Items

	Standard																															
Form	1							2									3					4						6				
	A	B	C	D	E	F	G	A	B	C	D	E	F	G	H	I	A	B	C	D	E	A	B	C	D	E	F	A	B	C	D	E
A				1	1		1	1	1	1							1							1					1			1
B		1		1		1			1					1		1				1				1					1			1
C	1			1			1		1	1		1									1				1			1				1
D		1		1			1	1	1							1					1								1			
E		1					1		1			1					1								1					1		1
F		1		1		1				1						1			1				1									
G		1			1		1	1		1										1				1				1				
H	1	1		1	1	1		1			1																	1				
I	1	1		1			1	1		1				1					1									1				
J	1	1				1		1		1	1						1					1									1	
K	1	1		1			1	1		1				1			1										1		1			
L				1		1			1	1		1					1	1								1		1				
Total	5	9		9	3	5	7	7	6	8	2	3		3		3	5	1	2	2	2	1	1	3	2	1	1	5	4	1	1	4
Matrix Total	38							32									12					9						15				
W	1	2		1	1	1	2	3	2	2	1	2		2	1	1	3	2	1	1	2	1	2		1	1		1	1	1	1	1
Common Items Total	8							14									9					5						5				
Total by Substandard	6	11	0	10	4	6	9	10	8	10	3	5	0	5	1	4	8	3	3	3	4	2	3	3	3	2	1	6	5	2	2	5
Final Total	46							46									21					14						20				

Table B-8. 2002 Grade 5 Math Multiple-Choice Items (Continued)

	Standard																																						
Form	7										8									9											10		11					
	A	B	C	D	E	F	G	H	I	J	A	B	C	D	E	F	G	H	I	A	B	C	D	E	F	G	H	I	J	K	L	A	B	A	B	C	D	E	
A											1										1								1			1		1					
B											1							1											1			1		1					
C																				1											1	1					1		
D				1							1									1										1		1	1		1				
E		1												1															1		1	1							
F					1								1							1		1										1					1		
G										1	1		1				1							1		1						1				1			
H								1										1							1			1				1							
I									1						1						1				1		1					1		1					
J								1				1										1										1						1	
K							1									1								1							1	1							
L					1									1							1								1			1							
Total		1		1	2		1	2	1	1	4	1	2	2	1	1	1	2		3	3	2		2	2	1	1	1	4	1	3	12	1	3	1	1	2	1	
Matrix Total	9										14									23												13		9					
W		1	1		1		1		1		2	1		2		1		1		1	1							1	1		1	4	1	2	1		1	1	
Common Item Total	5										7									5												5		5					
Total by Substandard	0	2	1	1	3	0	2	2	2	1	6	2	2	4	1	2	1	3	0	4	4	2	0	2	2	1	1	2	5	1	4	16	2	5	2	1	3	2	
Final Total	14										21									28												18		14					

Table B-9. 2002 Grade 8 Reading Multiple-Choice Items

	Standard																						
	1								2			3						7			8		
	A	B	C	D	E	F	G	H	A	B	C	A	B	C	D	E	F	A	B	C	A	B	C
Form A	3		2	1	1	1			7			4	2	3				4				6	1
Form B	1		1	3	3		1		8			3	3			1	1	3		1		6	1
Form C	1	1	1	2	2		2		9			6	2	1				2				5	2
Form D			2		3	2	2		9			4	2	2				3	1			5	1
Form E	4	1	2	1	1				8			5	1	2				2	1	1		5	1
Form F	1	1	1	1	3		1		8			5	1	1		1		3	1	1	1	5	1
Form G	2	1	2		1		1		8			3	5	2				2	2			6	1
Form H	2		1		2		2		9			3	3	3				3	2			6	
Form I	1	1	2	2		1			7			3	3	3				4	1	1		7	
Form J	2	1	2	2	4				8			4	2	1			1	2	1		1	5	
Form K	1	2	1	2	3		1		9			3	3	1				2	2			5	1
Form L	2		3		1	2	2		8			1	3	3				4	1			5	1
Total	20	8	20	14	24	6	12		80			44	30	22		2	2	34	12	4	2	66	10
Matrix Total	104								80			100						50			78		
Form W		3	4	1	2	2	4		15	1		6	3	7				7	2	3	2	7	3
Common Items Total	16								16			16						12			12		
Total by Substandard	20	11	24	15	26	8	16	0	95	1	0	50	33	29	0	2	2	41	14	7	4	73	13
Final Total	120								96			116						62			90		

Table B-10. 2002 Grade 8 Math Multiple-Choice Items

Standard

Form	1							2							3							4						6				
	A	B	C	D	E	F	G	A	B	C	D	E	F	G	A	B	C	D	E	F	G	A	B	C	D	E	F	A	B	C	D	E
A		1				1					1					1		1				1									1	
B				1		1			2							1						1										1
C	1	1							1	1					1					1	1		1									
D		1		1		1			1	1								1	1								1			1		
E	1			1					2								1							1								1
F	1								2				1		1			1							1						1	
G	2								1						1			1		1				1					1			1
H								1	2	1							1	1					1									
I	1					2			2						1			1						1								
J			1		1							2								1		1										1
K	1		1					1								1	1			1				1				1				
L				1				1									1	1					1					1				
Total	7	3	2	4	1	5		3	13	3	1	2	1		4	3	4	7	1	4	1	3	3	4	1		1	2	1	1	2	4
Matrix Total	22							23							24							12						10				
W	5			1		1		2	7		1					3		3		1		1		1	2				1		1	2
Common Items Total	7							10							7							4						4				
Total by Substandard	12	3	2	5	1	6	0	5	20	3	2	2	1	0	4	6	4	10	1	5	1	4	3	5	3	0	1	2	2	1	3	6
Final Total	29							33							31							16						14				

Table B-10. 2002 Grade 8 Math Multiple-Choice Items (Continued)

	Standard																																					
Form	7										8										9											10		11				
	A	B	C	D	E	F	G	H	I	J	A	B	C	D	E	F	G	H	I	J	A	B	C	D	E	F	G	H	I	J	K	A	B	A	B	C	D	E
A	1												3														1						1			1		
B					1									1	1					1				1								1				2		
C	1												1		1		1							2									1					
D	1												2		1																	1			1			
E					1							1	1											1								1				1		
F					1								2		1									1								1		1				
G		1			1																	1										1		1		1		
H					1								1		1		1			1		1											1					
I	1														1			1																	1			
J													1	1	1							1			1							1			1			
K			1									1	1																				1	1				
L					1						1	1	2											1								2				1		
Total	4	1	1		6						1	3	14	2	7		2	1		2		3		5	1		1					8	4	3	3	6		
Matrix Total	12										32										10											12		12				
W		1			1								5		6		2			1		4		4							1	2	2		2	2		
Common Item Total	2										14										9											4		4				
Total by Substandard	4	2	1	0	7	0	0	0	0	0	1	3	19	2	13	0	4	1	0	3	0	7	0	9	1	0	1	0	0	0	1	10	6	3	5	8	0	0
Final Total	14										46										19											16		16				

Table B-11. 2002 Grade 11 Reading Multiple-Choice Items

	Standard																						
	1								2			3						7			8		
	A	B	C	D	E	F	G	H	A	B	C	A	B	C	D	E	F	A	B	C	A	B	C
Form A	1	2	1			2	2		7	1		2	1	5				7	1		1	7	
Form B		1	1	2			4		7	1		1	3	4				6	1	1		7	1
Form C			1	1	2		3	1	7	1		1	1	6				6		1		7	1
Form D		1		1	1	1	4		7	1		1	2	5				4	1	1		7	1
Form E	1	1	1	1	1	1	2		7	1		3	1	4				8			2	5	1
Form F	1		1	2	1		3		8			2	2	4				7		1		6	2
Form G		1		2	2		2	1	8			1	2	4			1	7		1		6	2
Form H	1			2		1	4		8			2	1	4			1	7		1		5	3
Form I	2	1	2	1	1	1			8			3	2	3				7	1		1	6	1
Form J	1	1	2	2	1		1		7	1		3	1	4				7	1			7	1
Form K		1	1	3	2		1		7	1		2	1	4			1	7				7	1
Form L	1	1		3	1		2		7	1		1	3	3			1	5	1			6	2
Total	8	10	10	20	12	6	28	2	88	8		22	20	50			4	78	6	6	4	76	16
Matrix Total	96								96			96						90			96		
Form W	1	2	2	4	2	2	5		15	1		3	5	8		1	1	10		1	2	13	1
Common Items Total	18								16			18						11			16		
Total by Substandard	9	12	12	24	14	8	33	2	103	9	0	25	25	58	0	1	5	88	6	7	6	89	17
Final Total	114								112			114						101			112		

Table B-12. 2002 Grade 11 Math Multiple-Choice Items

	Standard																																
Form	1							2								3						4					6					
	A	B	C	D	E	F	G	A	B	C	D	E	F	G	H	A	B	C	D	E	F	A	B	C	D	E	A	C	D	E	H	I
A	1							1									1							1				1				
B	1								1								1									1						1
C								2	1							1																
D	1							1										1				1									1	
E	1							1		1								1									1					1
F	1							1															1					1				
G	1									1								2				1						1				
H								1		1													1									
I									1							1																
J	2									1																				1		
K								1		1							1	1														
L	1																									1						
Total	9							8	3	5						2	3	5				2	2	1		2	1	3		1	1	2
Matrix Total	9							16								10						7					8					
W	3							7	1		1					2								1		2			1	1		1
Common Items Total	3							9								2						3					3					
Total by Substandard	12	0	0	0	0	0	0	15	4	5	1	0	0	0	0	4	3	5	0	0	0	2	2	2	0	4	1	3	1	2	1	3
Final Total	12							25								12						10					11					

Table B-12. 2002 Grade 11 Math Multiple-Choice Items (Continued)

	Standard																																						
Form	7					8																	9									10		11					
	A	B	C	D	E	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	A	B	C	D	E	F	H	I	J	A	B	A	B	C	D	E
A		1							1							1						1		1					1								1	
B					1				1								3				1			1						1			1					
C								1									1		1								2					1						
D					1	1				1					1			1	1					1							1	1						
E				1						1										1						2							1				1	
F					1	1							1	1					1							1							1	1				
G					2			1											1			1															
H					1			2												1								1					1			1		
I		1					1				1	1	1											1												1		
J				1					1					1																	1		1					
K	1	1						1								1	1		1					1									1					
L	1			1		1											1								1							1					1
Total	2	3		3	6	3	1	5	3	2	1	1	2	2	1	2	6	1	5	2	1	2		5	1	3	2	1	1	1	2	3	6	1		2	2	1
Matrix Total	14					40																	16									9		6					
W	1			1	2			2	1	1				1	1			1		1	1	1				1		1			1	1	3					2
Common Item Total	4					10																	3									4		2					
Total by Substandard	3	3	4	4	8	3	1	7	4	3	1	1	2	3	2	2	6	2	5	3	2	3	0	5	1	4	2	2	1	1	3	4	9	1	0	2	2	3
Final Total	18					50																	19									13		8					

Table B-13. 2003 Grade 5 Reading Multiple-Choice Items

	Standard																						
	1								2			3						7			8		
	A	B	C	D	E	F	G	H	A	B	C	A	B	C	D	E	F	A	B	C	A	B	C
Form A	1		1		2		2		1			4	1	1				1		3		4	
Form B	2		1		2		1		2			3		2			1	2	1	1		4	
Form C	1		2	1	1		1		1			3	2	1				3		1		4	
Form D	1		1	1	1	1	1		1			3	1	1			1	1	1	2		4	
Form E		1			1		4					2	2	2				1	1	2		4	
Form F	1		1	1	1		2		1			1	1	3			1	2	2			4	
Form G			2	1			3					1	3	2				3		1		4	
Form H				3	2	1	1					1	2	1			1	1	1	2		4	
Form I	1	1	1		1		2		1			4	1	1				2	1	1		4	
Form J	1		2	1	1		1		1			4	1	1				2	1	1		4	
Form K	1		2		1		2		1			4	1	1				2		2		4	
Form L	1		1	2	3				1			4	1					2		2		4	
Total	10	2	14	10	16	2	20		10			34	16	16			4	22	8	18		48	
Matrix Total	74								10			70						48			48		
Form W	1	3	2	1		3	3		1	1		4	3	3				2	3	1	3	3	
Common Items Total	13								2			10						6			6		
Total by Substandard	11	5	16	11	16	5	23	0	11	1	0	38	19	19	0	0	4	24	11	19	3	51	0
Final Total	87								12			80						54			54		

Table B-14. 2003 Grade 5 Math Multiple-Choice Items

	Standard																															
Form	1							2									3					4						6				
	A	B	C	D	E	F	G	A	B	C	D	E	F	G	H	I	A	B	C	D	E	A	B	C	D	E	F	A	B	C	D	E
A	1			1	1		1	1				1					1					1							1		1	
B	1			1	1	1		1	1								1							1								1
C		1		1			1		1	1		1					1							1								1
D		1		1			1	1	1	1							1								1				1			
E		1		1			1	1		1											1				1						1	
F		1		1		1				1	1			1			1				1					1						
G		1	1				1		1					1	1			1		1				1					1			
H		1			1						1			1				1		1					1			1				
I	1	1		1				1			1			1			1		1										1			
J	1					1		1	1					1			1													1		
K		1			1		1	1		1						1	1				1											1
L		1		1		1	1		1	1								1								1		1		1		
Total	4	9	1	8	4	4	7	7	6	6	3	2		5	1	1	8	3	1	2	3	1		3	3	2		2	4	2	2	3
Matrix Total	37							31									17					9						13				
W	1	2		2	1	1	2	3	3	2	1	1		2	1	1	1	2	1		1	1	1	2	1			2	3	1	1	1
Common Items Total	9							14									5					5						8				
Total by Substandard	5	11	1	10	5	5	9	10	9	8	4	3	0	7	2	2	9	5	2	2	4	2	1	5	4	2	0	4	7	3	3	4
Final Total	46							45									22					14						21				

Table B-14. 2003 Grade 5 Math Multiple-Choice Items (Continued)

	Standard																																						
Form	7										8									9												10		11					
	A	B	C	D	E	F	G	H	I	J	A	B	C	D	E	F	G	H	I	A	B	C	D	E	F	G	H	I	J	K	L	A	B	A	B	C	D	E	
A								1								1						1							1					1					
B								1									1						1						1			1							
C									1								1								1						1						1		
D											1								1	1										1					1				
E			1								1		1														1				1	1							
F											1						1											1						1					
G											1		1											1		1							1						
H					1								1					1											1			1				1			
I									1						1			1			1											1		1					
J							1					1						1				1										1						1	
K														1						1											1		1					1	
L					1									1							1												1				1		
Total			1		2		1	2	2		4	1	3	2	1	1	3	3	1	2	2	2	1	1	1	1	1	1	3	1	3	5	3	3	1	1	2	2	
Matrix Total	8										19									19												8		9					
W		1			2			1		1	1		1				1	1		1	1	1			1				2	1	2	3	2	1		1	1	1	
Common Item Total	5										4									9												5		5					
Total by Substandard	0	1	1	0	4	0	1	3	2	1	5	1	4	2	1	1	4	4	1	3	3	3	1	1	2	1	1	1	5	2	5	8	5	4	1	2	3	3	
Final Total	13										23									28												13		14					

Table B-15. 2003 Grade 8 Reading Multiple-Choice Items

	Standard																						
	1								2			3						7			8		
	A	B	C	D	E	F	G	H	A	B	C	A	B	C	D	E	F	A	B	C	A	B	C
Form A	1		1	3		1	1		7			4	3	3				2	2	2		6	
Form B	1		2	2	3				8			6	2	2				2	1	1		6	
Form C	2		2	1		1			9			5	1	2	1			3	2	1		6	
Form D	1		2	1		1			7			6	2	3				3	3	1		6	
Form E				2	1	2	3		7			4	2	3				3	2	1		6	
Form F			1	2	4	1	1		8			4	2	3				3	1			6	
Form G	1	1	1	1	1	1	1		9			3	1	3	1			3	3			6	
Form H			2		1	2	1		7			4	2	4				3	2			6	
Form I	1		1	1	1	1	2		8			6	1	2				3	2	1		6	
Form J	1		1	2	1	1	1		8			4	2	3				3	2	1		6	
Form K	1	1	1	2	1		1		8			4	2	3				2	3	1		6	
Form L	1		2	1	1	1	1		8			4	2	3				2	1	1		6	
Total	10	2	16	18	14	12	12		94			54	22	34	2			32	24	10		72	
Matrix Total	84								94			112						66			72		
Form W	2	2	4	3	1	2	5		14			7	4	5				6	4	2	3	5	3
Common Items Total	19								14			16						12			11		
Total by Substandard	12	4	20	21	15	14	17	0	108	0	0	61	26	39	2	0	0	38	28	12	3	77	3
Final Total	103								108			128						78			83		

Table B-16. 2003 Grade 8 Math Multiple-Choice Items

	Standard																															
Form	1							2									3						4					6				
	A	B	C	D	E	F	G	A	B	C	D	E	F	G	H	I	A	B	C	D	E	F	A	B	C	D	F	A	B	C	D	E
A		1							1											2											1	
B				1					1		1							1					1									1
C	1	1							1								1					2		1								1
D			1	1		1			1	1	1		1							1							1			1		
E				1					3		1								1		1			1								1
F									2								1			1						1					1	
G	2								1								1			2					1						1	1
H		1							2									1	1	1				1								
I	1				1	1			1			1	1				1			1								1				
J			1	1						1	1											1	1									1
K					1			1				1						1	1			1		1								1
L				1				1			1								1	1											1	
Total	4	3	2	5	2	2		2	13	2	5	2	2				4	3	4	9	1	4	2	4	1	1	1	1		1	4	6
Matrix Total	18							26									25						9					12				
W	2		2	2				2	8	2	2						1	1		3		1	2		2	1						2
Common Items Total	6							14									6						5					2				
Total by Substandard	2	3	4	7	2	2	0	4	21	4	7	2	2	0	0	0	5	4	4	12	1	5	4	4	3	2	1	1	0	1	4	8
Final Total	24							40									31						14					14				

Table B-16. 2003 Grade 8 Math Multiple-Choice Items (Continued)

	Standard																																				
Form	7										8										9											10		11				
	A	B	C	D	E	F	G	H	I	J	A	B	C	D	E	F	G	H	I	J	A	B	C	D	E	F	G	H	I	J	K	A	B	A	B	C	D	E
A	1												3									1													1	1		
B					1								2	1	1							1										1				2		
C	1																1	1						2								1						
D					1								2		1																	1			1			
E					1								1		1									1								1				1		
F					1								1		2		1							1								1		1				
G					2																	1										1		1		1		
H		1			1								1		1					1		1											1					
I	1														1									1								1			1			
J			1										1		1							1									1				1			
K					1								1		2							1			1								1	1				
L					1						1	2	1		1							1										1	1			1		
Total	3	1	1		9						1	2	13	1	11		2	1		1		7		5	1						1	8	3	3	4	6		
Matrix Total	14										32										14											11		13				
W	1		1	2	2							2	7	1	4		1			2		2		5	2							2	1		2	2		
Common Item Total	6										17										9											3		4				
Total by Substandard	4	1	2	2	11	0	0	0	0	0	1	4	20	2	15	0	3	1	1	3	0	9	0	10	3	0	0	0	0	0	1	10	4	3	6	8	0	0
Final Total	20										49										23											14		17				

Table B-17. 2003 Grade 11 Reading Multiple-Choice Items

	Standard																						
	1								2			3						7			8		
	A	B	C	D	E	F	G	H	A	B	C	A	B	C	D	E	F	A	B	C	A	B	C
Form A	1	2	1	2			3		5	1		3	2	3				5	3	1		8	
Form B		3	1	1			2		6	1		5	1	3				6	2			8	
Form C		1	2	1			3		7	1		3	2	4				5	2			8	
Form D		1	2	1			3		7	1		4	2	3				5	2	1		8	
Form E	2	1	2	1			2		7			3	2	3				4	2	3		8	
Form F		3		1		1	2		7			6		3				5	2	1		8	
Form G			2	2		1	2		8			4	1	4				3	2	2		8	
Form H		1	2	1			3		8			5	1	2	1			3	2	3		8	
Form I	1	1	3	1			1		8	1		2	2	4				5	1	2		8	
Form J		2	1	2		1	2		7	1		3	1	4				5	2	1		8	
Form K		1	2	3		1	1		7	1		3	1	4				4	2	2		8	
Form L		2	2	2			2		7	1		3	1	3	1			4	2	2		8	
Total	4	18	20	18		4	26		84	8		44	16	40	2			54	24	18		96	
Matrix Total	90								92			102						96			96		
Form W	1	2	3	5	2		4		13	2		6	5	6			2	9	1	2	3	11	2
Common Items Total	17								15			19						12			16		
Total by Substandard	5	20	23	23	2	4	30	0	97	10	0	50	21	46	2	0	2	63	25	20	3	107	2
Final Total	107								107			121						108			112		

Table B-18. 2003 Grade 11 Math Multiple-Choice Items

	Standard																														
Form	1				2														3			4					6				
	A	B	C	D	A	B	C	D	E	F	G	H	I	J	K	L	M	N	A	B	C	A	B	C	D	E	A	C	D	E	H	I
A					3																	1									1
B	1				2	1														1				1			1				1
C					1	1													1							1		1			
D	1				1					1											1										
E					1																		1						1		
F	1																						1								
G	1				2																1										
H					1																1				1				1		
I	1				1		1													1			1								
J	1				1																									1	
K	1						1														1										
L						1												1	1												1
Total	7				13	3	2			1								1	2	2	4	1	3	1	1	1	1	1	2	1	1	2
Matrix Total	7				20														8			7					8					
W	4			1				4	3										1				1				2		1			1
Common Items Total	5				7														1			1					4					
Total by Substandard	11	0	0	1	13	4	2	4	3	1	0	0	0	0	0	0	0	1	3	2	4	1	4	1	1	1	3	1	3	1	1	3
Final Total	12				27														9			8					12					

Table B-18. 2003 Grade 11 Math Multiple-Choice Items (Continued)

	Standard																																						
Form	7					8																			9									10		11			
	A	B	C	D	E	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	S	T	B	C	D	E	F	G	H	I	J	A	B	A	C	D	
A										1					1						1				1				1									1	
B			1						1								1										1								1				
C			1																	1			1					1											
D			1				1	1									1												1					1					
E		1										1		1			1			1											1	1			1	1			
F					1	1																	1		1	1				1						1			
G					1			1											1			1				1		1										1	
H		1																				1													1			1	
I					1					1									1					1						1					1				
J				1								1								1				1	1								1	1					
K	1								1	1						1					1		1												1	1			
L				1				2		1																				1					1				
Total	1	2	3	2	3	1	1	4	2	4		2		1	1	1	3		2	3	2	2	3	2	3	2	1	2	2	3	1	1	1	2	6	3		3	
Matrix Total	11					34																			16									8		8			
W	1	2			2	2	1		1	1	1		1	1			1		2	1	1	1			3		2		2				1	1	3	1	1	1	
Common Item Total	5					14																			8									4		4			
Total by Substandard	2	4	3	2	5	3	2	4	3	5	1	2	1	2	1	1	4	0	4	4	3	3	3	2	6	2	3	2	4	3	1	1	2	3	9	4	1	4	
Final Total	16					48																			24									12		12			

Appendix C

Performance-Task Item Tables

Table C-1. 2001 Grade 5 Math Performance-Task Items

	Standard																																			
Form	1							2							3							4							6						
	A	B	E	G	I	K	L	A	B	E	G	I	K	L	A	B	E	G	I	K	L	A	B	E	G	I	K	L	A	B	E	G	I	K	L
A																								1												
B																																				
C																													1							
D																																				
E			1																																	
F								1																												
G															1																					
H											1																									
I																																				
J																																				
Total			1					1			1				1									1					1							
Matrix Total	1							2							1							1							1							
W				1					1																											
Common Items Total	1							1							0							0							0							
Total by Substandard	0	0	1	1	0	0	0	1	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0
Final Total	2							3							1							1							1							

Table C-2. 2001 Grade 5 Math Performance-Task Items (continued)

	Standard																												
Form	7							8							9							11							
	A	B	E	G	I	K	L	A	B	E	G	I	K	L	A	B	E	G	I	K	L	A	B	E	G	I	K	L
A																												
B									1																			
C																												
D					1																							
E																												
F																												
G																												
H																												
I																				1								
J																								1				
Total					1				1											1				1				
Matrix Total	1							1							1							1						
W																					1							
Common Items Total	0							0							1							0						
Total by Substandard	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0
Final Total	1							1							2							1						

Table C-3. 2002 Grade 8 Math Performance-Task Items

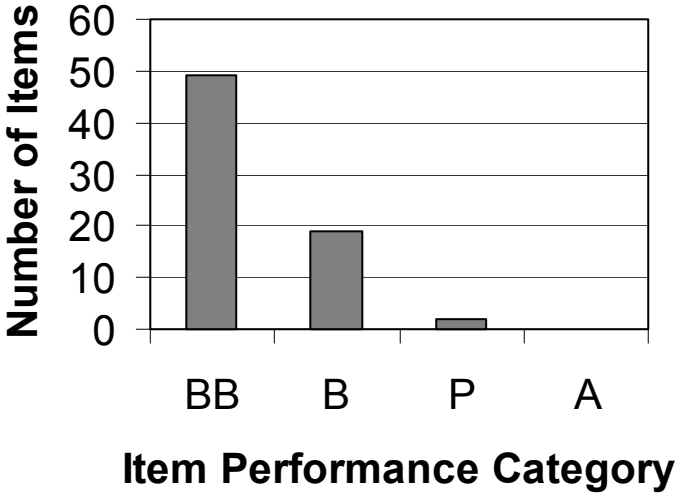
	Standard																	
Form	2			3			7			8			9			10		
	A	B	D	A	B	D	A	B	D	A	B	D	A	B	D	A	B	D
A	1																	
B																		
C														1				
D									1									
E																		
F																		
G			1															
H																		
I																		
J																		
K																		
L		1																
Total	1	1	1						1					1				
Matrix Total	3			0			1			0			1			0		
Form W																		
Common Items Total	0			0			0			0			0			0		
Total by Substandard	1	1	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0
Final Total	3			0			1			0			1			0		

Table C-4. 2003 Grade 8 Math Performance-Task Items

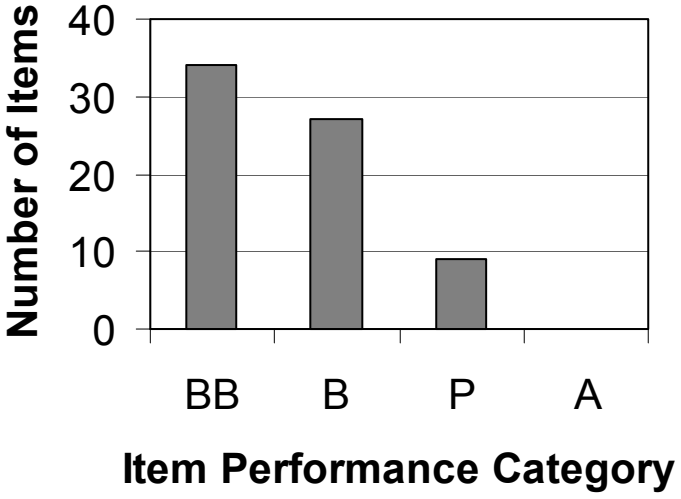
	Standard																				
Form	1			2			3			4			7			9			10		
	A	B	D	A	B	D	A	B	D	A	B	D	A	B	D	A	B	D	A	B	D
A													1								
B																					
C											1										
D						1															
E																					
F																					
G						1															
H																					
I																					
J																					
K																					
L					1																
Total					1	2					1		1								
Matrix Total	0			3			0			1			1			0			0		
W																					
Common Items Total	0			0			0			0			0			0			0		
Total by Substandard	0	0	0	0	1	2	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0
Final Total	0			3			0			1			1			0			0		

Appendix D
Graphs of Common Multiple-Choice Items

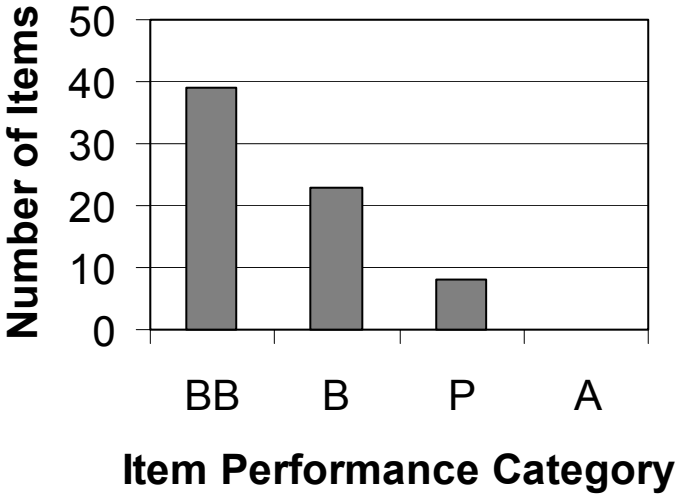
PSSA Multiple-Choice Common Items Grade 5 Mathematics 2001



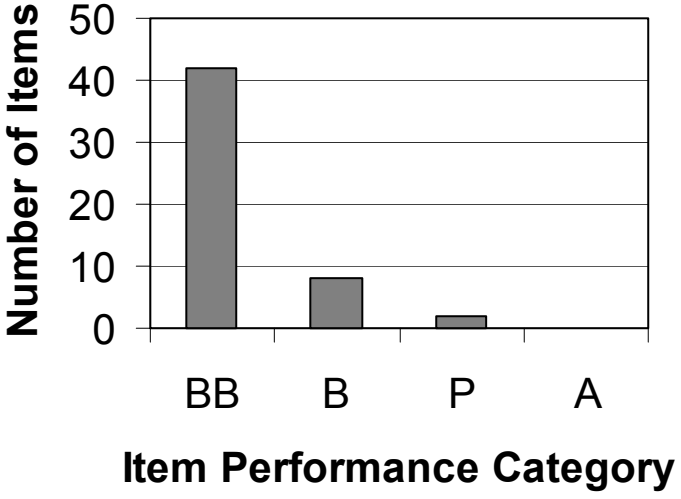
PSSA Multiple-Choice Common Items Grade 8 Mathematics 2001



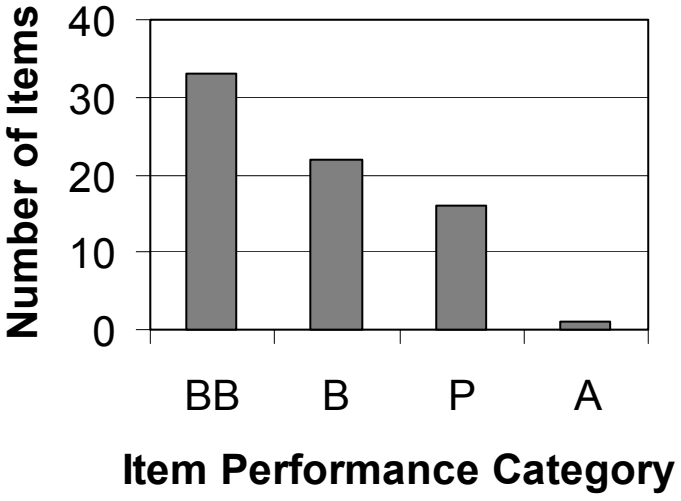
PSSA Multiple-Choice Common Items Grade 11 Mathematics 2001



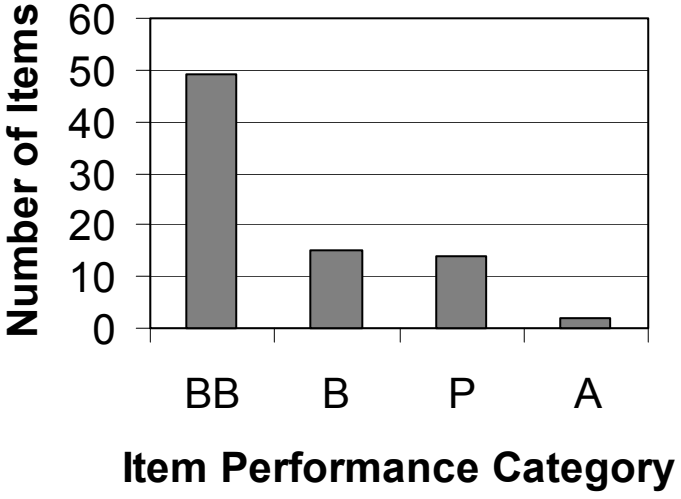
PSSA Multiple-Choice Common Items Grade 5 Reading 2001



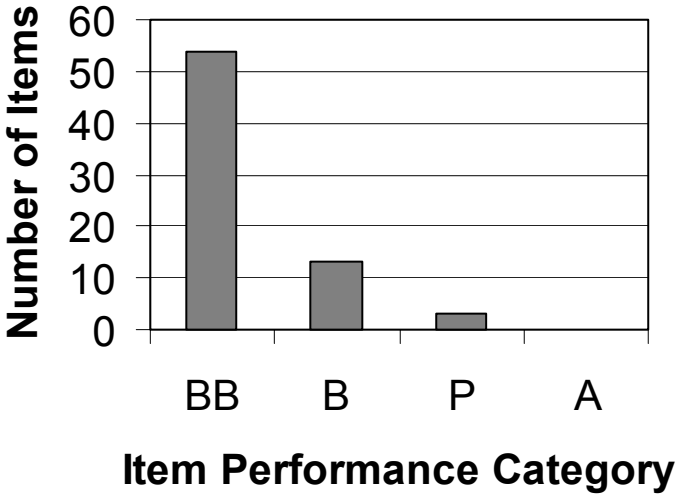
PSSA Multiple-Choice Common Items Grade 8 Reading 2001



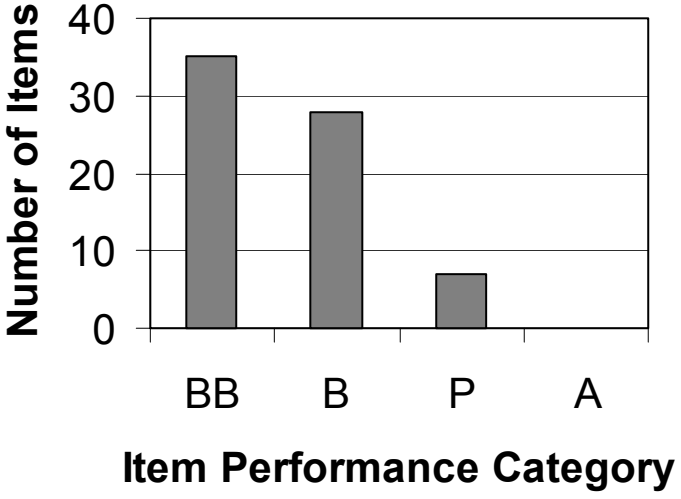
PSSA Multiple-Choice Common Items Grade 11 Reading 2001



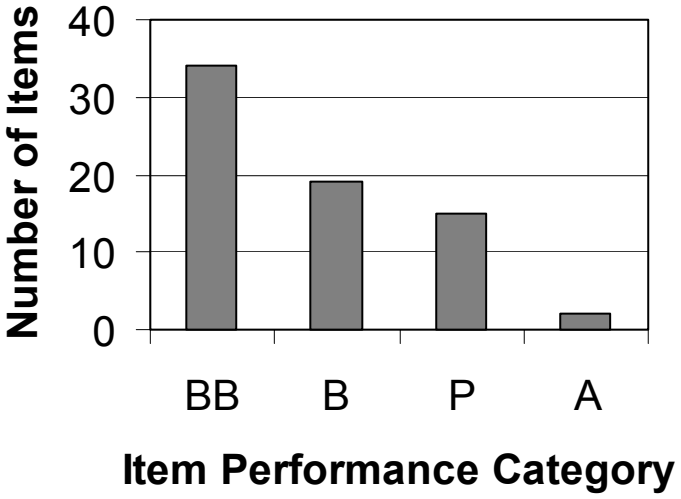
PSSA Multiple-Choice Common Items Grade 5 Mathematics 2002



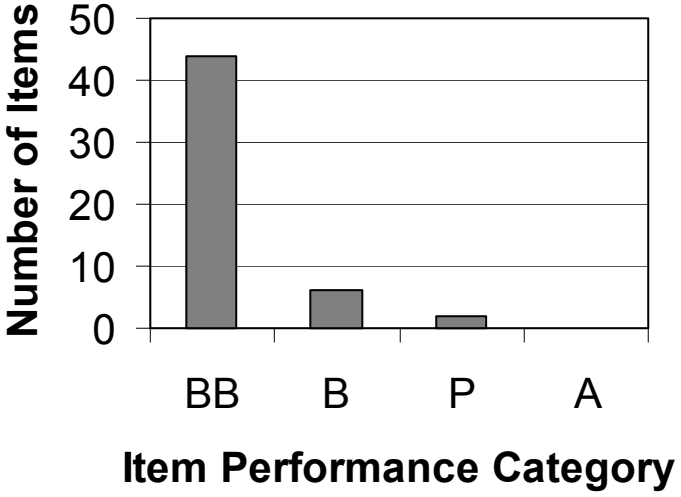
PSSA Multiple-Choice Common Items Grade 8 Mathematics 2002



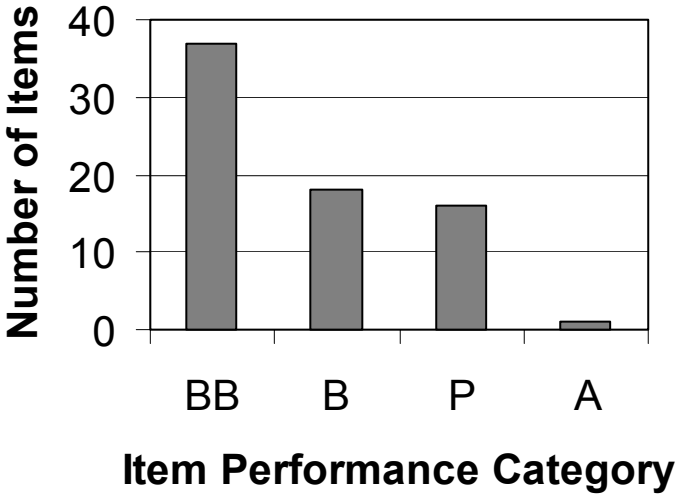
PSSA Multiple-Choice Common Items Grade 11 Mathematics 2002



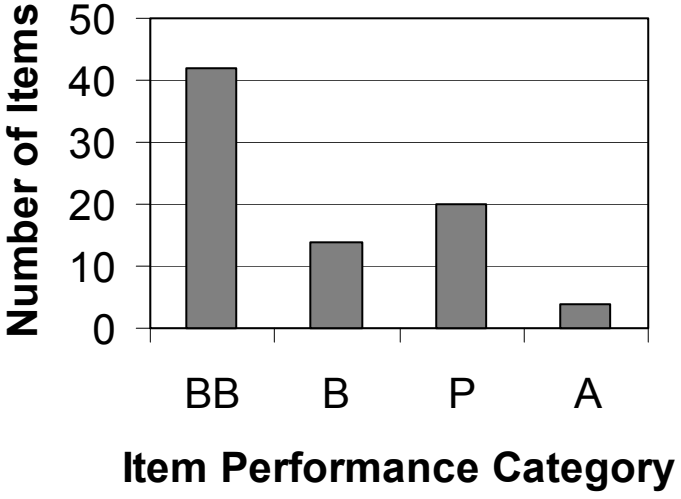
PSSA Multiple-Choice Common Items Grade 5 Reading 2002



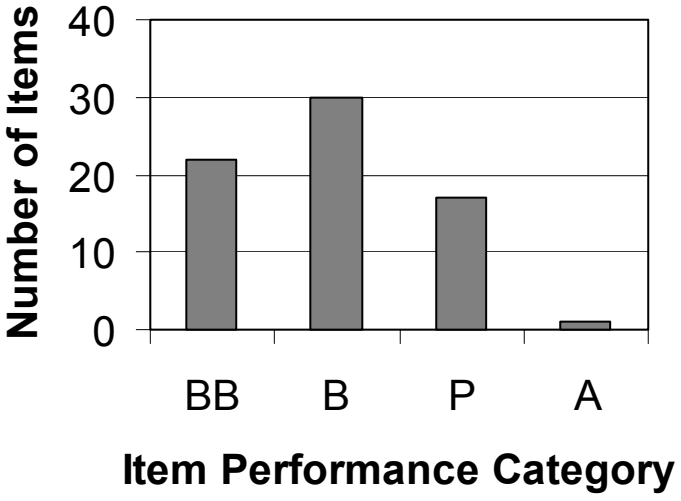
PSSA Multiple-Choice Common Items Grade 8 Reading 2002



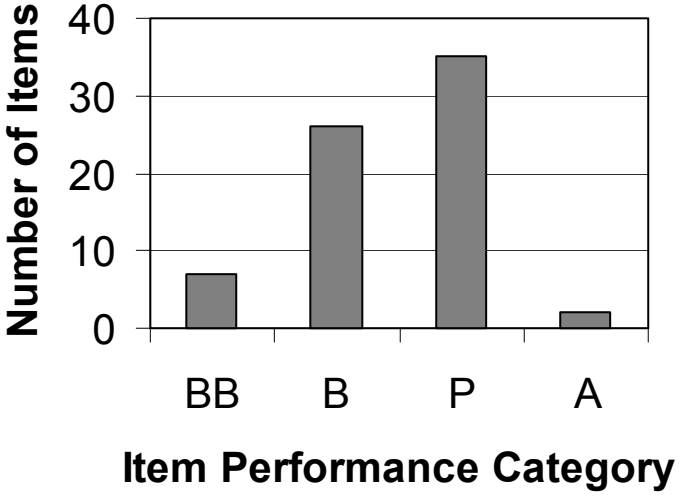
PSSA Multiple-Choice Common Items Grade 11 Reading 2002



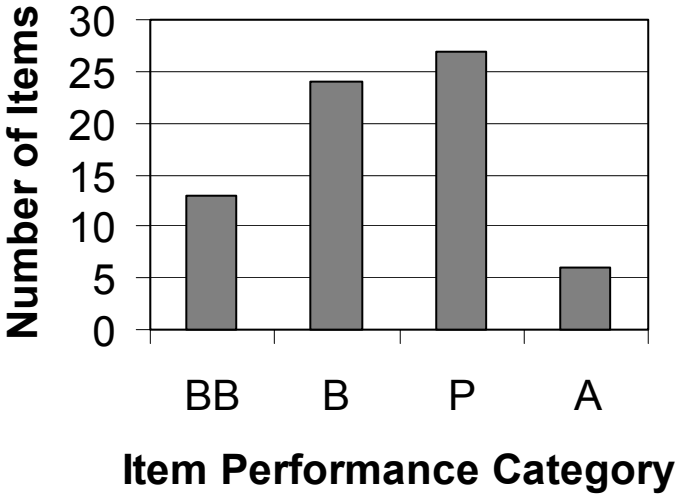
PSSA Multiple-Choice Common Items Grade 5 Mathematics 2003



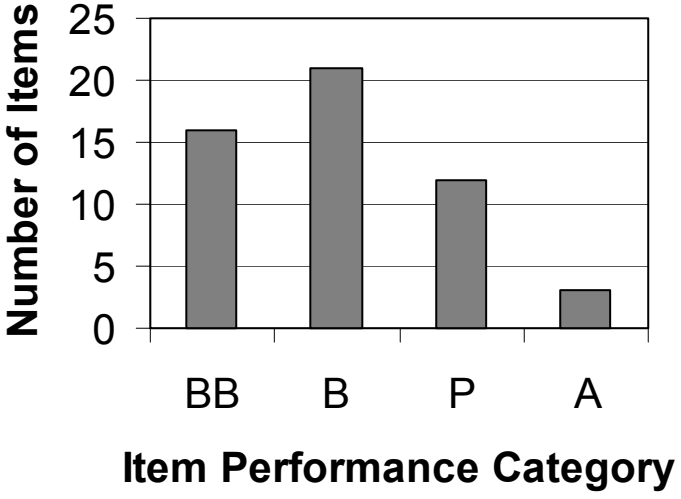
PSSA Multiple-Choice Common Items Grade 8 Mathematics 2003



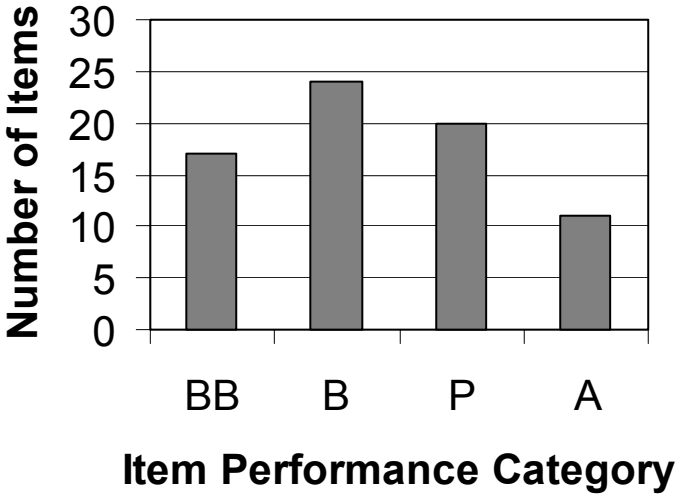
PSSA Multiple-Choice Common Items Grade 11 Mathematics 2003



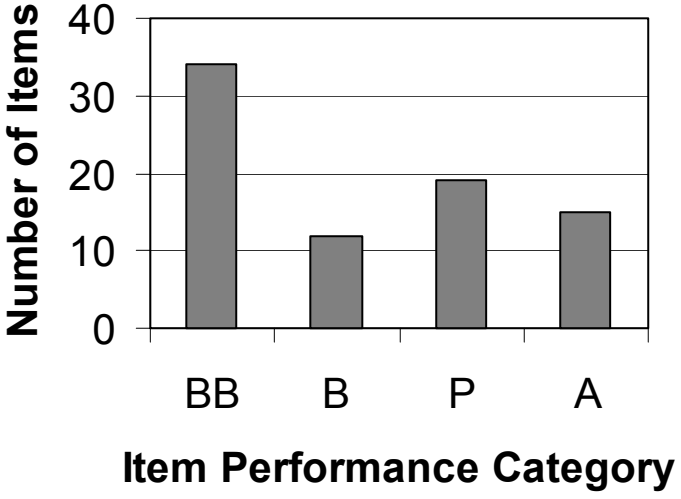
PSSA Multiple-Choice Common Items Grade 5 Reading 2003



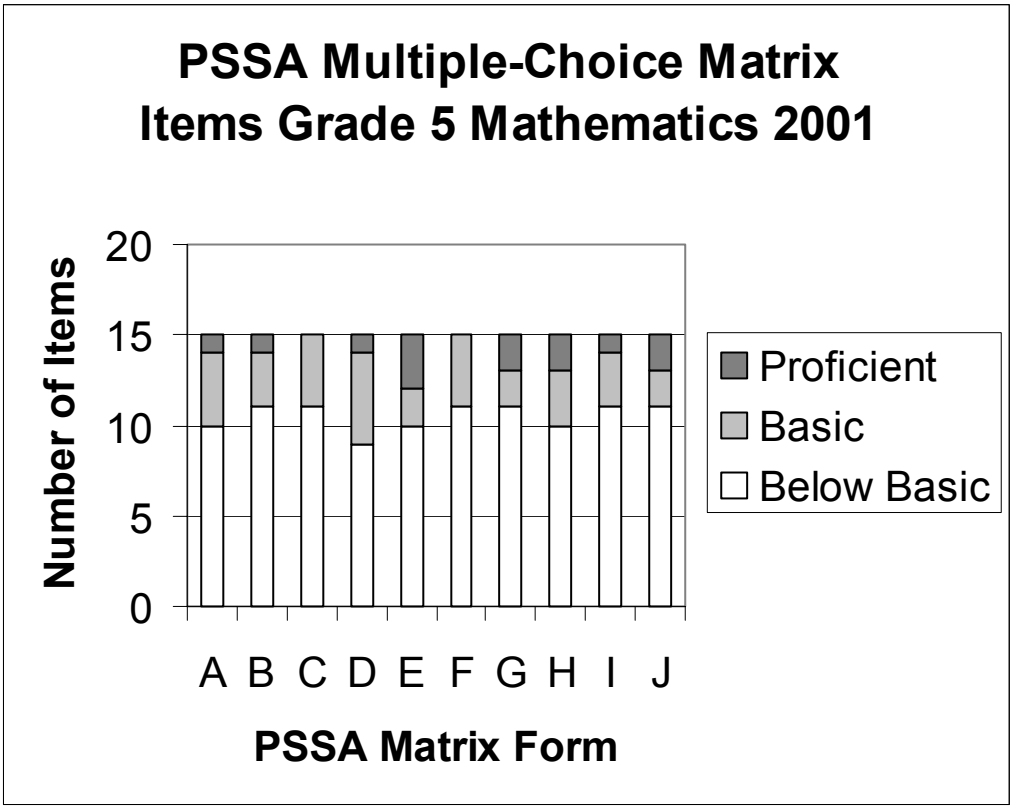
PSSA Multiple-Choice Common Items Grade 8 Reading 2003

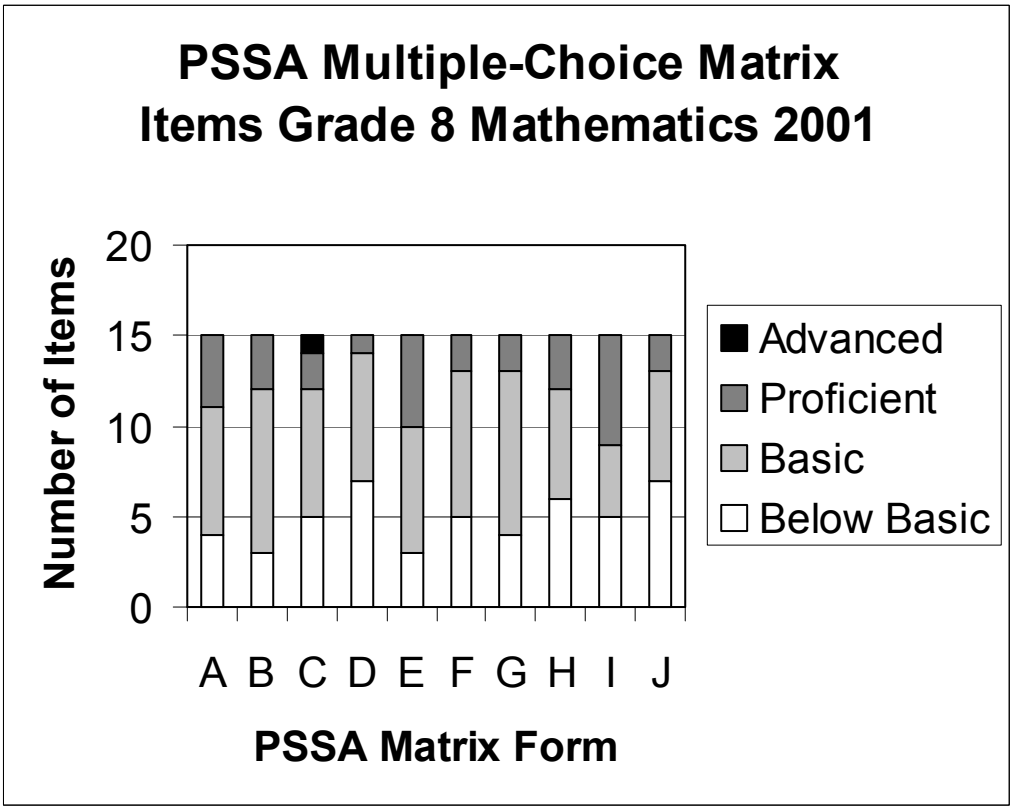


PSSA Multiple-Choice Common Items Grade 11 Reading 2003



Appendix E
Graphs of Multiple Choice Matrix Items


PSSA Multiple-Choice Matrix
Items Grade 5 Mathematics 2001
Number of Items
20
15
10
5
0
A B C D E F G H I J
PSSA Matrix Form
Proficient
Basic
Below Basic


PSSA Multiple-Choice Matrix
Items Grade 8 Mathematics 2001
Number of Items
20
15
10
5
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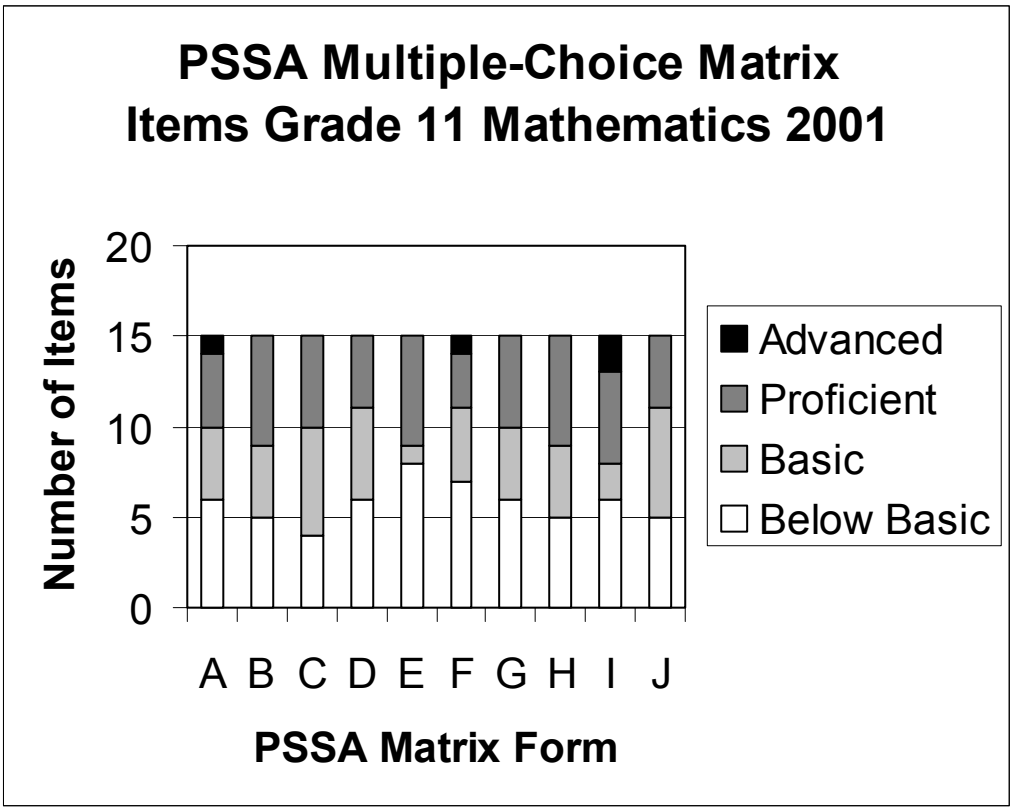
A B C D E F G H I J
PSSA Matrix Form
Advanced
Proficient
Basic
Below Basic


PSSA Multiple-Choice Matrix
Items Grade 11 Mathematics 2001
Number of Items
20
15
10
5
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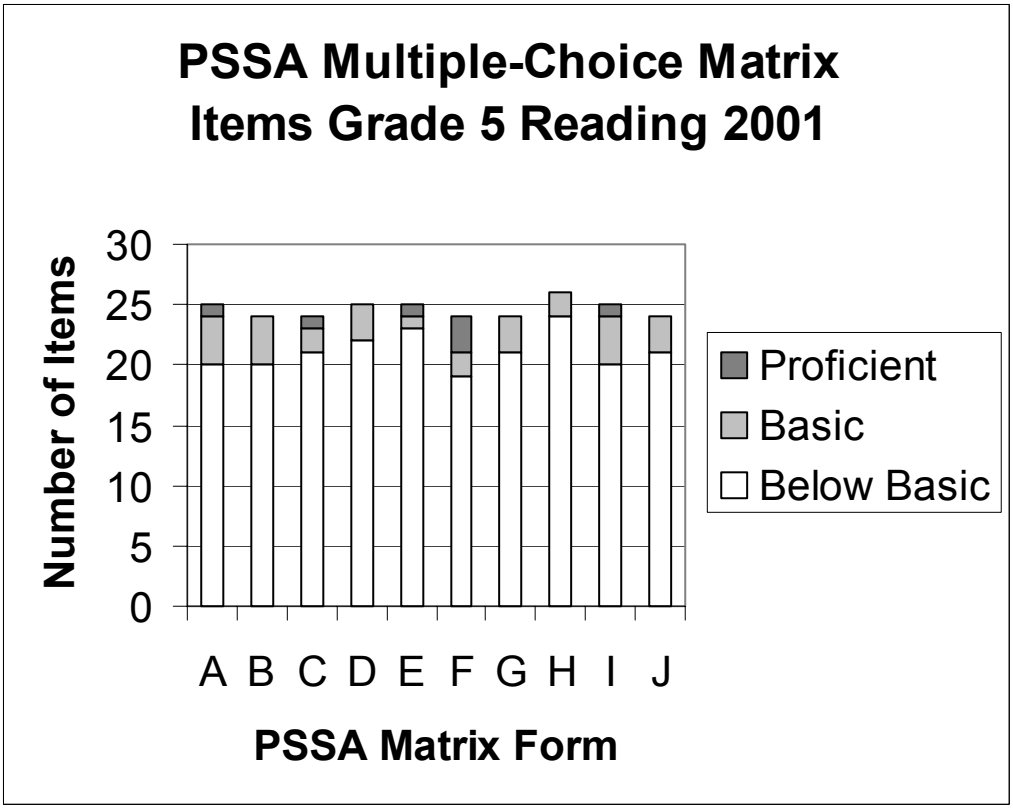
A B C D E F G H I J
PSSA Matrix Form
Advanced
Proficient
Basic
Below Basic


PSSA Multiple-Choice Matrix
Items Grade 5 Reading 2001
Number of Items
30
25
20
15
10
5
0
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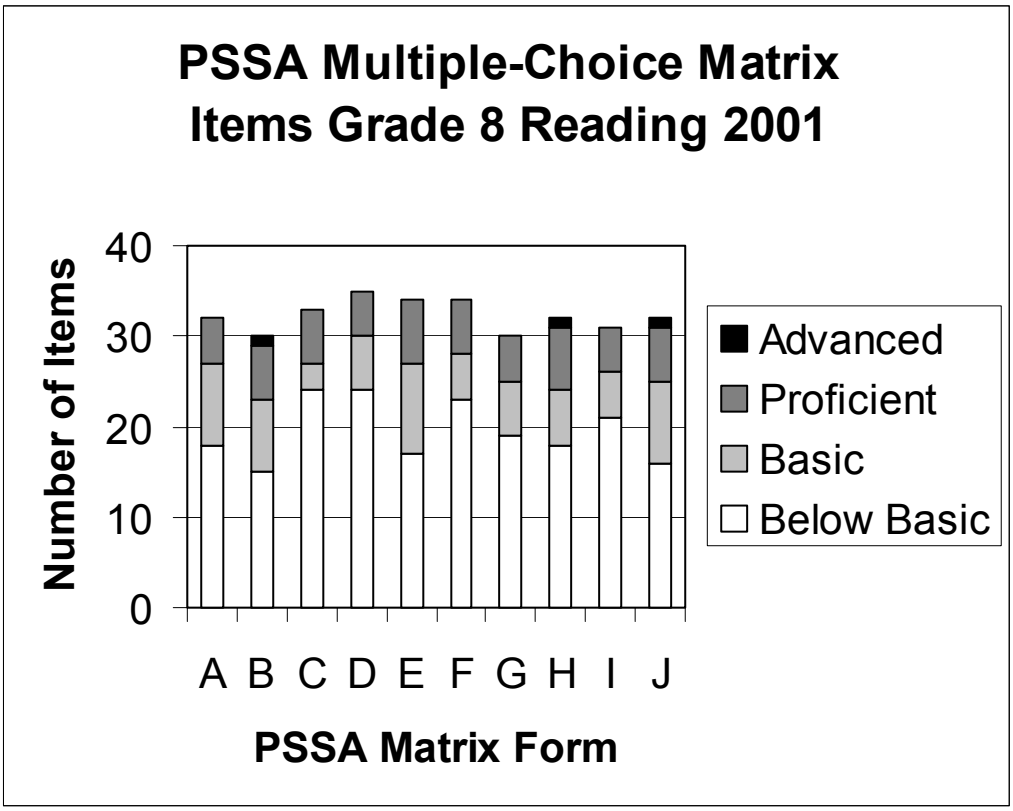
PSSA Matrix Form
Proficient
Basic
Below Basic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Items Grade 8 Reading 2001
Number of Items
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30
20
10
0
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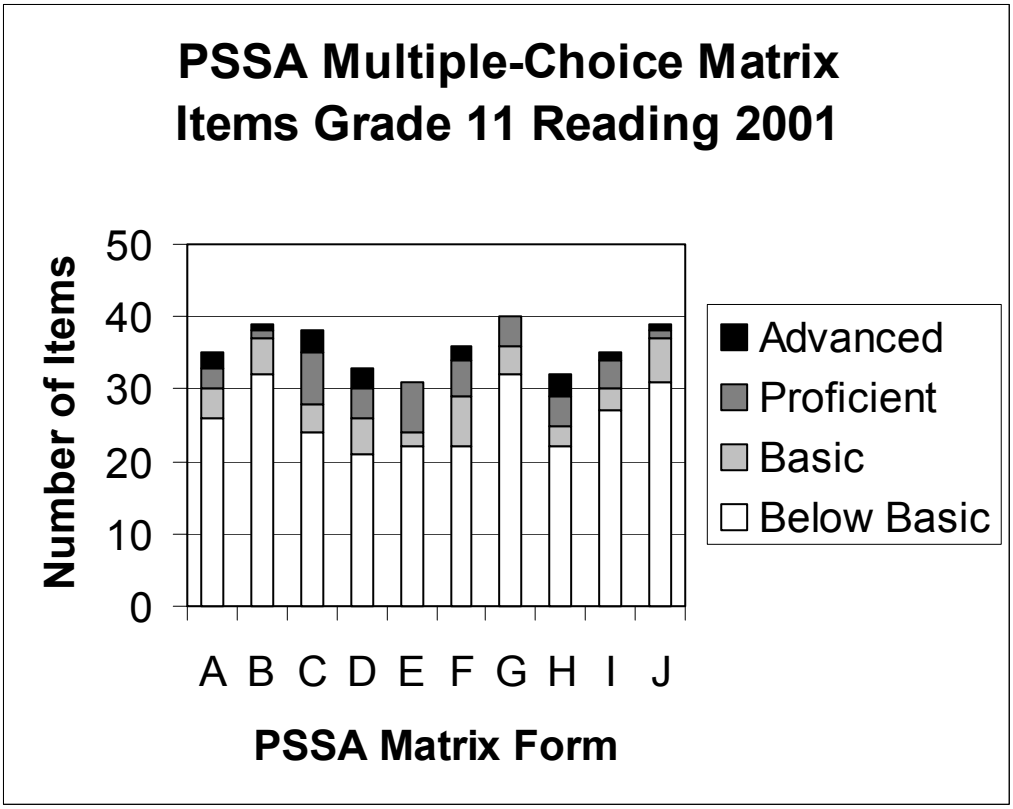
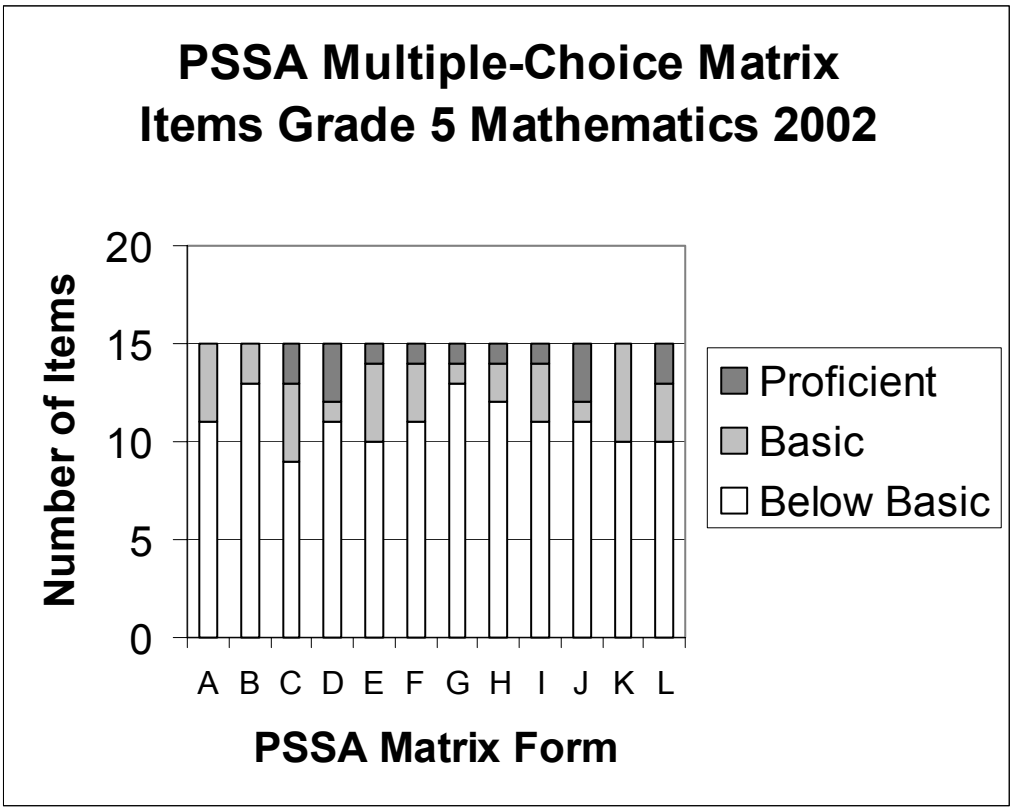
PSSA Matrix Form
Advanced
Proficient
Basic
Below Basic


PSSA Multiple-Choice Matrix
Items Grade 11 Reading 2001
Number of Items
50
40
30
20
10
0
A B C D E F G H I J
PSSA Matrix Form
Advanced
Proficient
Basic
Below Basic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Items Grade 5 Mathematics 2002
Number of Items
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Proficient
Basic
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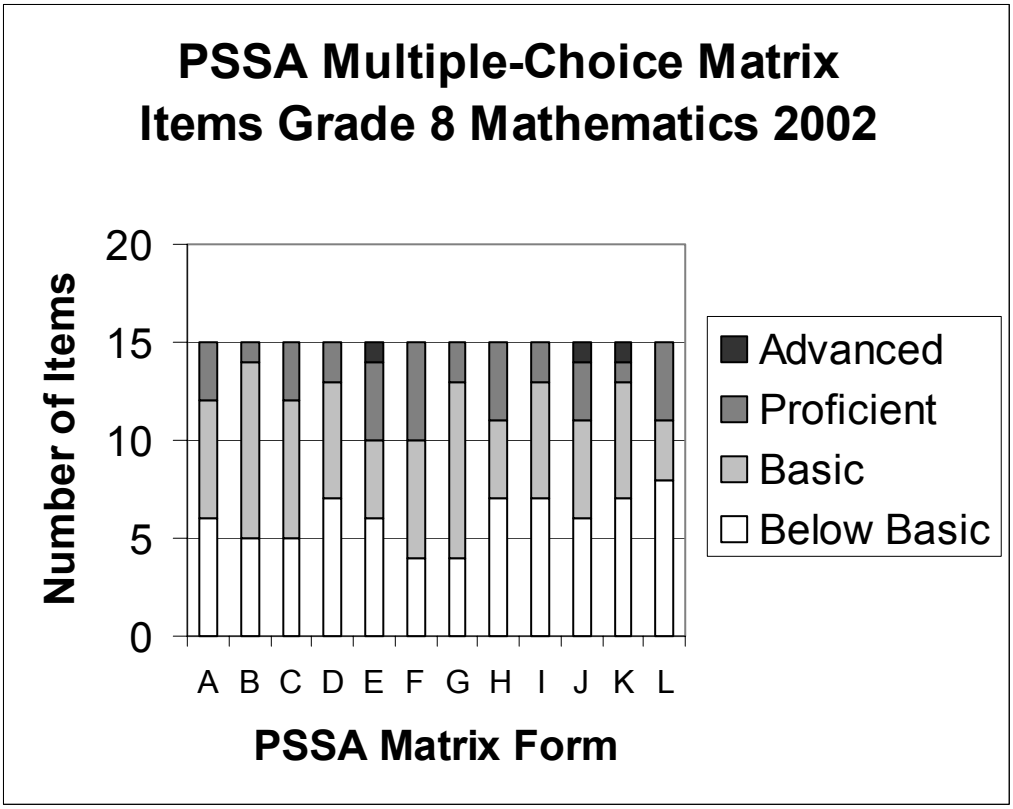
PSSA Multiple-Choice Matrix
Items Grade 8 Mathematics 2002
Number of Items
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Advanced
Proficient
Basic
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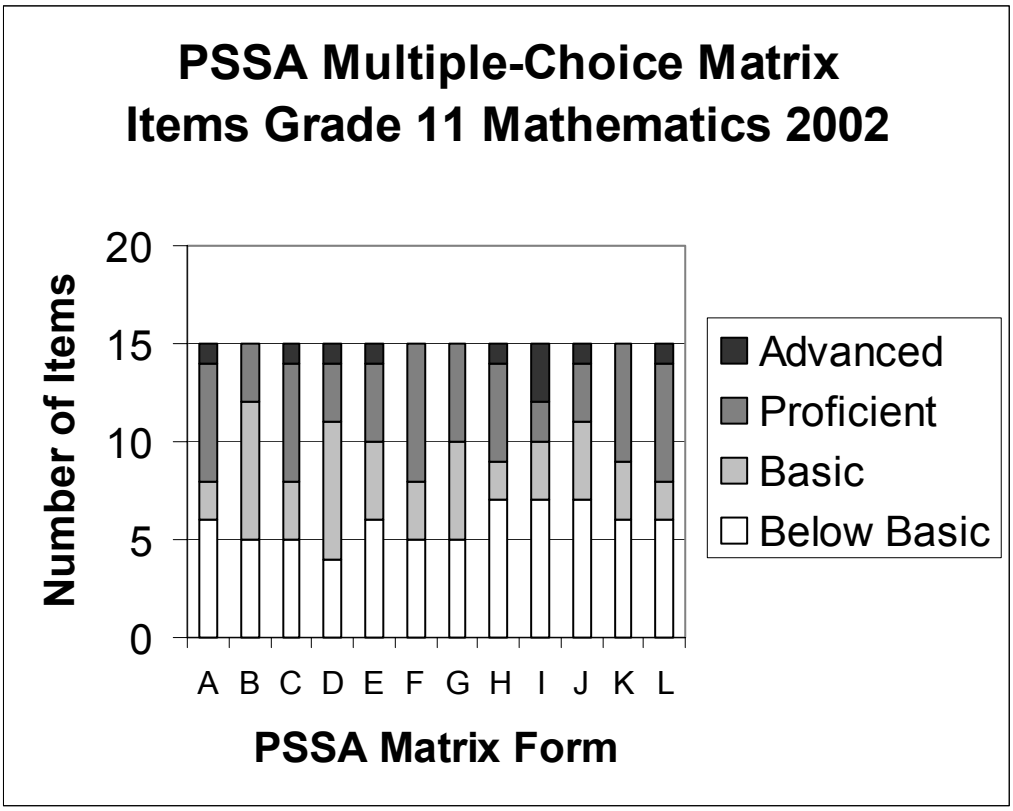
PSSA Multiple-Choice Matrix
Items Grade 11 Mathematics 2002
Number of Items
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15
10
5
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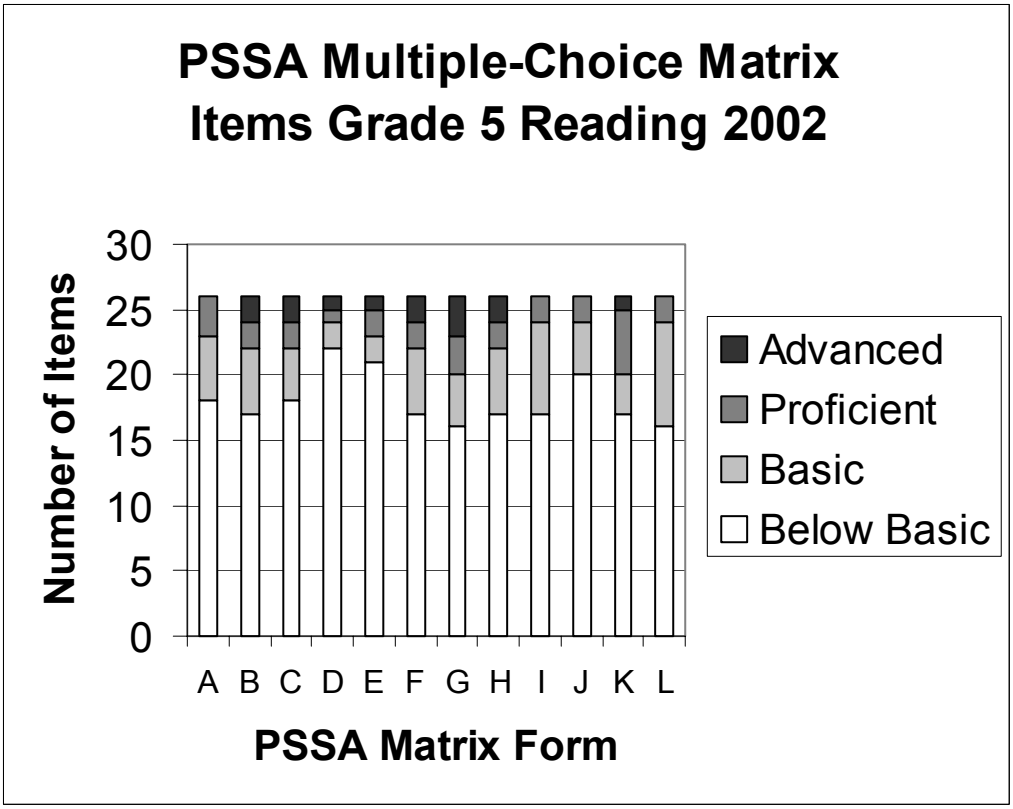
PSSA Matrix Form
Advanced
Proficient
Basic
Below Basic


PSSA Multiple-Choice Matrix
Items Grade 5 Reading 2002
Number of Items
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15
10
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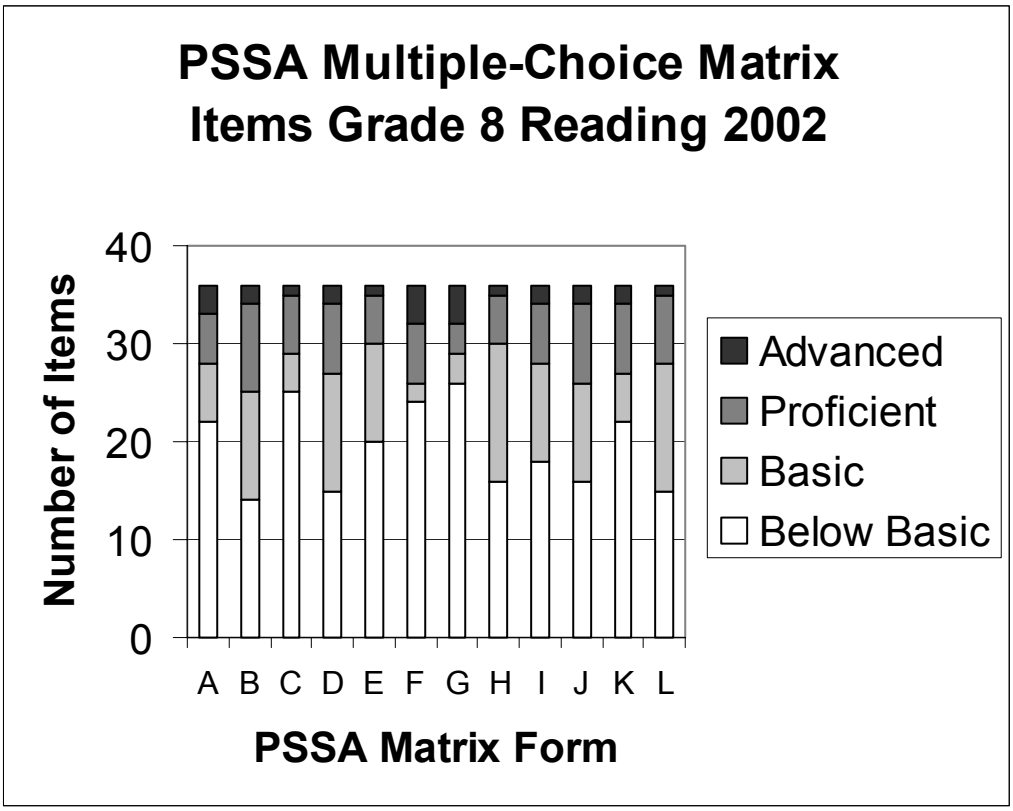
PSSA Matrix Form
Advanced
Proficient
Basic
Below Basic


PSSA Multiple-Choice Matrix
Items Grade 8 Reading 2002
Number of Items
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10
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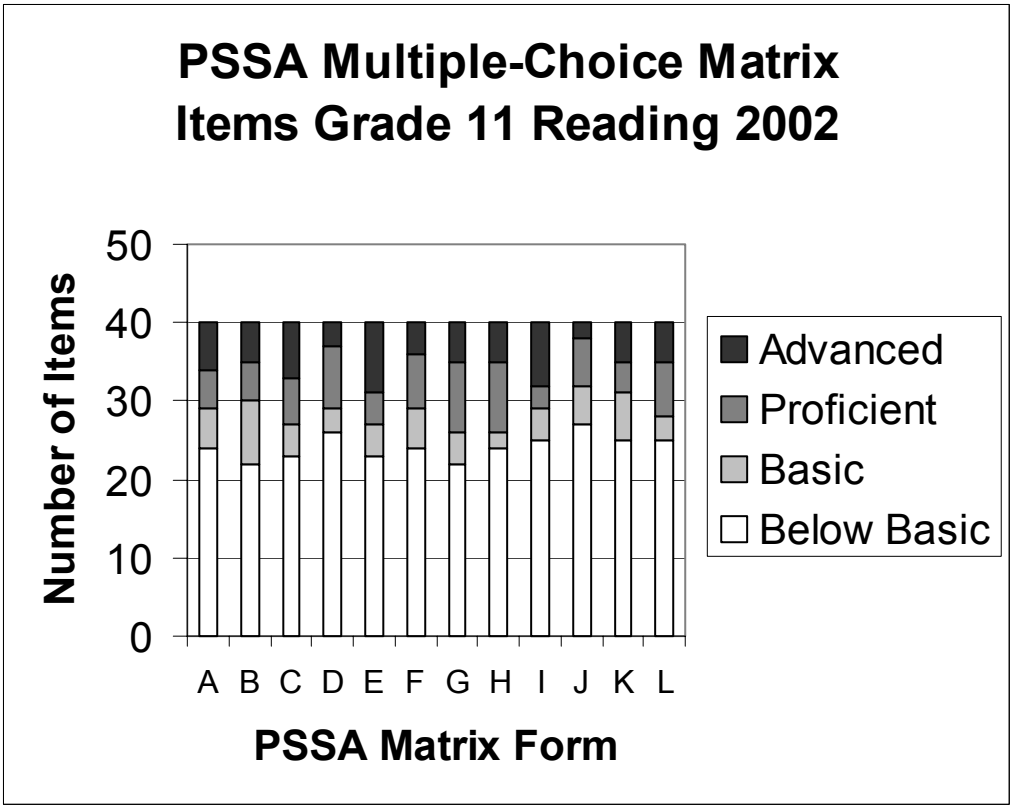
A B C D E F G H I J K L
PSSA Matrix Form
Advanced
Proficient
Basic
Below Basic


PSSA Multiple-Choice Matrix
Items Grade 11 Reading 2002
Number of Items
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40
30
20
10
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A B C D E F G H I J K L
PSSA Matrix Form
Advanced
Proficient
Basic
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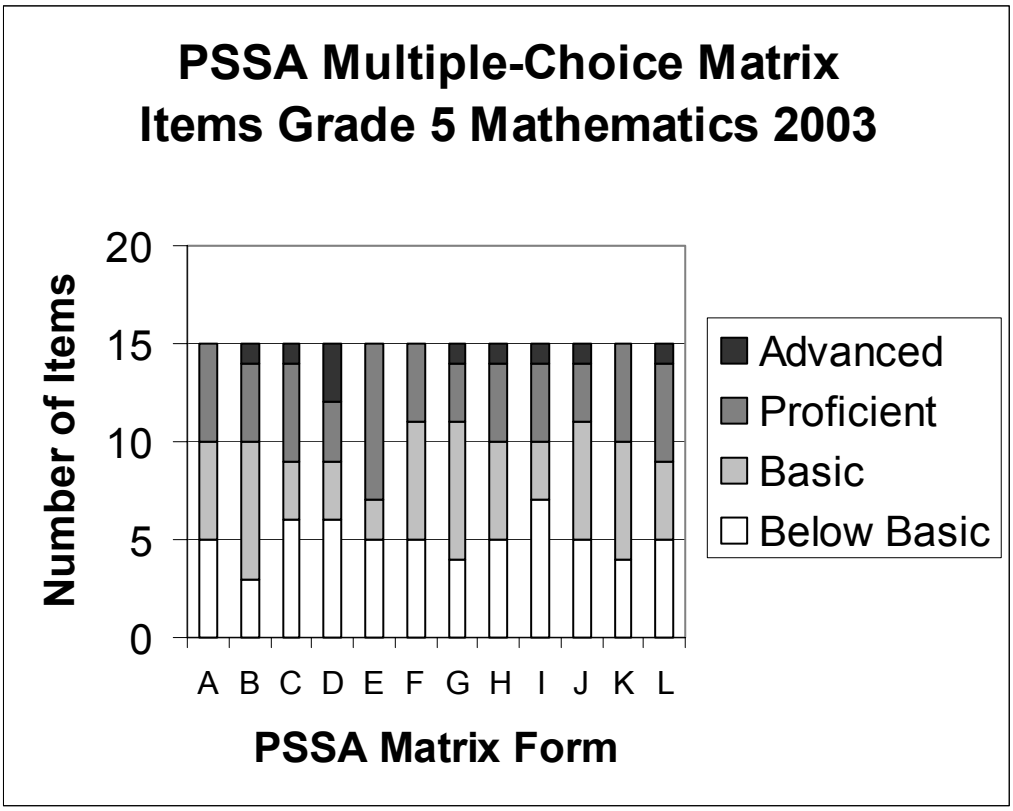
PSSA Multiple-Choice Matrix
Items Grade 5 Mathematics 2003
Number of Items
20
15
10
5
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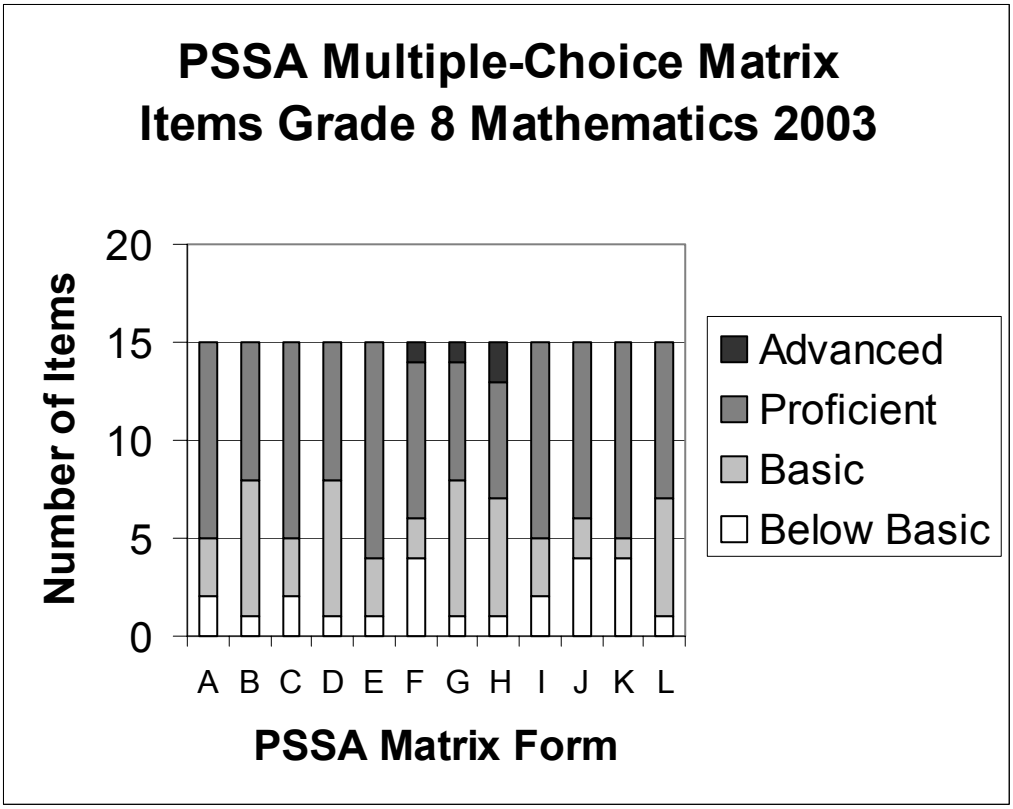
A B C D E F G H I J K L
PSSA Matrix Form
Advanced
Proficient
Basic
Below Basic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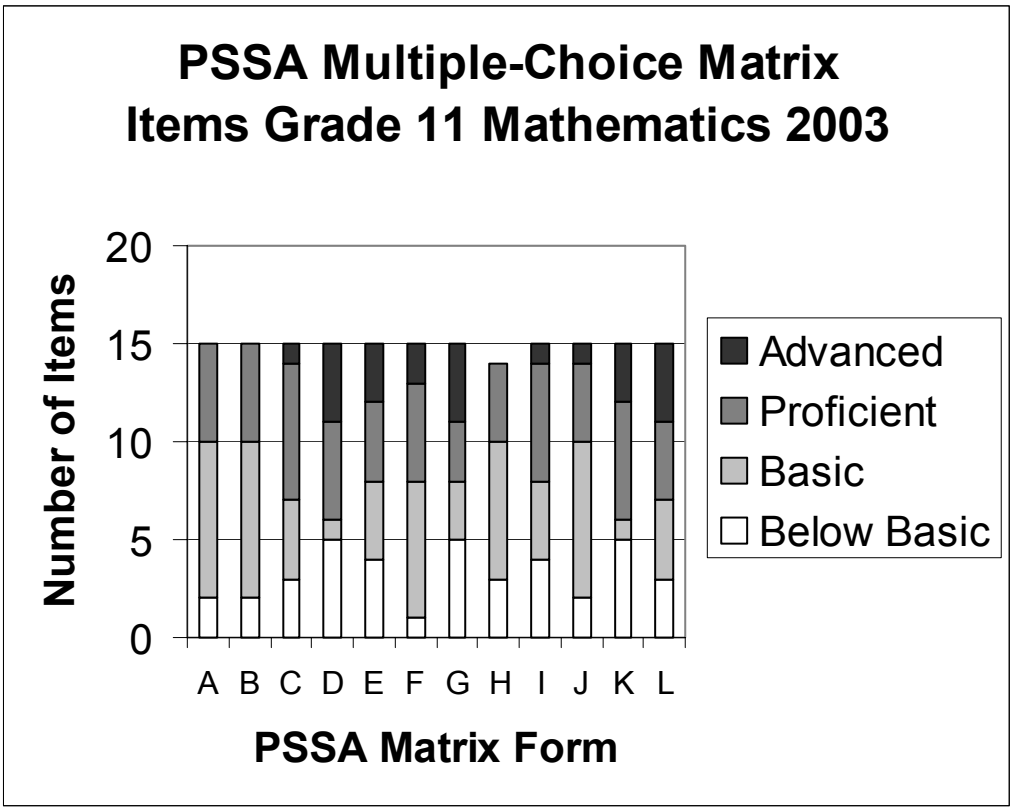
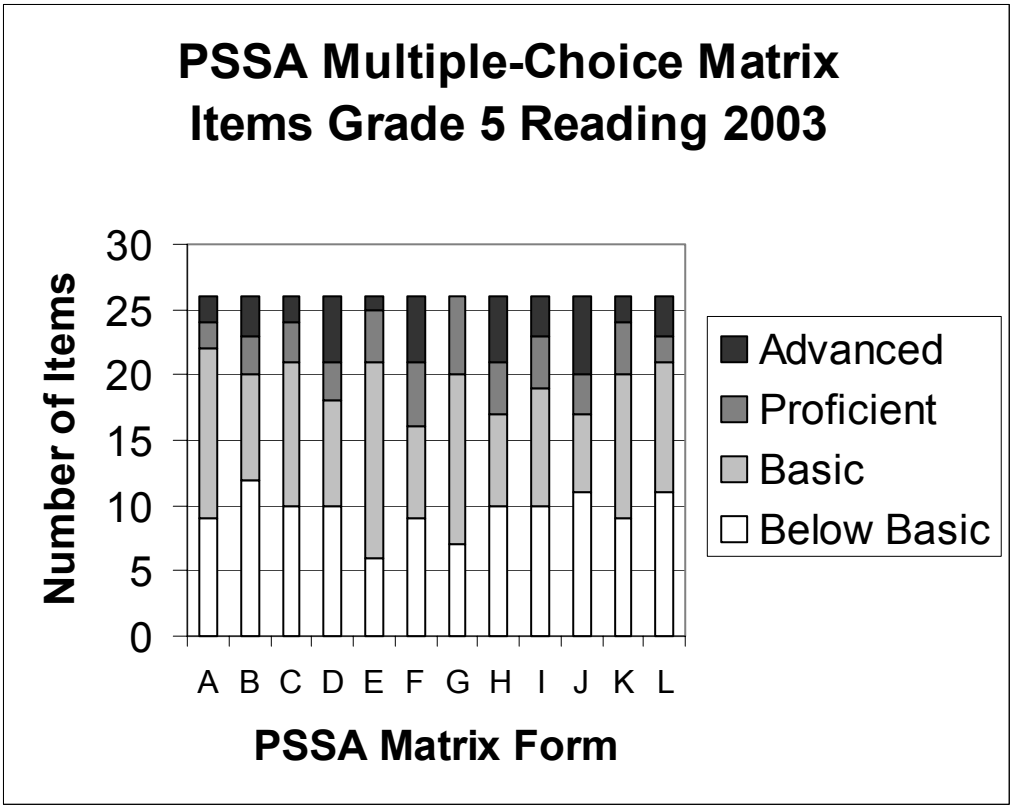
Items Grade 8 Mathematics 2003
Number of Items
20
15
10
5
0
A B C D E F G H I J K L
PSSA Matrix Form
Advanced
Proficient
Basic
Below Basic


PSSA Multiple-Choice Matrix
Items Grade 11 Mathematics 2003
Number of Items
20
15
10
5
0
A B C D E F G H I J K L
PSSA Matrix Form
Advanced
Proficient
Basic
Below Basic


PSSA Multiple-Choice Matrix
Items Grade 5 Reading 2003
Number of Items
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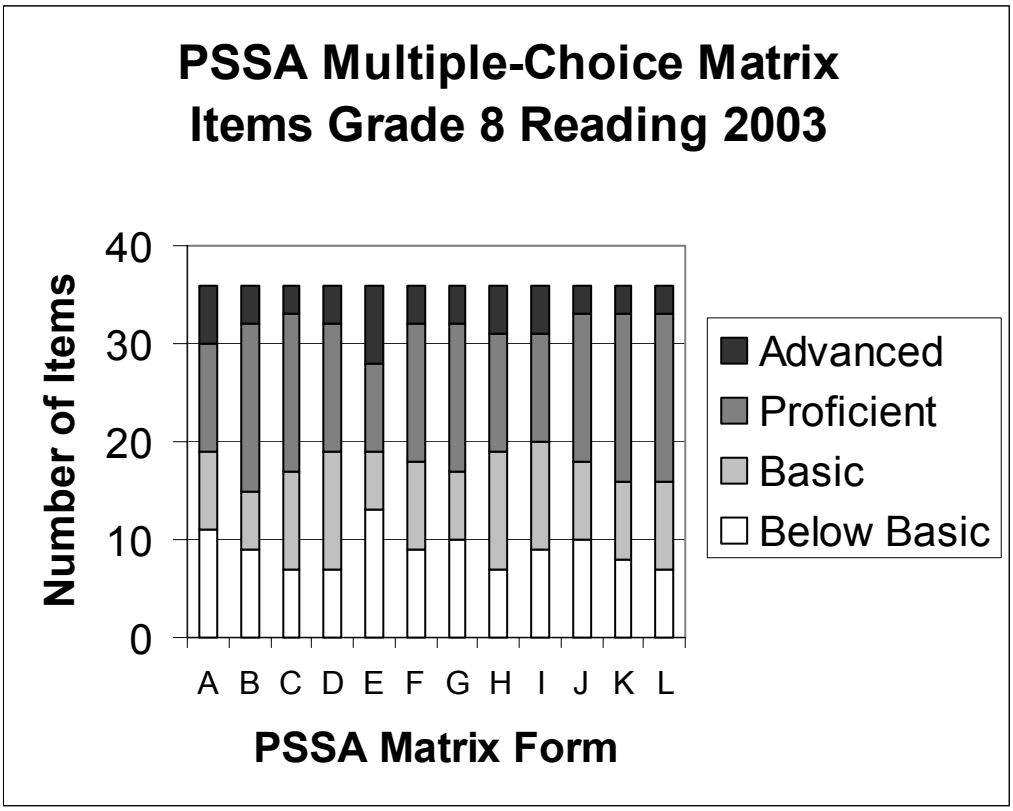
25
20
15
10
5
0
A B C D E F G H I J K L
PSSA Matrix Form
Advanced
Proficient
Basic
Below Basic


PSSA Multiple-Choice Matrix
Items Grade 8 Reading 2003
Number of Items
40
30
20
10
0
A B C D E F G H I J K L
PSSA Matrix Form
Advanced
Proficient
Basic
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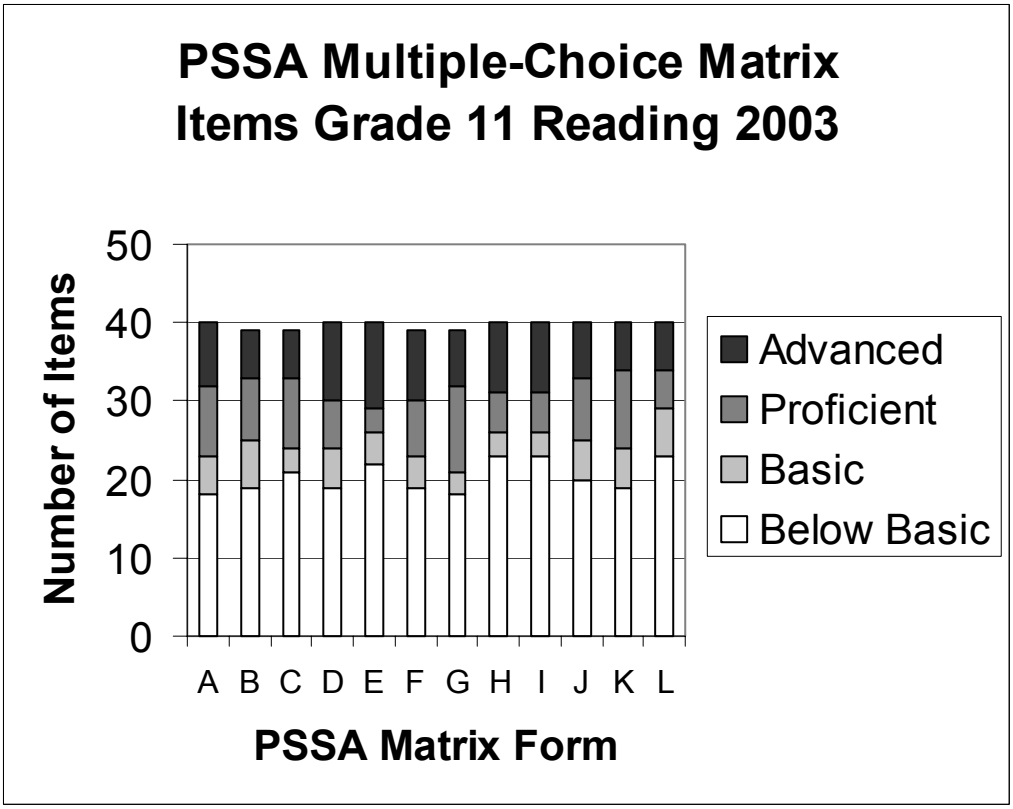
PSSA Multiple-Choice Matrix
Items Grade 11 Reading 2003
Number of Items
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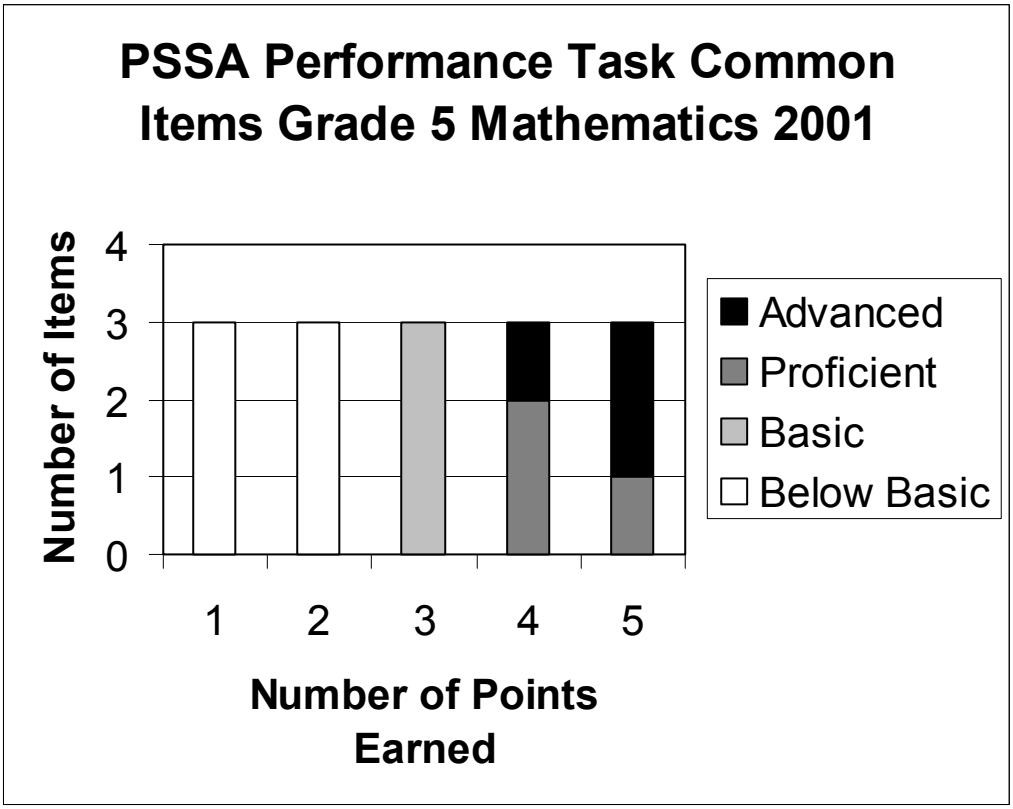
A B C D E F G H I J K L
PSSA Matrix Form
Advanced
Proficient
Basic
Below Basic

Appendix F
Graphs of Performance-Task Common Items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Number of Items
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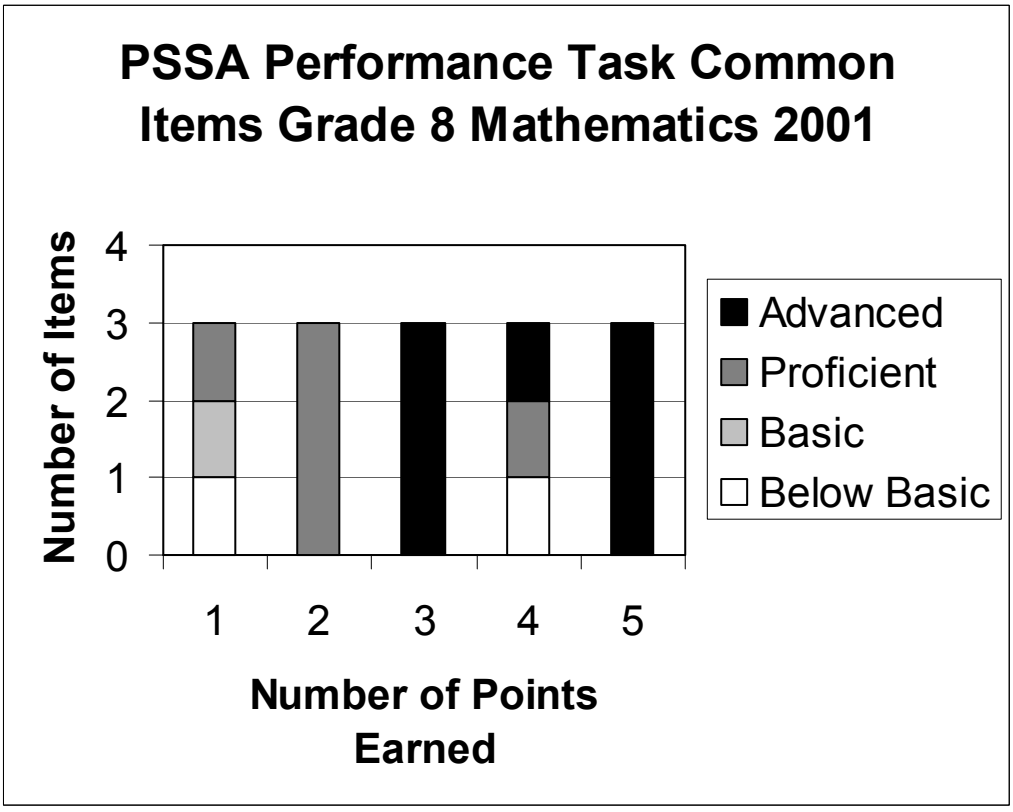
2
3
4
1
2
3
4
5
Number of Points Earned
Advanced
Proficient
Basic
Below Basic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Number of Items
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2
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Number of Points Earned
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Proficient
Basic
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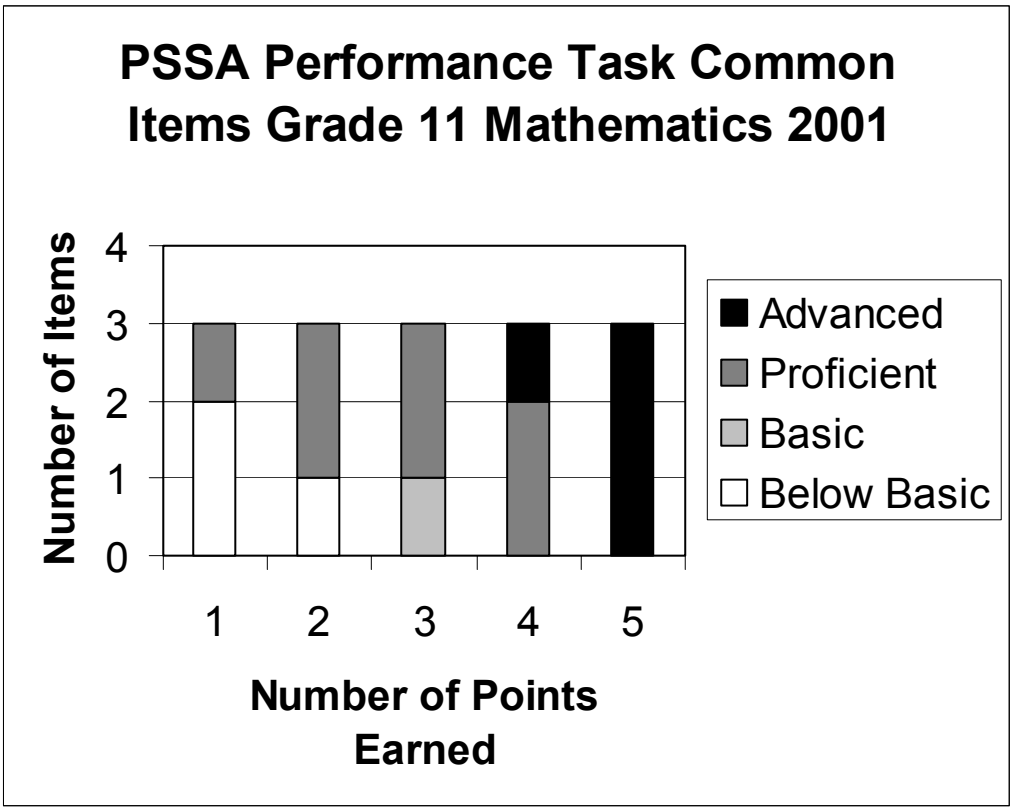
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Number of Items
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3
4
5
Number of Points Earned
Advanced
Proficient
Basic
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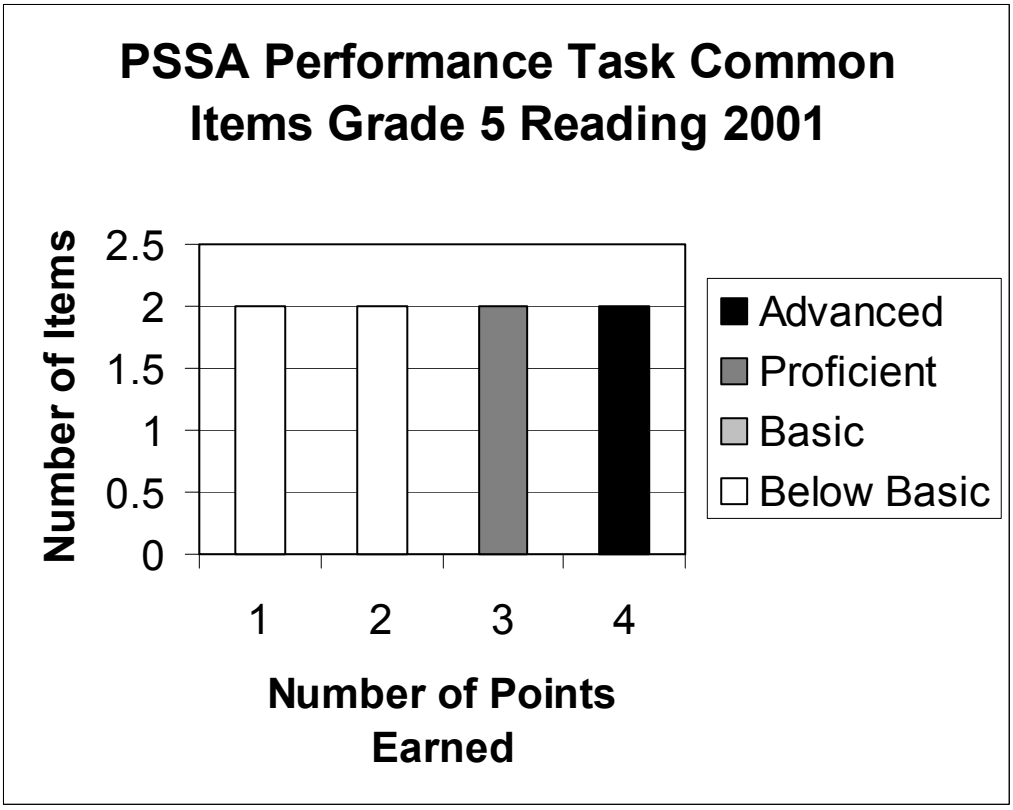
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2
3
4
Number of Points Earned
Advanced
Proficient
Basic
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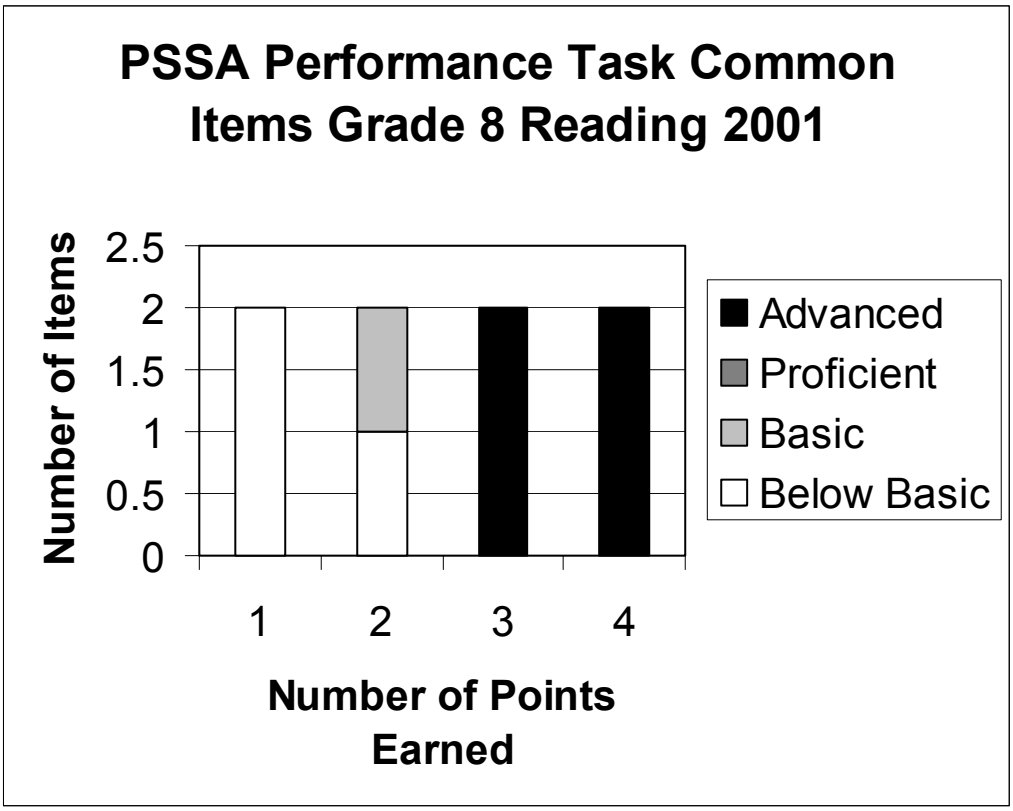
PSSA Performance Task Common Items Grade 8 Reading 2001
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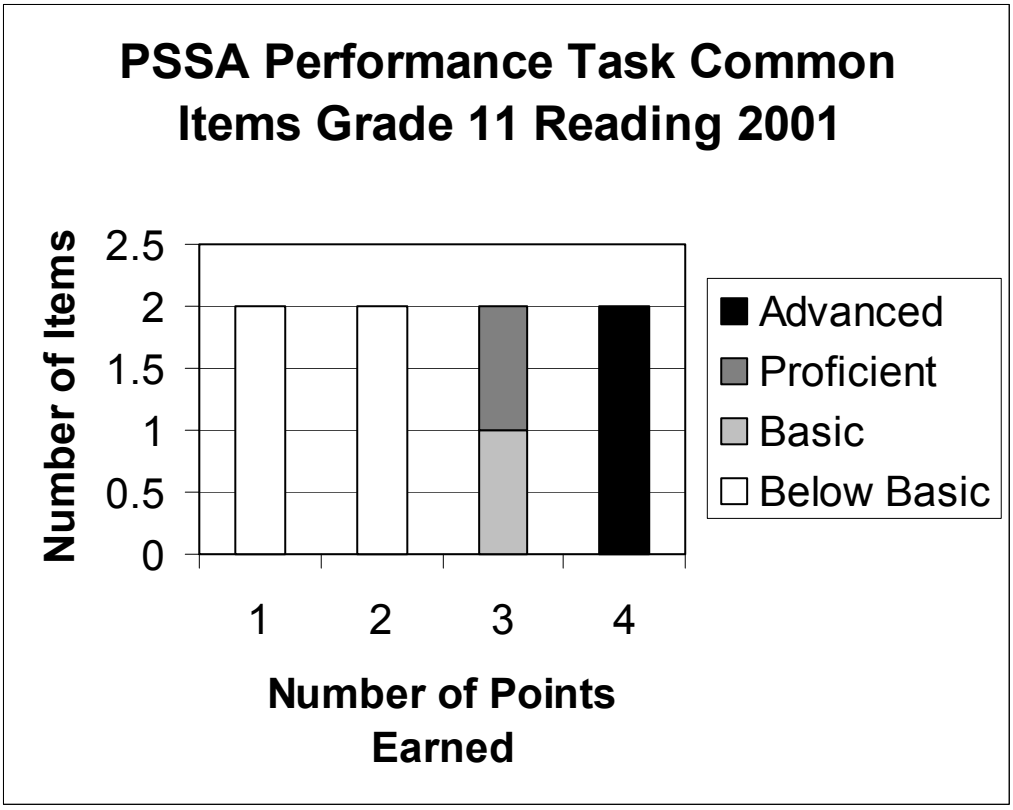
0
1
2
3
4
Number of Points Earned
Advanced
Proficient
Basic
Below Basic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Number of Points Earned
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Proficient
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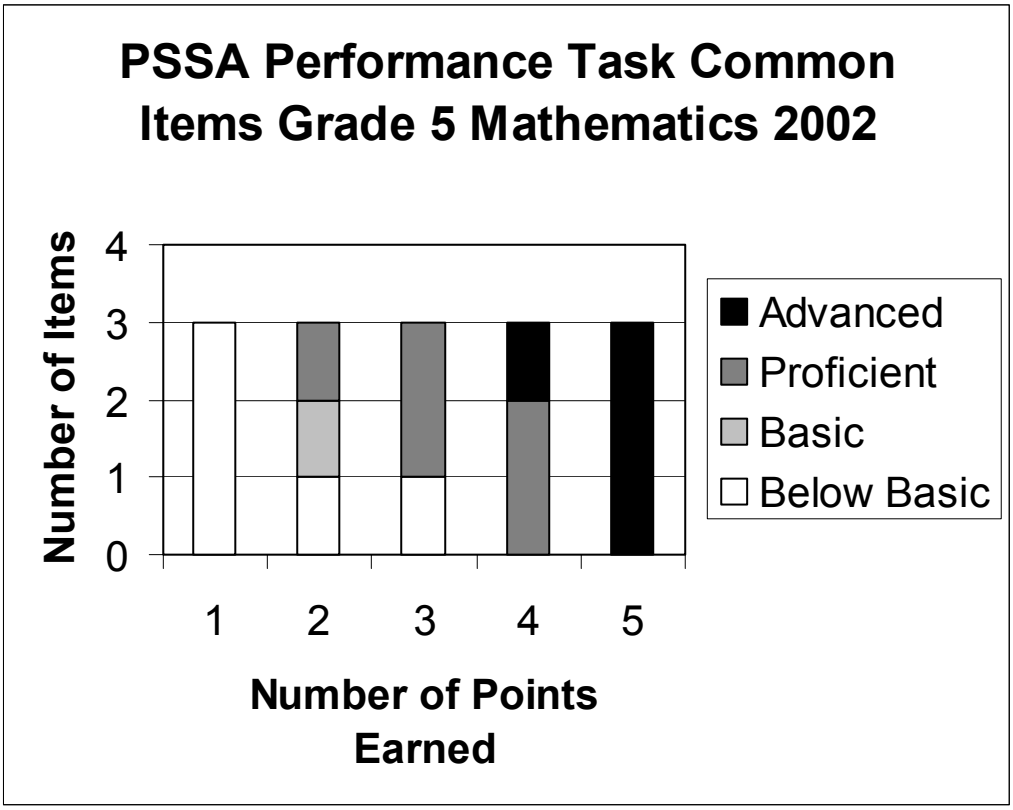
PSSA Performance Task Common Items Grade 5 Mathematics 2002
Number of Items
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Number of Points Earned
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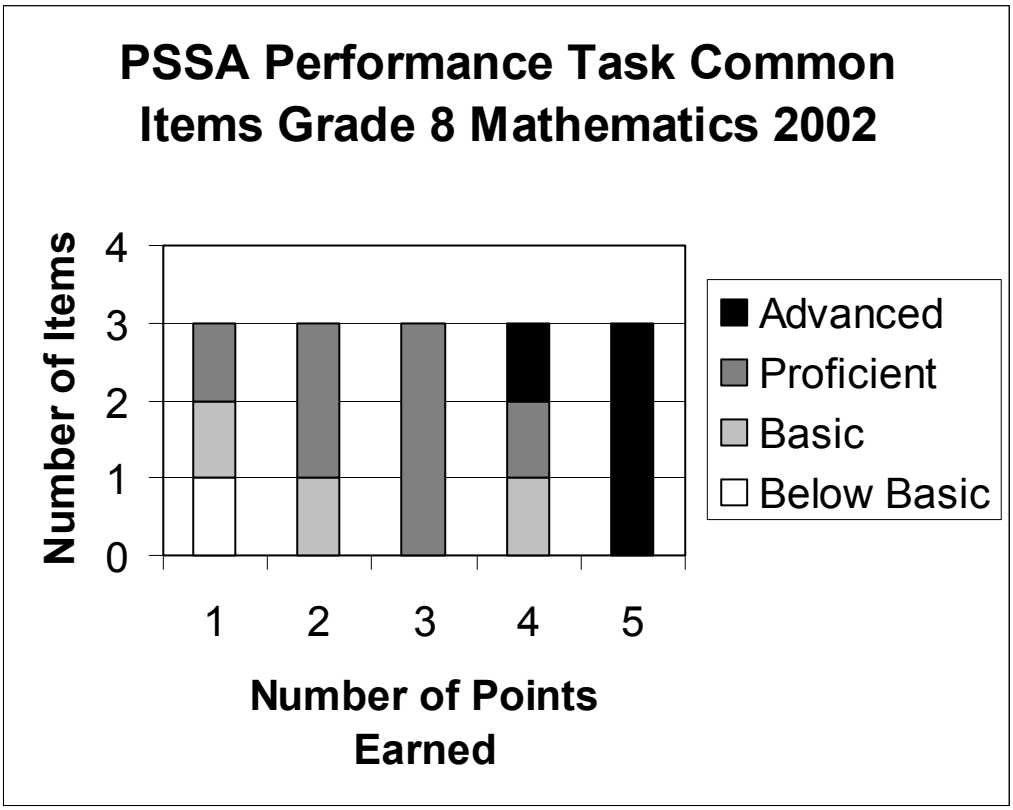
PSSA Performance Task Common Items Grade 8 Mathematics 2002
Number of Items
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Number of Points Earned
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Proficient
Basic
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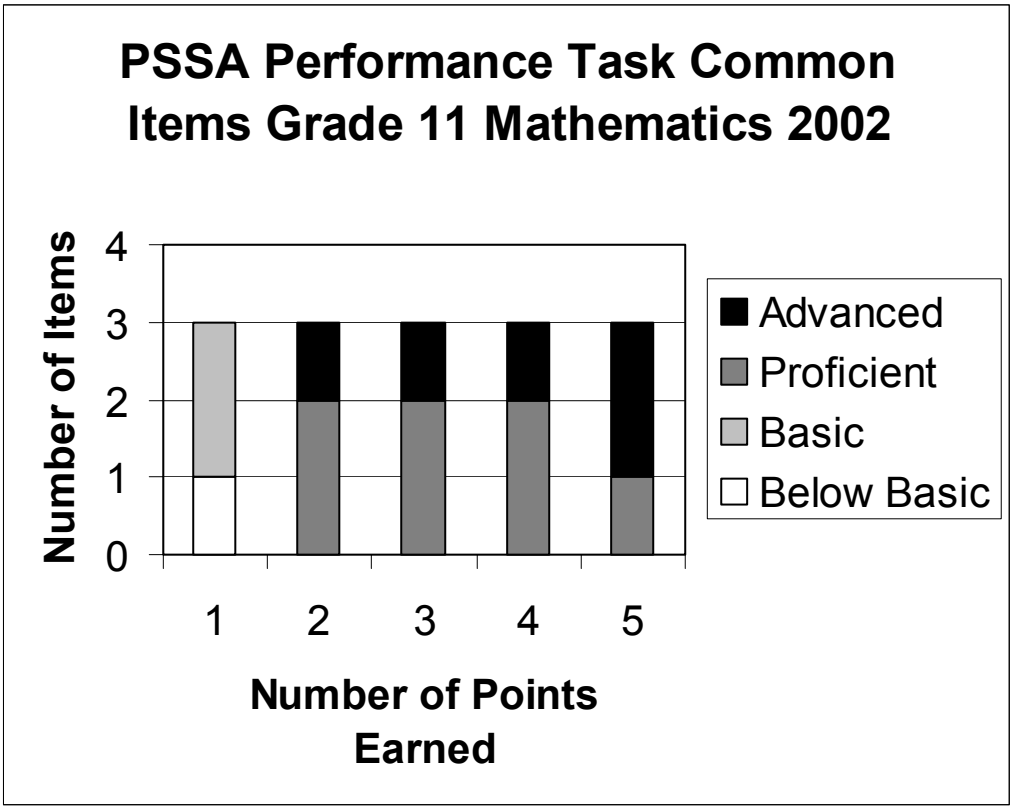
PSSA Performance Task Common Items Grade 11 Mathematics 2002
Number of Items
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Number of Points Earned
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Proficient
Basic
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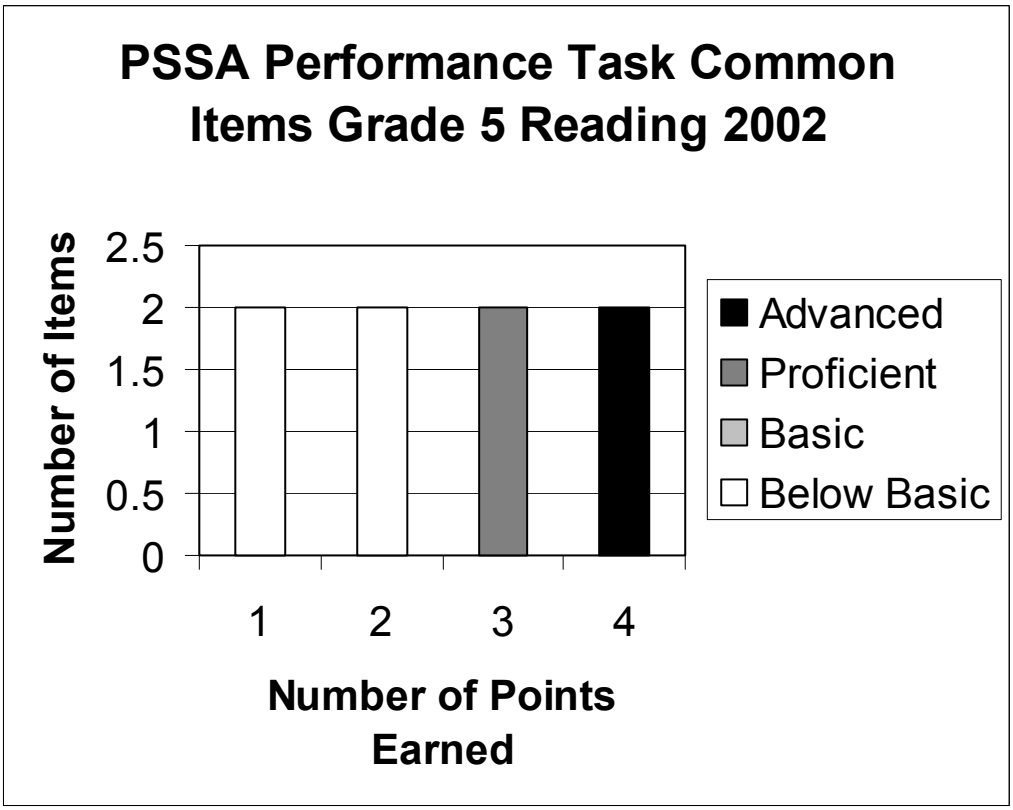
PSSA Performance Task Common Items Grade 5 Reading 2002
Number of Items
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Number of Points Earned
Advanced
Proficient
Basic
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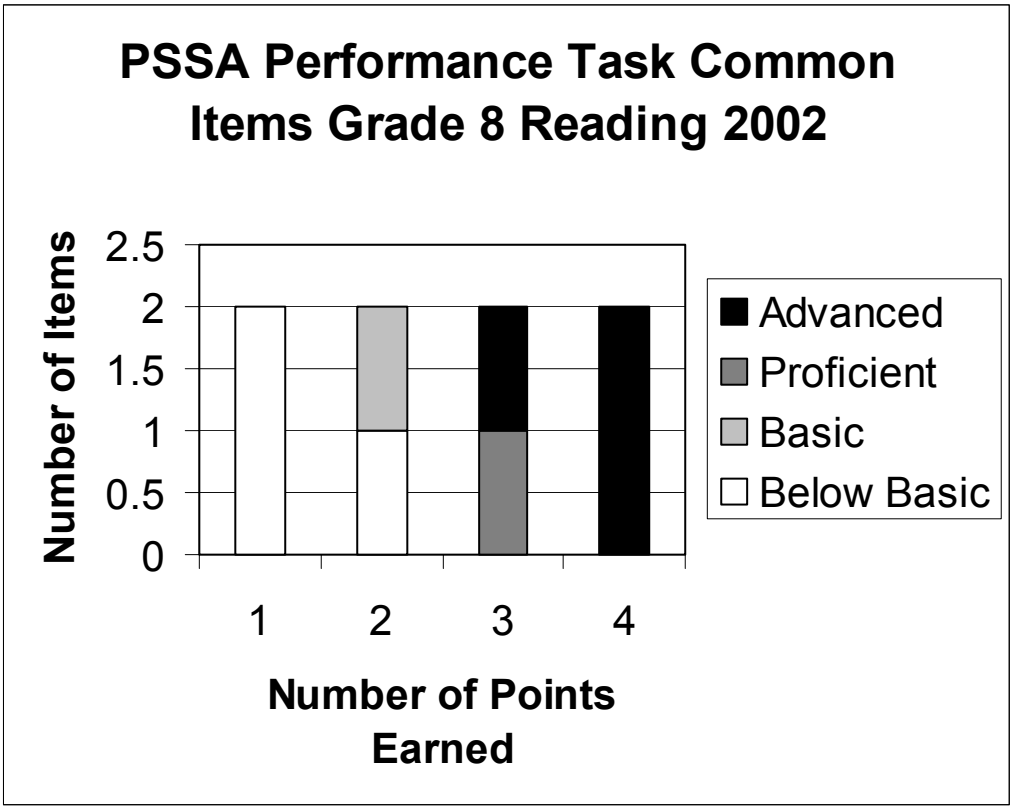
PSSA Performance Task Common Items Grade 8 Reading 2002
Number of Items
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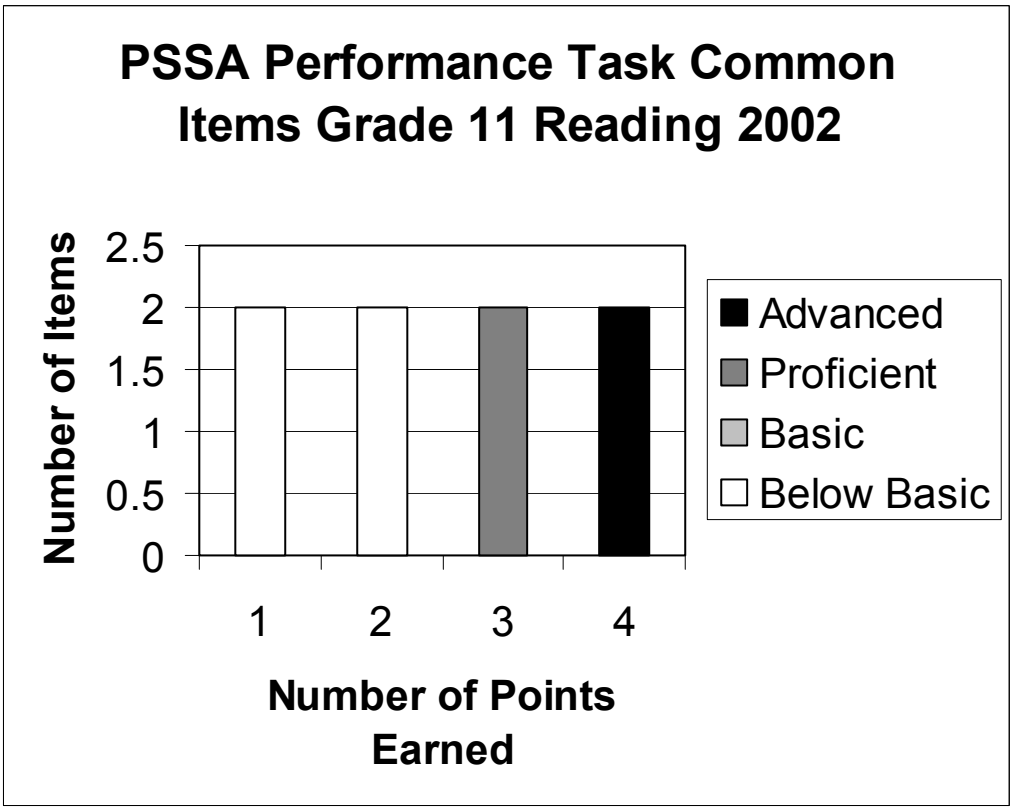
Number of Points Earned
Advanced
Proficient
Basic
Below Basic


PSSA Performance Task Common Items Grade 11 Reading 2002
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2
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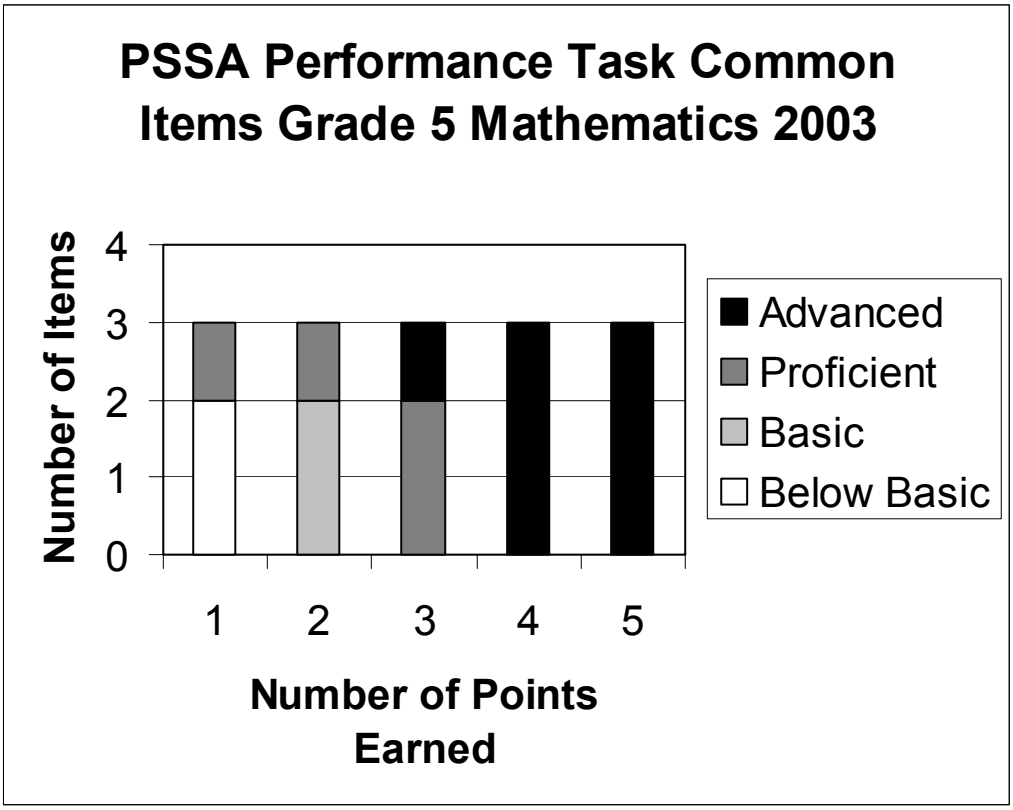
4
Number of Points Earned
Advanced
Proficient
Basic
Below Basic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Number of Items
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5
Number of Points Earned
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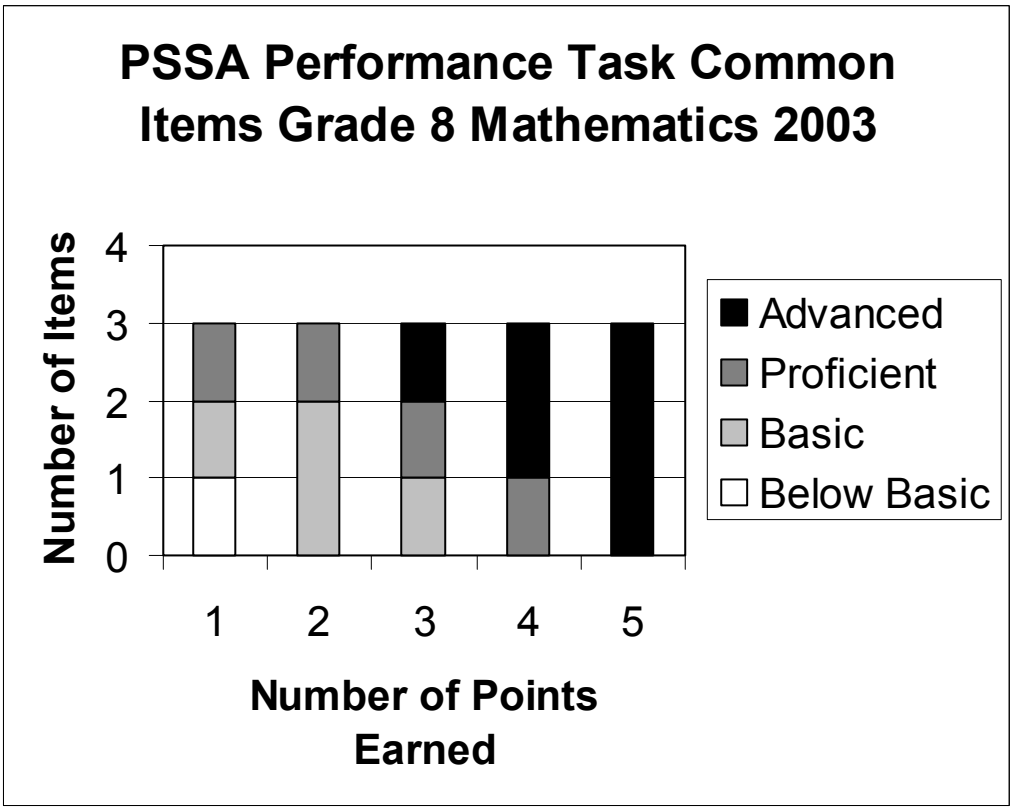
Proficient
Basic
Below Basic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Number of Items
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Number of Points Earned
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Basic
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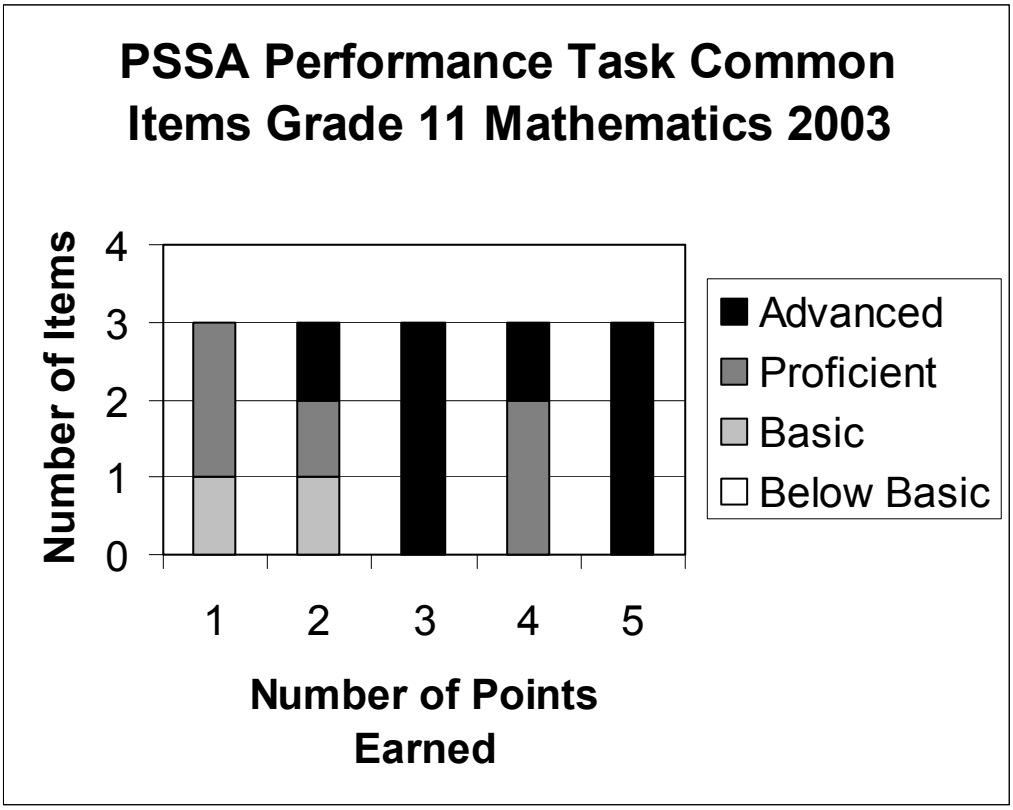
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Number of Items
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3
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Number of Points Earned
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Basic
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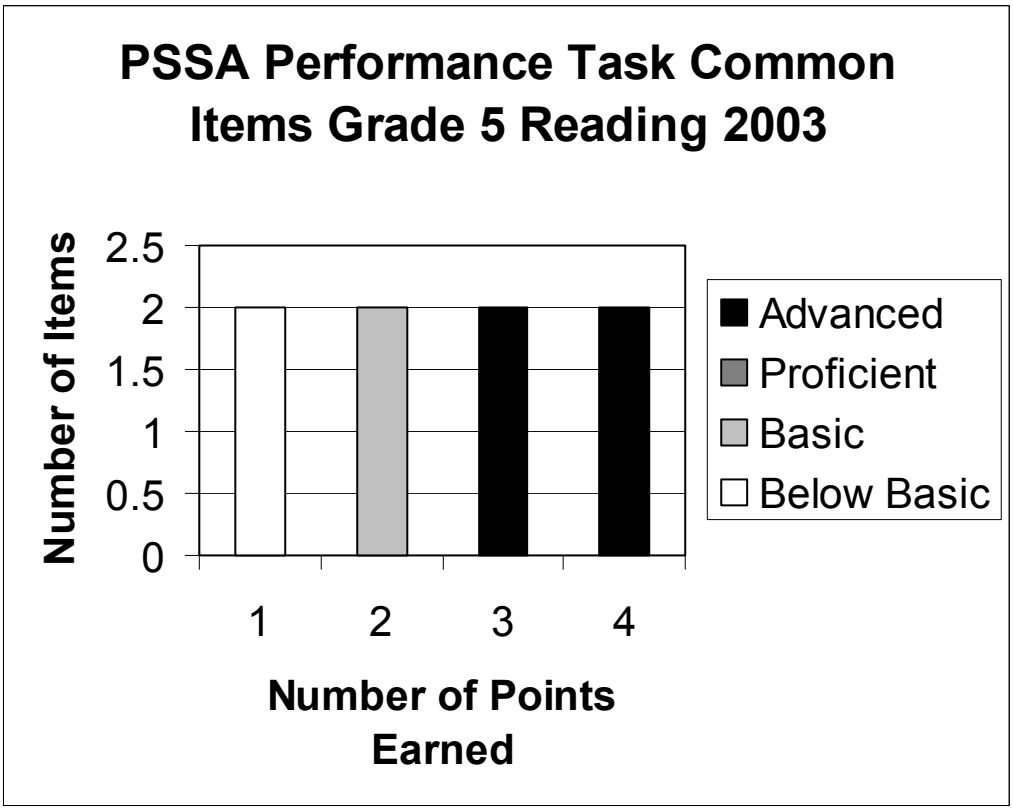
PSSA Performance Task Common Items Grade 5 Reading 2003
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1
2
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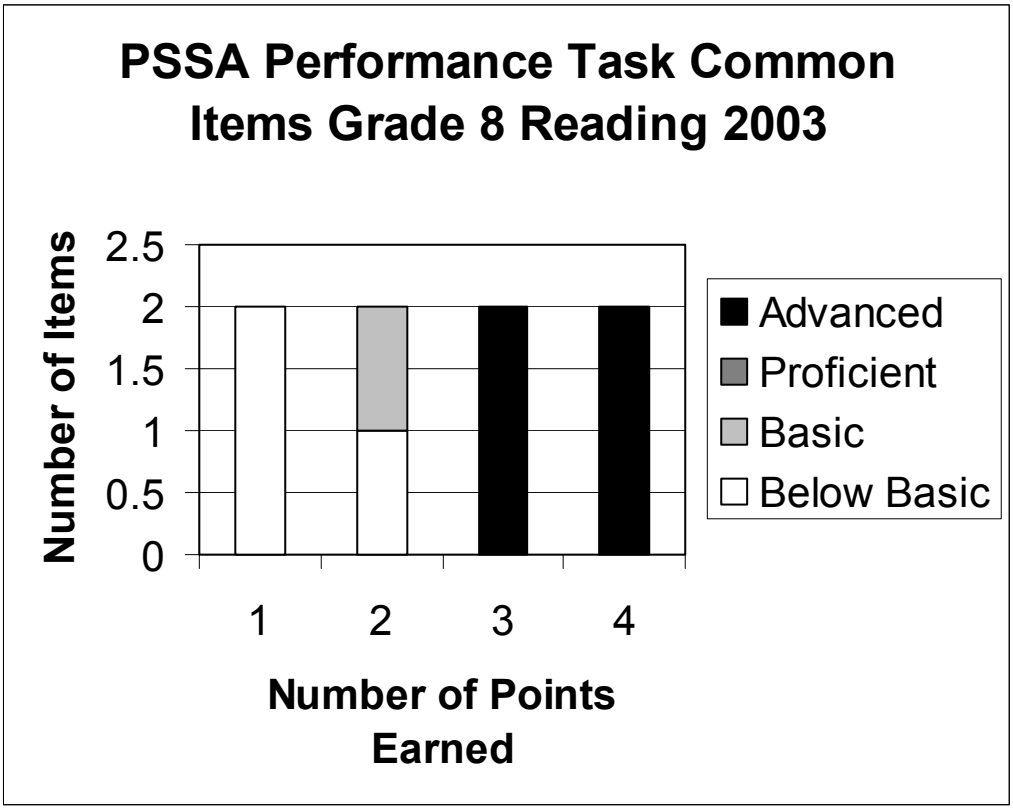
4
Number of Points Earned
Advanced
Proficient
Basic
Below Basic


PSSA Performance Task Common Items Grade 8 Reading 2003
Number of Items
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1
2
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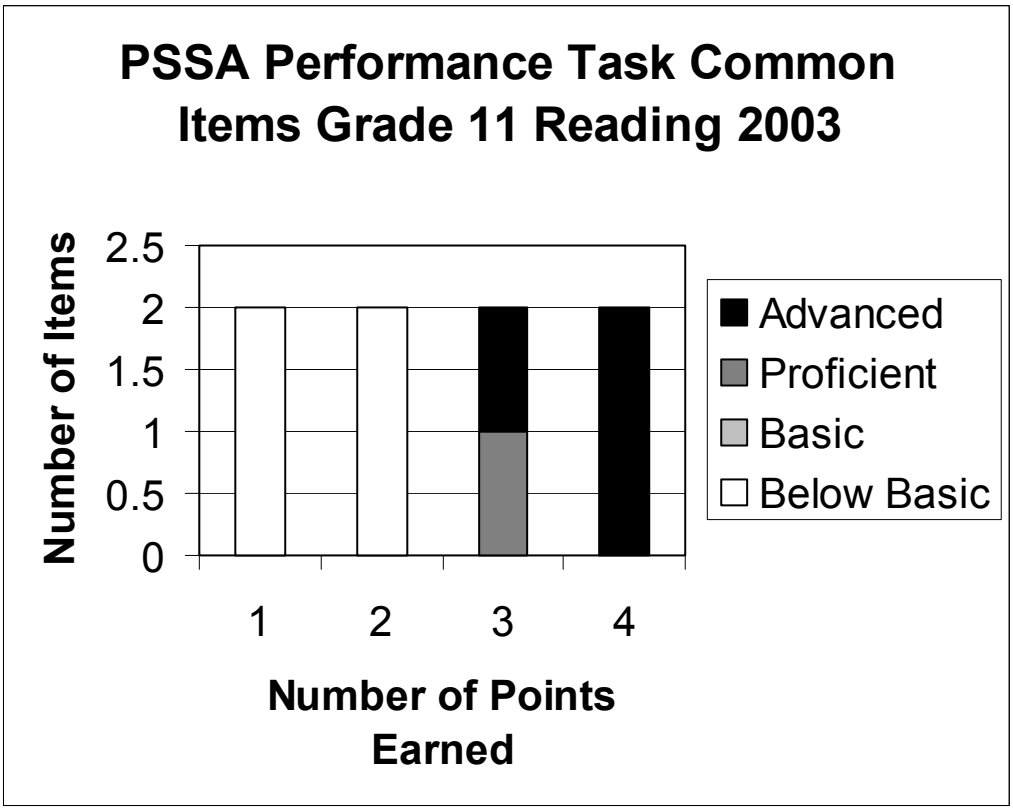
4
Number of Points Earned
Advanced
Proficient
Basic
Below Basic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Number of Items
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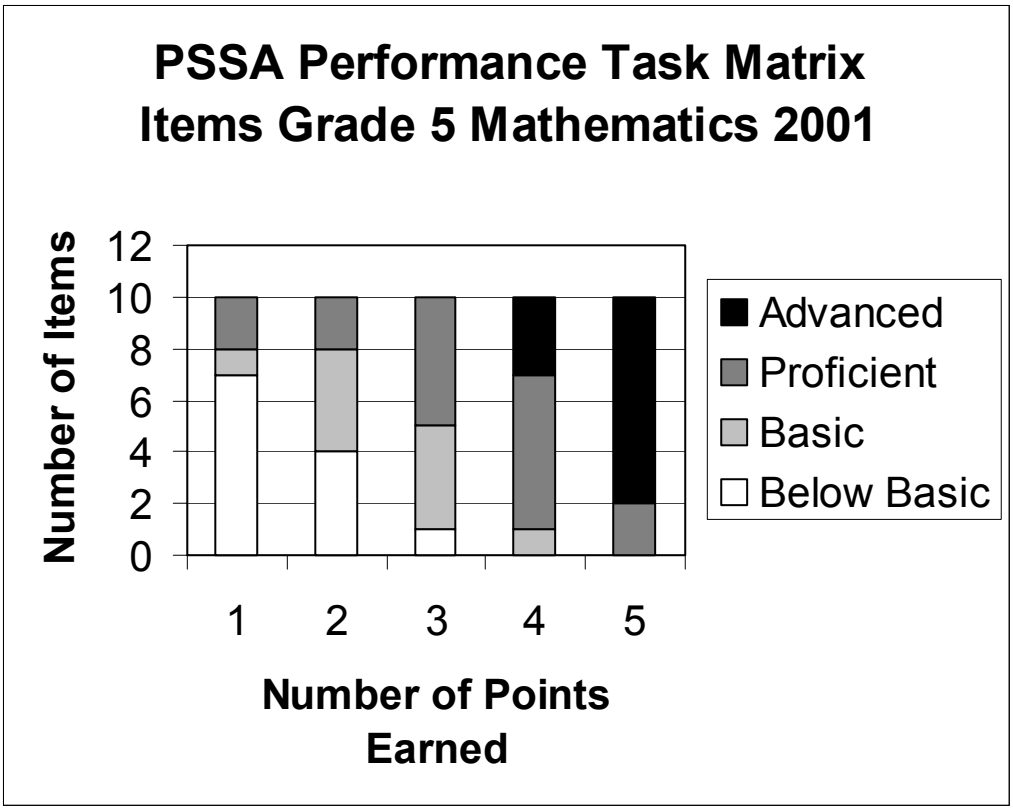
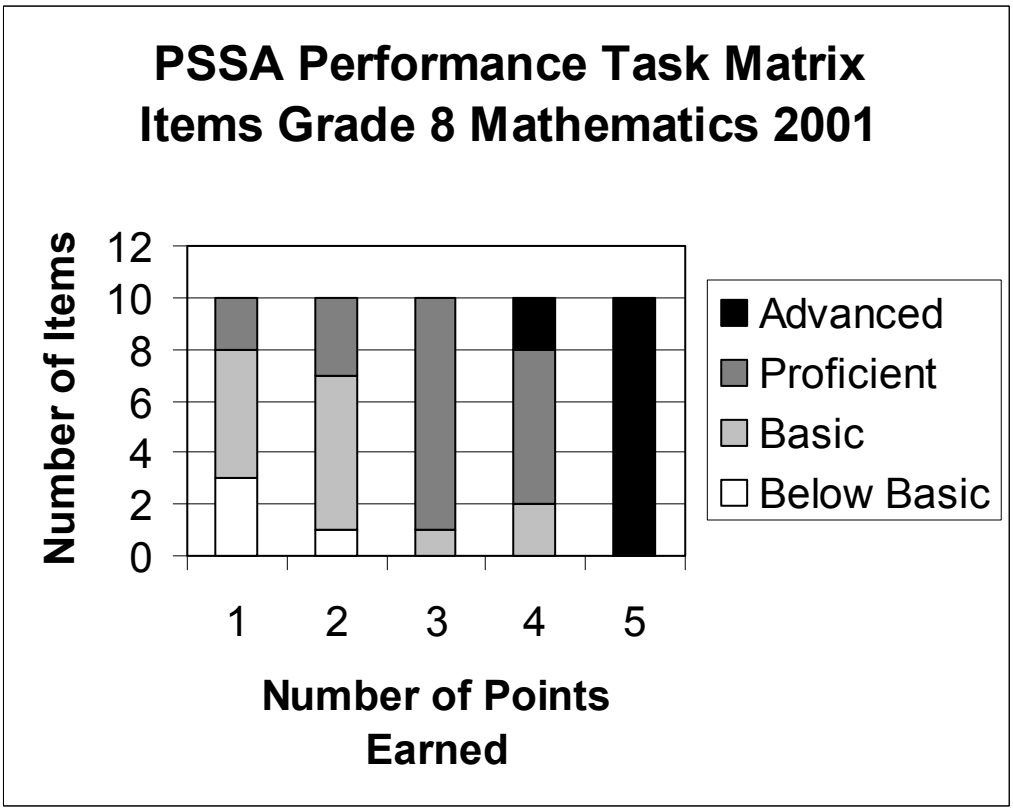
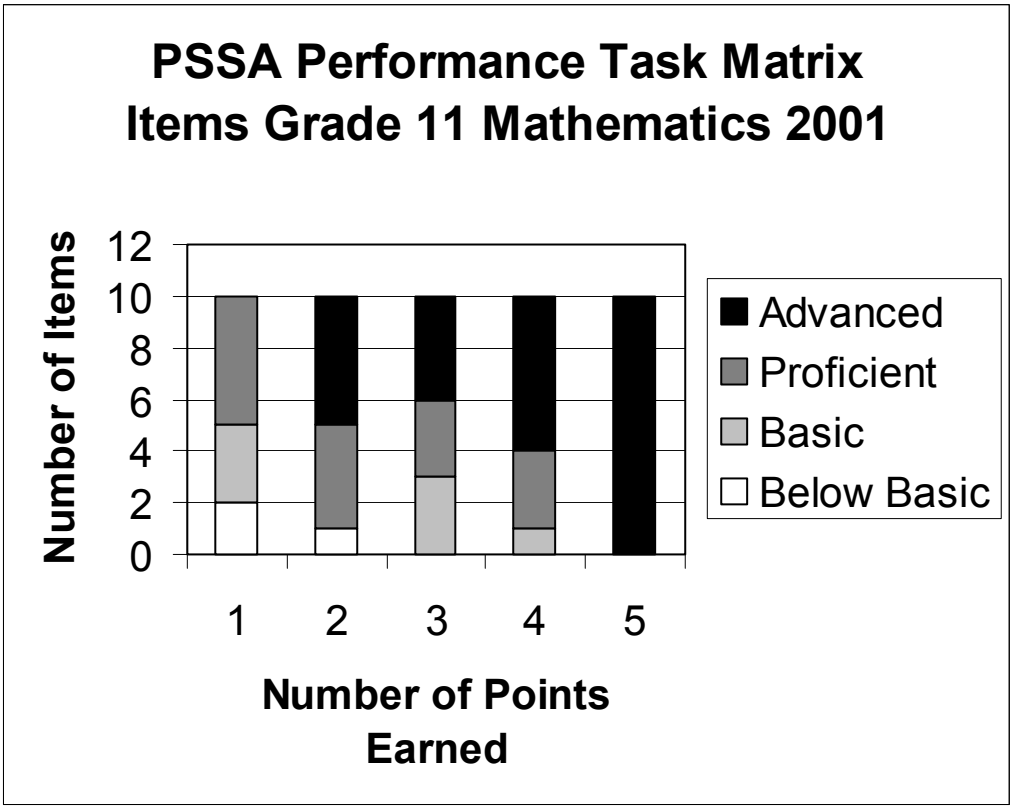
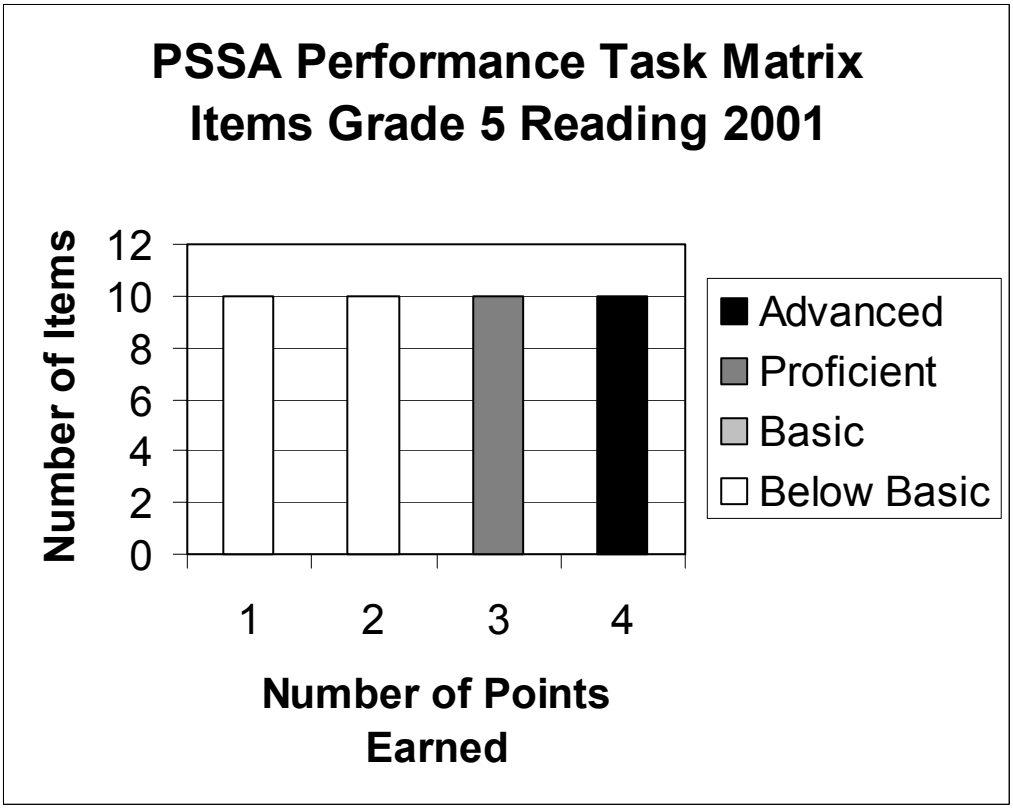
1.5
1
0.5
0
1
2
3
4
Number of Points Earned
Advanced
Proficient
Basic
Below Basic

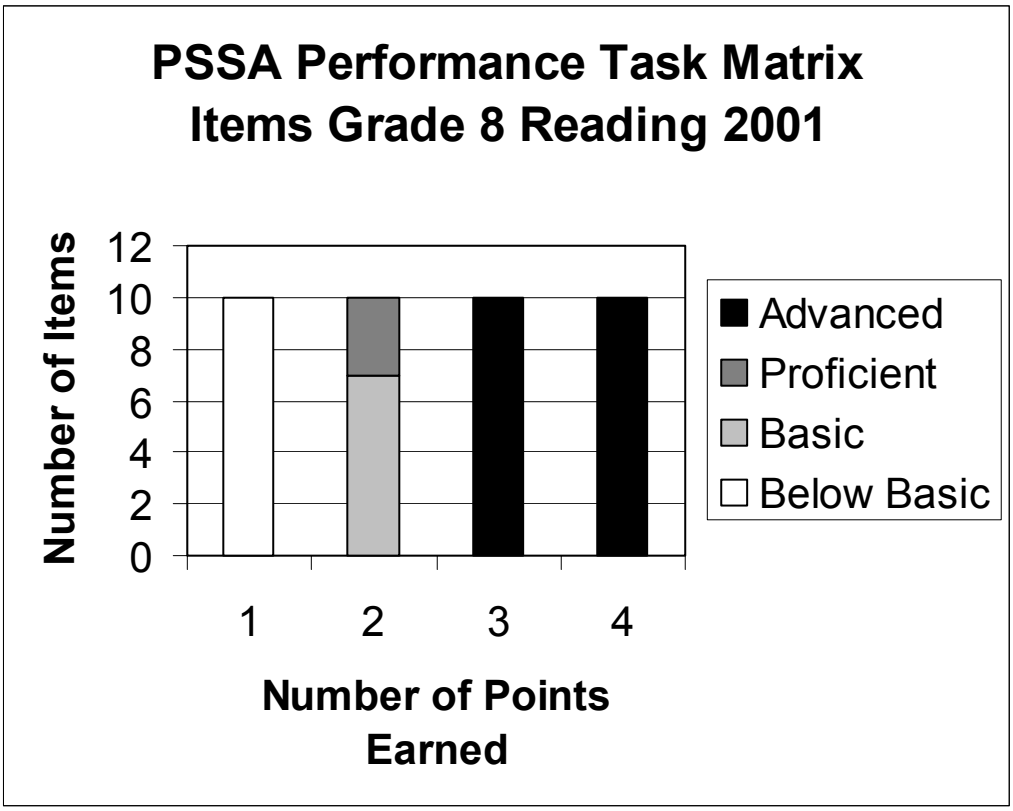
Appendix G
Graphs of Performance-Task Matrix Items

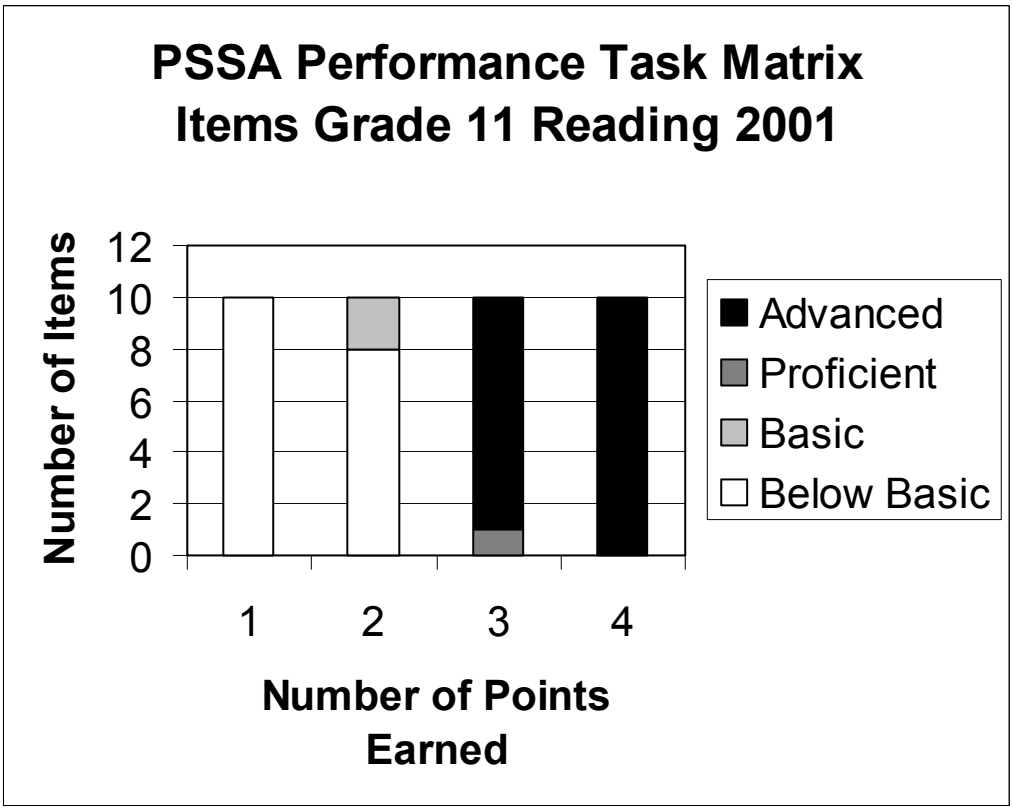

PSSA Performance Task Matrix
Items Grade 5 Mathematics 2001
Number of Items
12
10
8
6
4
2
0
1
2
3
4
5
Number of Points Earned
Advanced
Proficient
Basic
Below Basic

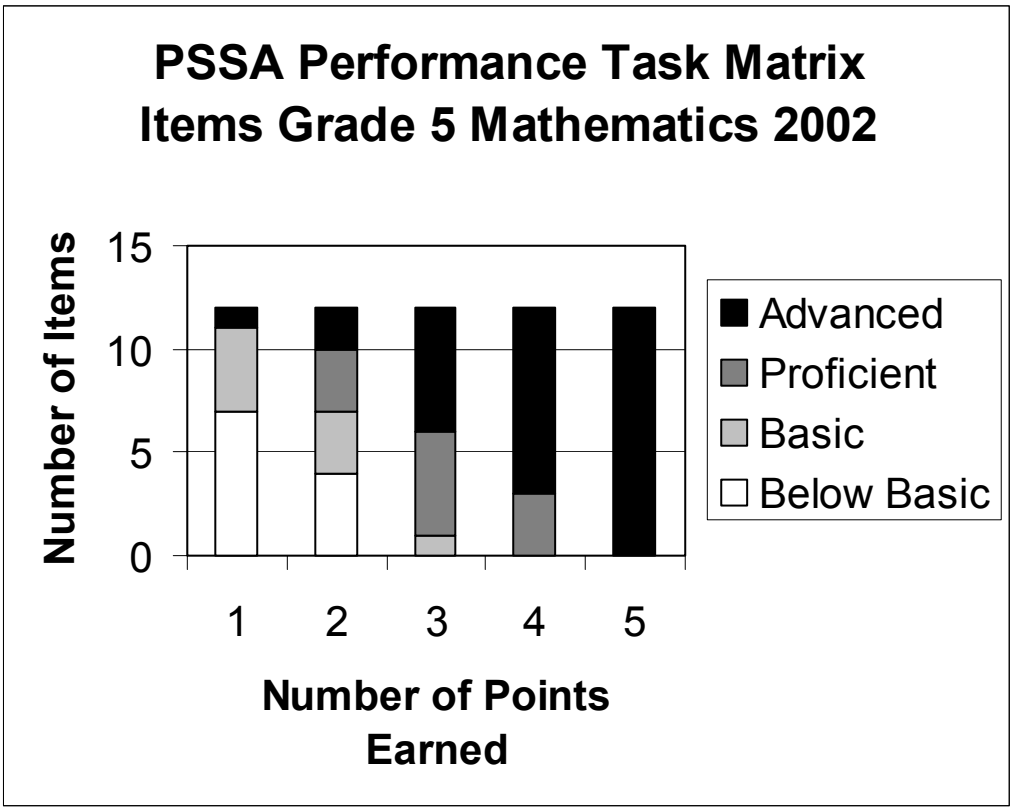

PSSA Performance Task Matrix
Items Grade 8 Mathematics 2001
Number of Items
12
10
8
6
4
2
0
1
2
3
4
5
Number of Points Earned
Advanced
Proficient
Basic
Below Basic

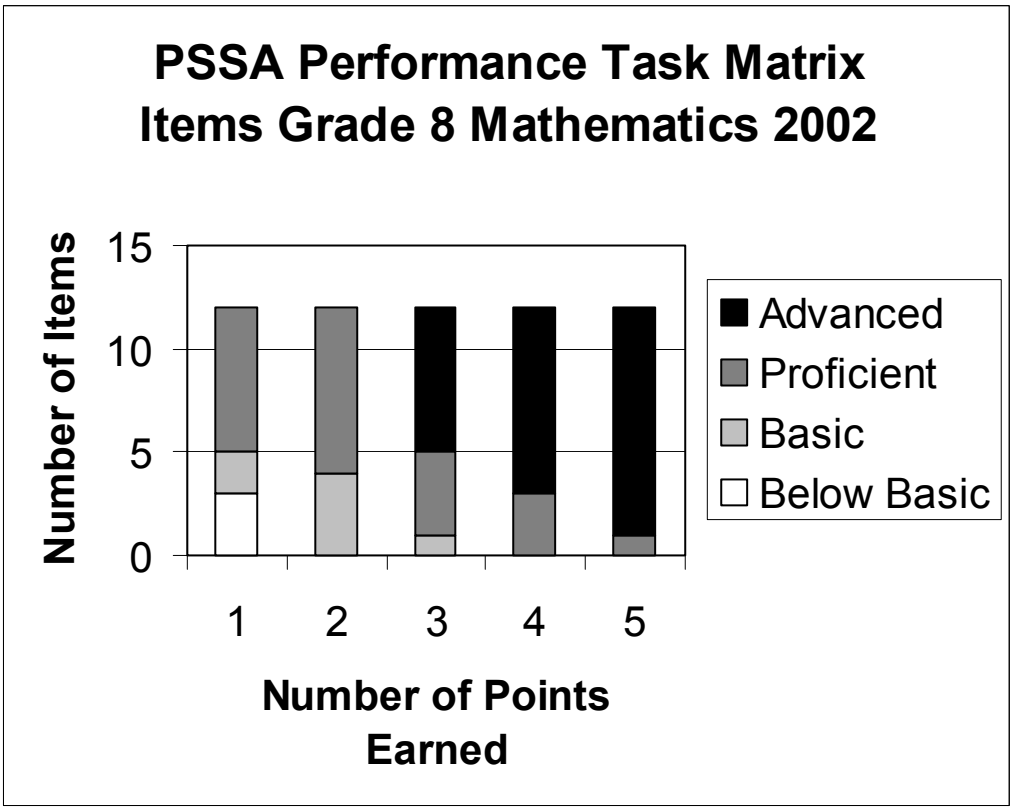

PSSA Performance Task Matrix
Items Grade 11 Mathematics 2001
Number of Items
12
10
8
6
4
2
0
1
2
3
4
5
Number of Points Earned
Advanced
Proficient
Basic
Below Basic

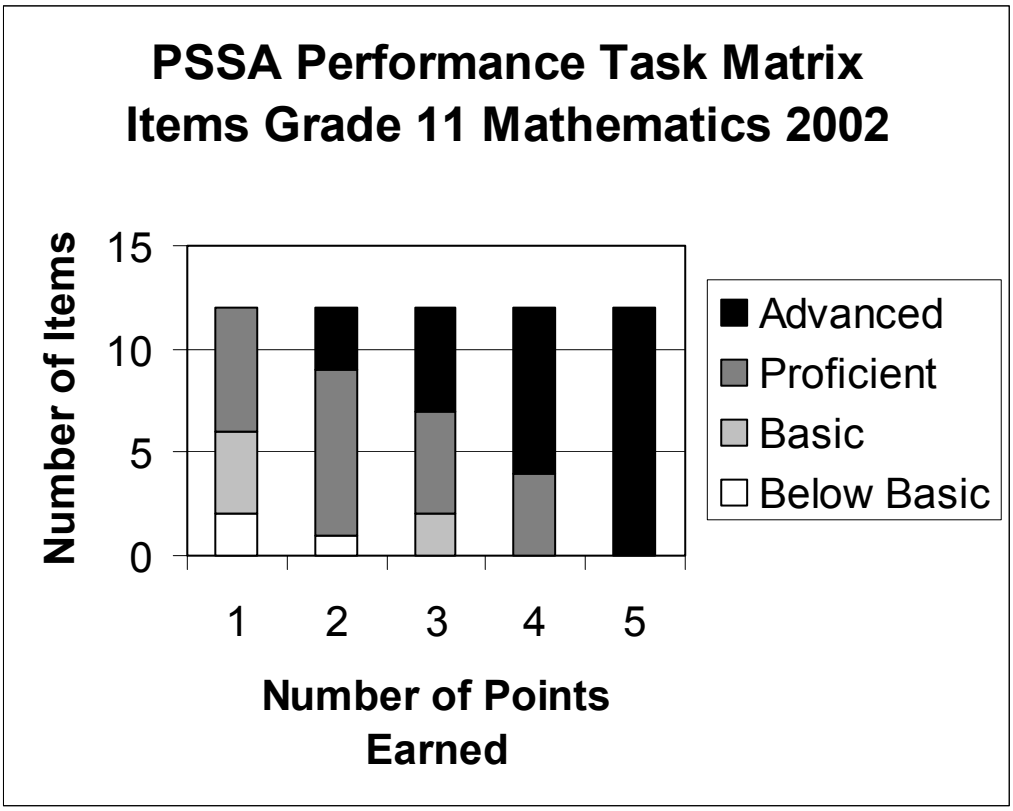

PSSA Performance Task Matrix
Items Grade 5 Reading 2001
Number of Items
12
10
8
6
4
2
0
1
2
3
4
Number of Points Earned
Advanced
Proficient
Basic
Below Basic

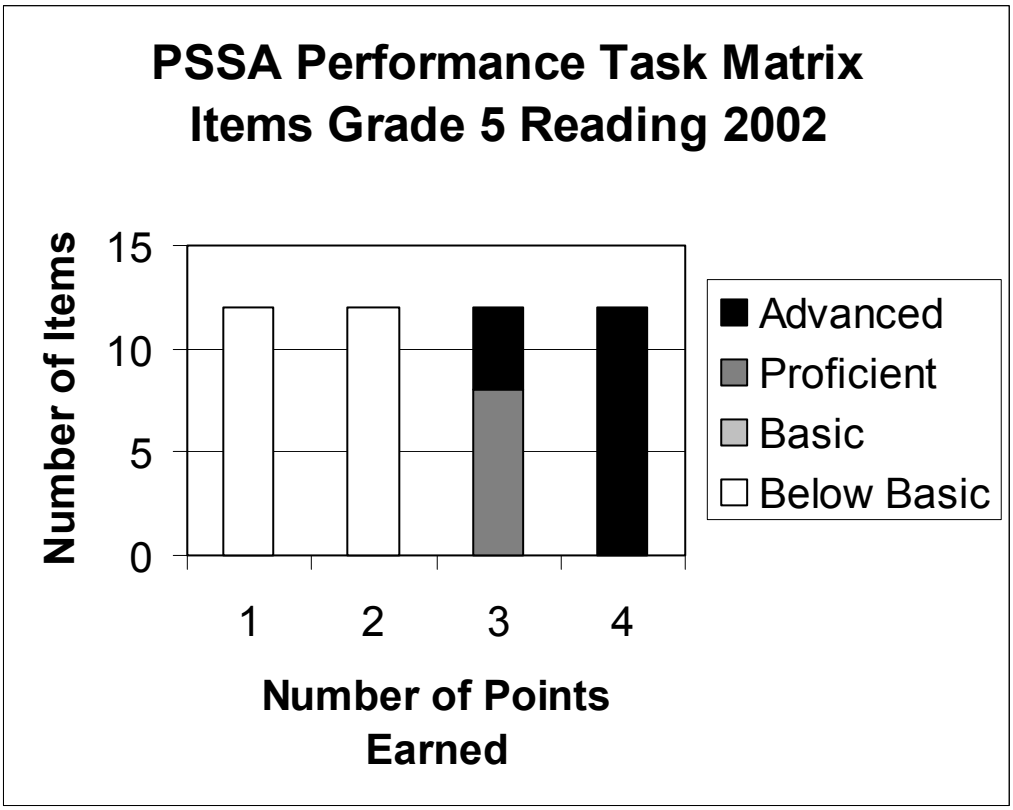

PSSA Performance Task Matrix
Items Grade 8 Reading 2001
Number of Items
12
10
8
6
4
2
0
1
2
3
4
Number of Points Earned
Advanced
Proficient
Basic
Below Basic

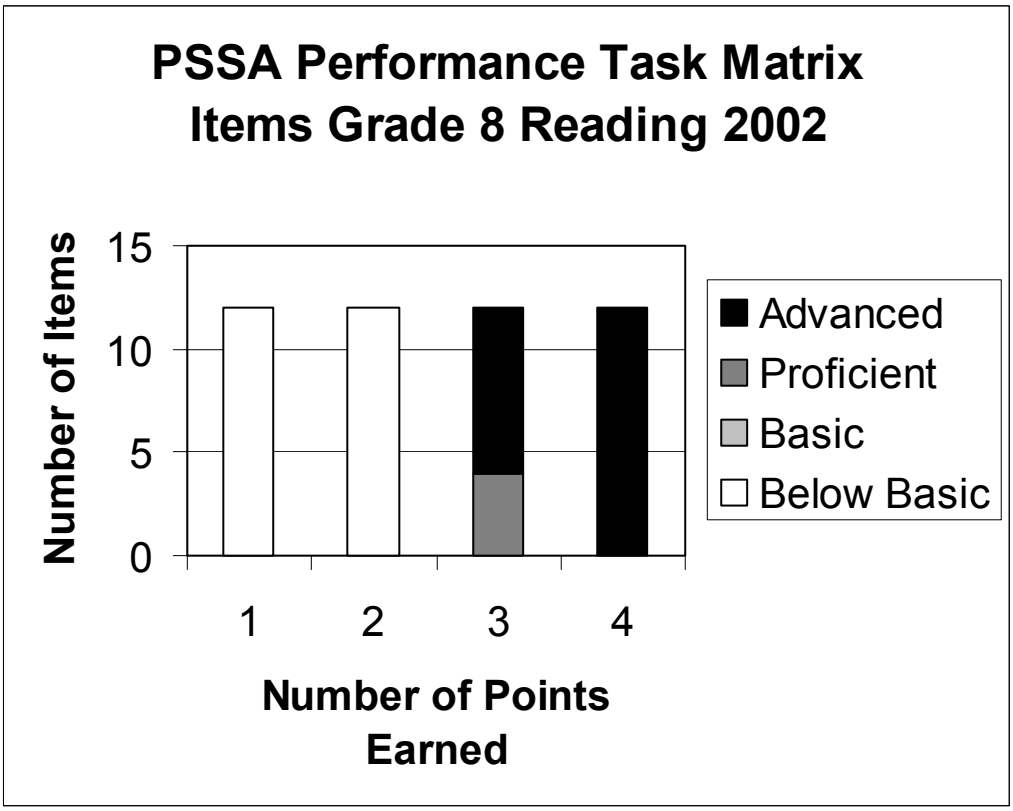

PSSA Performance Task Matrix
Items Grade 11 Reading 2001
Number of Items
12
10
8
6
4
2
0
1
2
3
4
Number of Points Earned
Advanced
Proficient
Basic
Below Basic

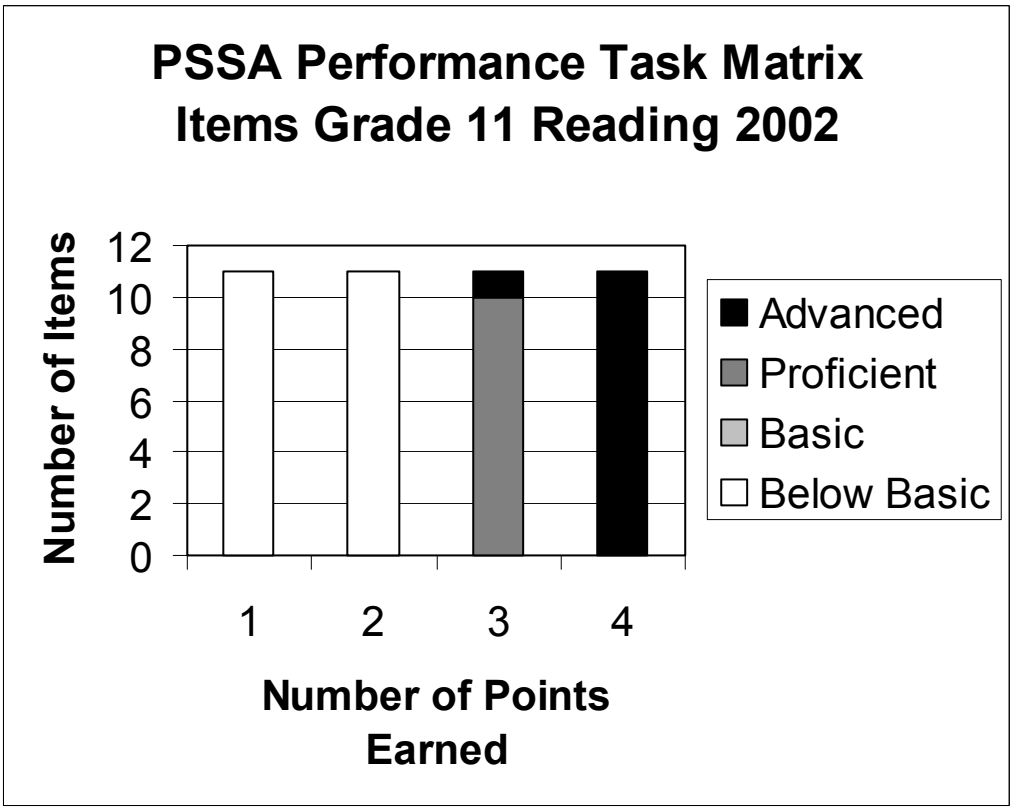

PSSA Performance Task Matrix
Items Grade 5 Mathematics 2002
Number of Items
15
10
5
0
1
2
3
4
5
Number of Points Earned
Advanced
Proficient
Basic
Below Basic

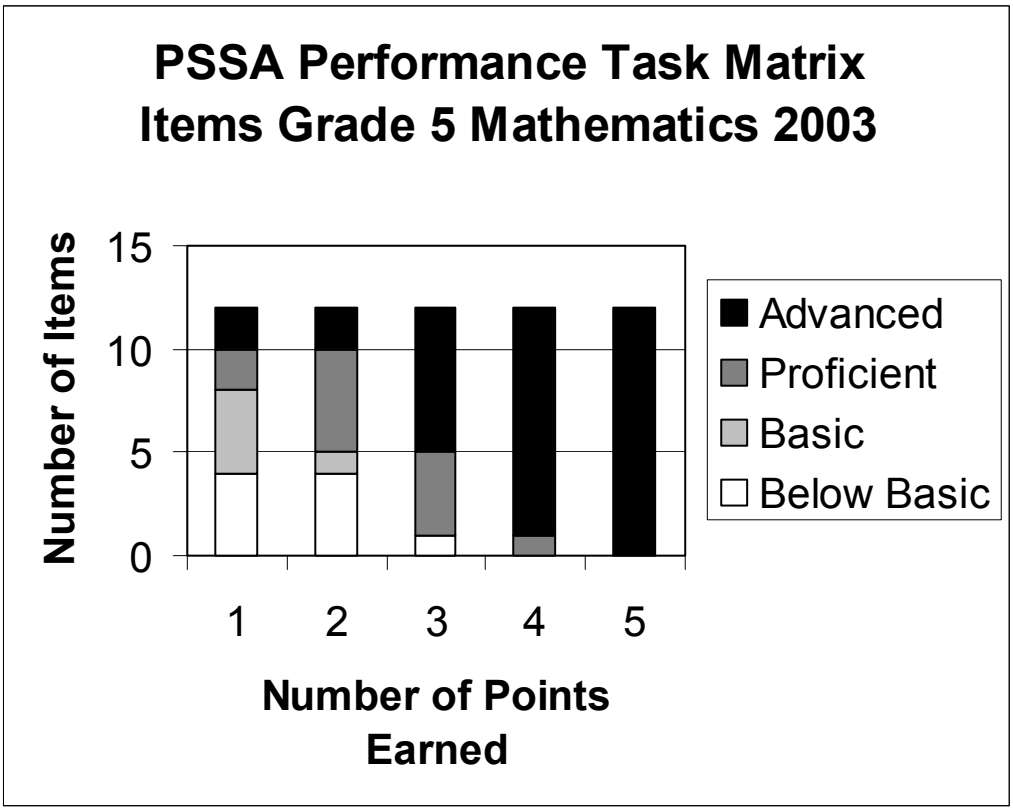

PSSA Performance Task Matrix
Items Grade 8 Mathematics 2002
Number of Items
15
10
5
0
1
2
3
4
5
Number of Points Earned
Advanced
Proficient
Basic
Below Basic

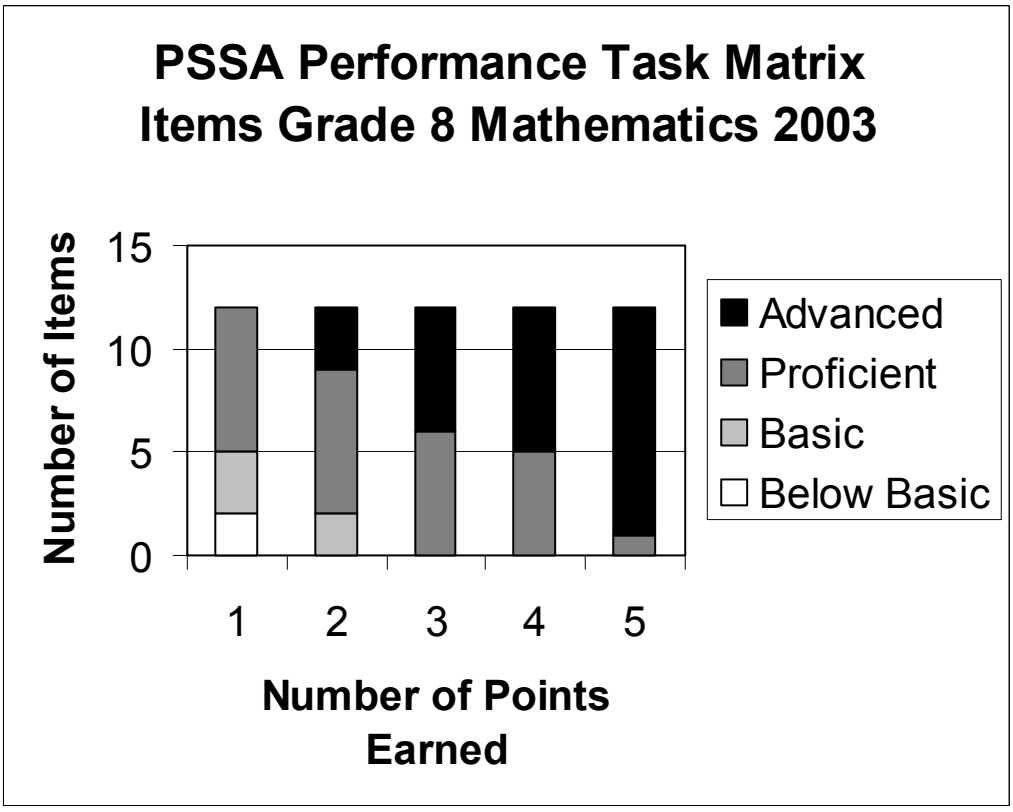

PSSA Performance Task Matrix
Items Grade 11 Mathematics 2002
Number of Items
15
10
5
0
1
2
3
4
5
Number of Points Earned
Advanced
Proficient
Basic
Below Basic

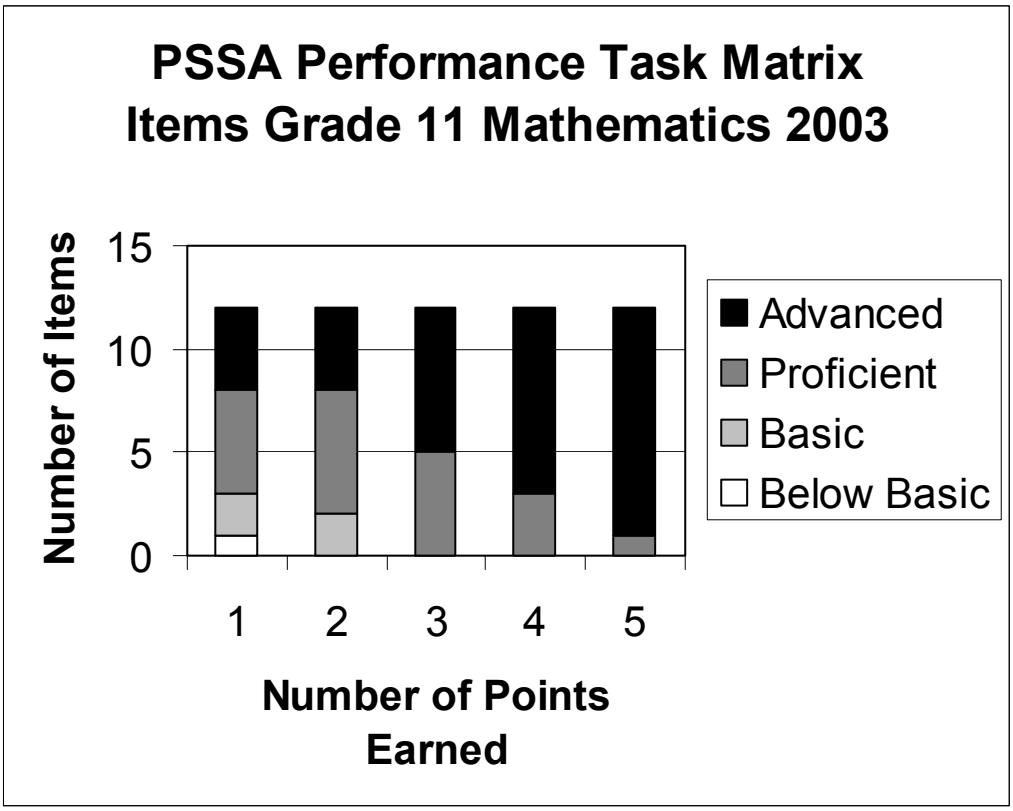

PSSA Performance Task Matrix
Items Grade 5 Reading 2002
Number of Items
15
10
5
0
1
2
3
4
Number of Points Earned
Advanced
Proficient
Basic
Below Basic

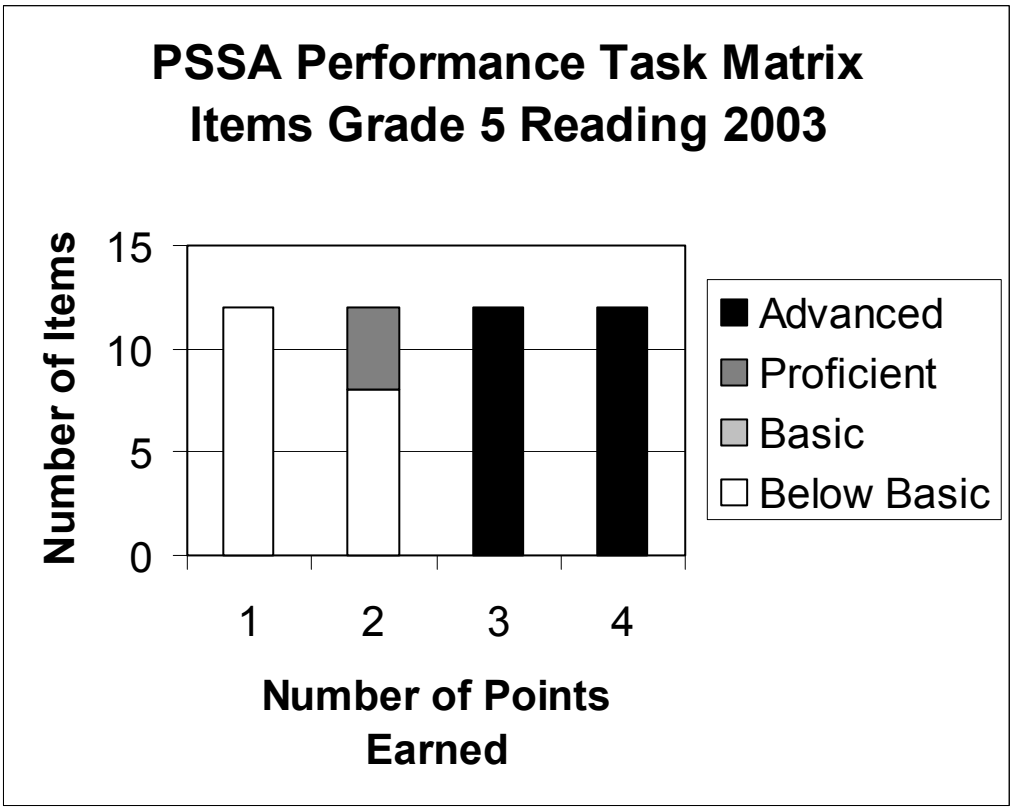

PSSA Performance Task Matrix
Items Grade 8 Reading 2002
Number of Items
15
10
5
0
1
2
3
4
Number of Points Earned
Advanced
Proficient
Basic
Below Basic

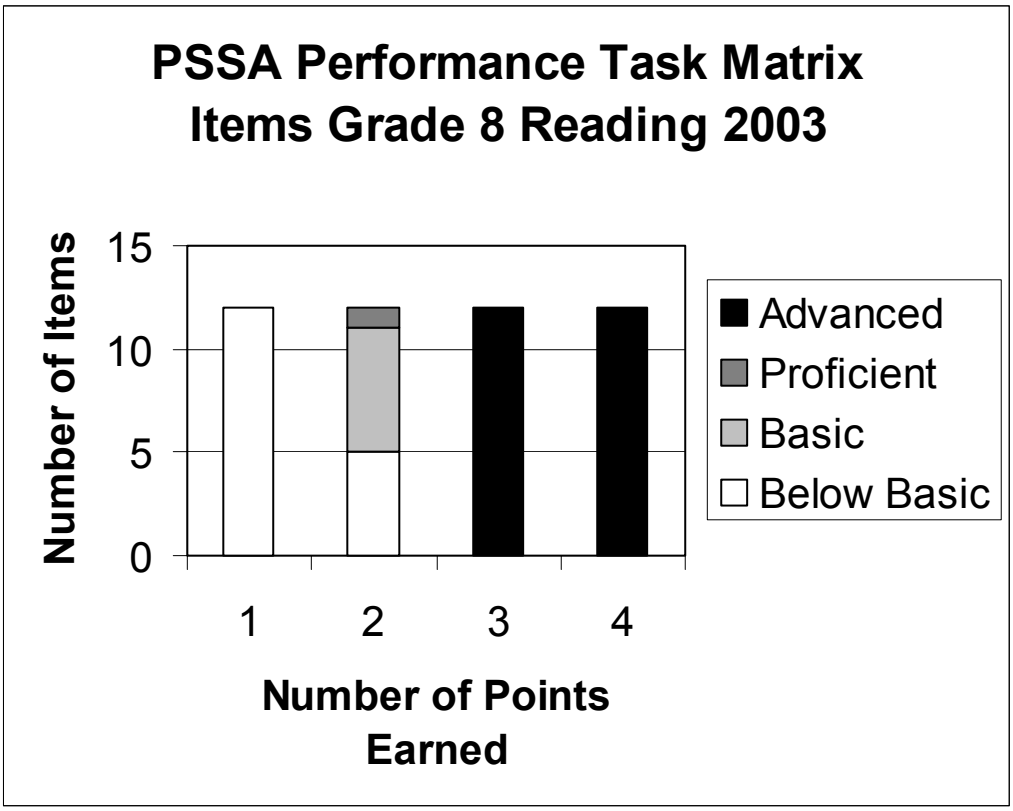

PSSA Performance Task Matrix
Items Grade 11 Reading 2002
Number of Items
12
10
8
6
4
2
0
1
2
3
4
Number of Points Earned
Advanced
Proficient
Basic
Below Basic

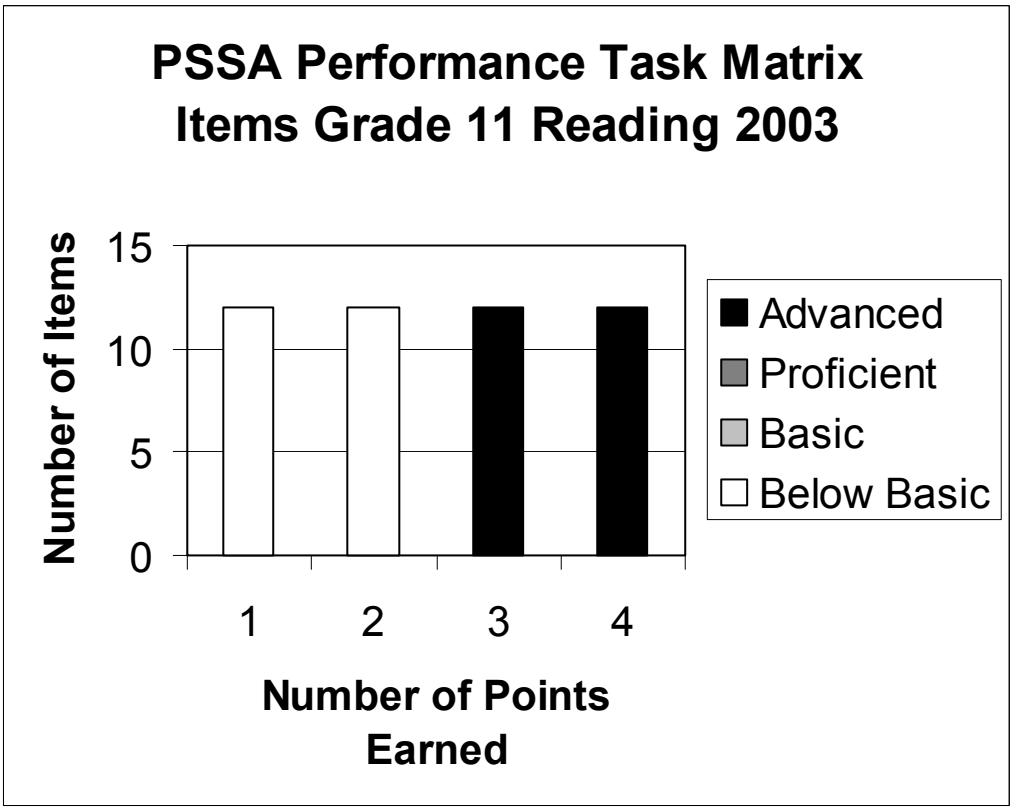

PSSA Performance Task Matrix
Items Grade 5 Mathematics 2003
Number of Items
15
10
5
0
1
2
3
4
5
Number of Points Earned
Advanced
Proficient
Basic
Below Basic


PSSA Performance Task Matrix
Items Grade 8 Mathematics 2003
Number of Items
15
10
5
0
1
2
3
4
5
Number of Points Earned
Advanced
Proficient
Basic
Below Basic


PSSA Performance Task Matrix
Items Grade 11 Mathematics 2003
Number of Items
15
10
5
0
1
2
3
4
5
Number of Points Earned
Advanced
Proficient
Basic
Below Basic


PSSA Performance Task Matrix
Items Grade 5 Reading 2003
Number of Items
15
10
5
0
1
2
3
4
Number of Points Earned
Advanced
Proficient
Basic
Below Basic


PSSA Performance Task Matrix
Items Grade 8 Reading 2003
Number of Items
15
10
5
0
1
2
3
4
Number of Points Earned
Advanced
Proficient
Basic
Below Basic


PSSA Performance Task Matrix
Items Grade 11 Reading 2003
Number of Items
15
10
5
0
1
2
3
4
Number of Points Earned
Advanced
Proficient
Basic
Below Basic

Appendix H
Tables of Item Difficulty by Academic Standard

Table H-1. 2001 Math Item Difficulty by Academic Standard

		Standard									
		1	2	3	4	6	7	8	9	10	11
Matrix Items											
Grade 5											
	N	30	24	19	7	16	8	12	18	9	7
	Min	663.75	840.50	952.50	1001.50	833.50	779.25	725.00	936.75	1019.00	789.75
	Max	1223.75	1376.00	1367.25	1276.25	1328.75	1253.50	1386.50	1421.50	1397.00	1169.50
	Mean	1008.38	1106.79	1176.04	1102.25	1079.70	1022.72	1082.73	1115.74	1218.31	988.00
Grade 8											
	N	18	21	22	10	12	11	25	12	10	9
	Min	1055.60	959.60	1025.20	1028.40	1082.80	967.60	1089.20	1036.40	994.80	910.00
	Max	1345.20	1334.00	1351.60	1556.40	1327.60	1319.60	1398.00	1369.20	1377.20	1377.20
	Mean	1209.56	1180.78	1218.44	1244.24	1221.87	1183.75	1247.66	1234.40	1214.64	1196.76
Grade 11											
	N	13	18	14	7	18	10	35	16	12	7
	Min	1036.00	848.00	836.00	936.00	782.00	1038.00	990.00	1028.00	1154.00	1002.00
	Max	1452.00	1382.00	1480.00	1414.00	1400.00	1484.00	1578.00	1486.00	1398.00	1436.00
	Mean	1255.54	1108.67	1186.29	1165.14	1197.33	1216.00	1315.14	1269.13	1289.00	1221.71
Common Items											
Grade 5											
	N	9	13	9	5	7	5	7	5	5	5
	Min	754.75	898.25	1043.50	910.50	779.25	810.75	770.50	884.25	1027.75	688.25
	Max	1292.00	1400.50	1274.50	1213.25	1257.00	1040.00	1297.25	1267.50	1355.00	1202.75
	Mean	1095.03	1069.35	1154.92	1076.40	1055.00	974.55	1088.75	1082.00	1175.10	1018.30
Grade 8											
	N	7	10	7	4	5	5	15	9	4	4
	Min	1063.60	938.80	890.80	1017.20	1023.60	1154.80	954.80	1054.00	1054.00	1169.20
	Max	1252.40	1370.80	1393.20	1348.40	1409.20	1322.80	1292.40	1295.60	1266.80	1318.00
	Mean	1151.83	1186.80	1155.94	1173.20	1147.44	1212.72	1152.77	1197.29	1169.20	1252.40
Grade 11											
	N	5	10	5	5	4	6	14	11	5	5
	Min	892.00	762.00	992.00	1020.00	1088.00	804.00	894.00	932.00	1114.00	856.00
	Max	1356.00	1288.00	1356.00	1448.00	1246.00	1478.00	1346.00	1422.00	1388.00	1176.00
	Mean	1157.20	1061.20	1197.20	1232.40	1163.00	1144.67	1137.14	1163.45	1232.00	1041.60

Table H-2. 2002 Math Item Difficulty by Academic Standard

		Standard									
		1	2	3	4	6	7	8	9	10	11
Matrix Items											
Grade 5											
	N	38	32	13	9	18	9	15	23	14	9
	Min	558.75	642.75	907.00	896.50	543.00	929.75	679.50	824.75	803.75	754.75
	Max	1300.75	1397.00	1388.25	1276.25	1404.00	1348.00	1255.25	1346.25	1453.00	1225.50
	Mean	989.30	1049.73	1142.71	1070.72	1069.46	1065.28	1056.92	1086.64	1113.63	988.08
Grade 8											
	N	22	23	26	12	11	13	36	12	13	12
	Min	1012.40	897.20	950.00	978.80	977.20	905.20	1052.40	1007.60	906.80	1010.80
	Max	1366.00	1380.40	1406.00	1614.00	1318.00	1458.80	1780.40	1409.20	1417.20	1369.20
	Mean	1197.56	1148.12	1194.74	1222.53	1184.33	1160.46	1246.98	1242.93	1215.85	1210.67
Grade 11											
	N	13	21	20	9	20	14	43	21	10	9
	Min	876.00	786.00	820.00	638.00	702.00	836.00	926.00	1060.00	1172.00	1094.00
	Max	1328.00	1462.00	1588.00	1390.00	1518.00	1430.00	1556.00	1506.00	1524.00	1498.00
	Mean	1153.69	1089.62	1260.90	1080.44	1206.50	1178.71	1268.74	1245.14	1337.80	1284.44
Common Items											
Grade 5											
	N	9	15	9	5	5	5	7	5	5	5
	Min	856.25	749.50	868.50	980.50	861.50	999.75	807.25	1013.75	1162.50	709.25
	Max	1166.00	1264.00	1335.75	1251.75	1342.75	1293.75	1397.00	1202.75	1267.50	1152.00
	Mean	1048.36	997.07	1129.06	1082.70	1106.15	1102.30	1085.75	1092.50	1214.65	979.45
Grade 8											
	N	7	10	7	4	6	4	15	9	4	4
	Min	1058.80	895.60	1047.60	986.80	1074.80	1034.80	1097.20	950.00	983.60	1033.20
	Max	1274.80	1234.80	1396.40	1119.60	1218.80	1182.00	1402.80	1385.20	1233.20	1298.80
	Mean	1179.71	1119.12	1222.23	1070.80	1158.00	1114.40	1225.09	1204.22	1133.60	1188.80
Grade 11											
	N	5	10	5	5	10	5	14	6	5	5
	Min	1084.00	826.00	934.00	862.00	710.00	1080.00	972.00	1080.00	1148.00	982.00
	Max	1496.00	1434.00	1256.00	1418.00	1282.00	1548.00	1376.00	1364.00	1472.00	1484.00
	Mean	1314.40	1117.80	1071.60	1134.40	1090.60	1334.40	1231.86	1223.67	1246.40	1222.80

Table H-3. 2003 Math Item Difficulty by Academic Standard

		Standard									
		1	2	3	4	6	7	8	9	10	11
Matrix Items											
Grade 5											
	N	40	31	18	9	18	8	19	19	9	9
	Min	726.75	872.00	896.50	1043.50	977.00	1099.50	803.75	1026.00	856.25	950.75
	Max	1566.75	1482.75	1552.75	1426.75	1446.00	1418.00	1419.75	1498.50	1486.25	1447.75
	Mean	1195.66	1178.42	1298.81	1206.25	1239.89	1241.25	1263.72	1263.63	1205.86	1167.56
Grade 8											
	N	18	24	27	9	12	14	35	15	13	13
	Min	1161.20	1038.00	1113.20	1110.00	1081.20	1087.60	1170.80	1169.20	1046.00	1143.60
	Max	1474.80	1492.40	1578.80	1590.00	1516.40	1450.80	1478.00	1468.40	1495.60	1487.60
	Mean	1319.96	1291.87	1326.30	1277.11	1284.00	1278.80	1329.25	1337.84	1316.65	1331.29
Grade 11											
	N	14	25	17	9	23	13	38	21	9	10
	Min	966.00	954.00	916.00	788.00	796.00	1020.00	1000.00	1056.00	1360.00	1102.00
	Max	1430.00	1438.00	1630.00	1492.00	1596.00	1528.00	1736.00	1562.00	1558.00	1702.00
	Mean	1265.29	1175.52	1275.18	1235.56	1235.04	1290.77	1343.00	1348.00	1476.22	1409.40
Common Items											
Grade 5											
	N	9	15	5	5	8	5	4	9	5	5
	Min	905.25	989.25	1113.50	1069.75	1027.75	1127.50	1055.75	1003.25	999.75	1110.00
	Max	1334.00	1432.00	1421.50	1313.00	1579.00	1255.25	1321.75	1402.25	1437.25	1367.25
	Mean	1227.25	1172.88	1306.00	1223.05	1278.88	1205.90	1239.50	1249.03	1204.85	1266.80
Grade 8											
	N	6	11	6	6	4	4	17	9	3	4
	Min	1225.20	970.80	1270.00	1100.40	1159.60	1178.80	1191.60	1225.20	1218.80	1121.20
	Max	1364.40	1382.00	1481.20	1666.80	1378.80	1401.20	1534.00	1422.00	1377.20	1394.80
	Mean	1286.53	1234.95	1355.33	1260.93	1240.80	1321.60	1352.35	1330.09	1292.93	1280.80
Grade 11											
	N	5	10	5	5	5	5	14	11	5	5
	Min	1086.00	846.00	1076.00	1204.00	1218.00	986.00	1072.00	1142.00	1252.00	1234.00
	Max	1328.00	1556.00	1418.00	1402.00	1584.00	1464.00	1694.00	1598.00	1448.00	1394.00
	Mean	1248.80	1210.40	1285.20	1275.60	1418.80	1259.60	1330.14	1314.00	1331.60	1329.20

Table H-4. 2001 Reading Item Difficulty by Academic Standard

		Standard				
		1	2	3	7	8
Matrix Items						
Grade 5						
	N	61	59	50	38	38
	Min	597.05	787.60	621.10	643.30	682.15
	Max	1407.35	1300.05	1466.55	1266.75	1279.70
	Mean	930.63	1055.44	954.73	987.69	1001.66
Grade 8						
	N	72	77	73	51	50
	Min	666.76	685.48	600.20	612.68	722.92
	Max	1446.76	1432.20	1463.40	1540.36	1392.68
	Mean	1016.17	1045.21	1174.54	1043.36	1099.69
Grade 11						
	N	69	78	70	74	67
	Min	180.00	204.00	316.00	340.00	268.00
	Max	1560.00	1568.00	1696.00	1732.00	1536.00
	Mean	850.67	812.05	1107.89	954.00	868.00
Common Items						
Grade 5						
	N	12	12	12	8	8
	Min	848.65	915.25	904.15	954.10	769.10
	Max	1168.70	1214.95	1374.05	1311.15	1231.60
	Mean	1016.38	1016.69	1094.39	1105.80	1037.81
Grade 8						
	N	16	16	16	12	12
	Min	829.00	781.16	766.60	878.92	939.24
	Max	1453.00	1532.04	1419.72	1484.20	1411.40
	Mean	1178.05	1098.23	1170.77	1184.68	1149.15
Grade 11						
	N	19	16	18	12	15
	Min	524.00	548.00	432.00	384.00	544.00
	Max	1540.00	1504.00	1520.00	1512.00	1500.00
	Mean	1012.84	1050.00	978.89	1136.67	1005.33

Table H-5. 2002 Reading Item Difficulty by Academic Standard

		Standard				
		1	2	3	7	8
Matrix Items						
Grade 5						
	N	72	72	72	48	48
	Min	554.50	770.95	597.05	733.95	730.25
	Max	1686.70	1573.85	1388.85	1762.55	1494.30
	Mean	975.12	1084.55	1011.04	1168.51	1112.93
Grade 8						
	N	104	100	100	50	78
	Min	683.40	625.16	562.76	764.52	621.00
	Max	1688.04	1704.68	1552.84	1841.96	1658.92
	Mean	1150.40	1092.54	1120.62	1121.82	1114.81
Grade 11						
	N	96	96	96	96	96
	Min	288.00	220.00	424.00	232.00	280.00
	Max	1904.00	1748.00	2060.00	2236.00	2080.00
	Mean	1017.71	941.79	1198.33	1144.08	1049.00
Common Items						
Grade 5						
	N	12	12	12	8	8
	Min	680.30	806.10	746.90	611.85	828.30
	Max	1172.40	1218.65	1318.55	1322.25	1209.40
	Mean	914.02	998.96	997.11	1060.24	1012.38
Grade 8						
	N	16	16	16	12	12
	Min	762.44	799.88	695.88	610.60	895.56
	Max	1421.80	1505.00	1382.28	1471.72	1378.12
	Mean	1102.39	1101.48	1180.26	1099.23	1138.05
Grade 11						
	N	18	16	18	12	16
	Min	440.00	524.00	412.00	480.00	484.00
	Max	1584.00	1536.00	1504.00	1584.00	1576.00
	Mean	990.89	1085.50	1088.22	1148.00	959.00

Table H-6. 2003 Reading Item Difficulty by Academic Standard

		Standard				
		1	2	3	7	8
Matrix Items						
Grade 5						
	N	74	72	70	48	48
	Min	907.85	980.00	983.70	965.20	1087.30
	Max	1588.65	1714.45	1531.30	1605.30	1522.05
	Mean	1208.85	1247.33	1185.14	1281.82	1248.02
Grade 8						
	N	84	94	112	70	72
	Min	743.72	960.04	993.32	1020.36	1014.12
	Max	1725.48	1665.16	1698.44	1721.32	2037.48
	Mean	1189.29	1284.70	1297.46	1322.17	1305.96
Grade 11						
	N	90	92	102	96	96
	Min	276.00	600.00	508.00	504.00	448.00
	Max	2044.00	1868.00	1908.00	1980.00	2400.00
	Mean	1172.36	1007.52	1375.49	1093.58	1190.21
Common Items						
Grade 5						
	N	13	11	12	8	8
	Min	815.35	981.85	1022.55	1092.85	1163.15
	Max	1403.65	1300.05	1418.45	1529.45	1544.25
	Mean	1143.94	1172.57	1226.36	1314.16	1317.63
Grade 8						
	N	19	14	16	12	11
	Min	1030.76	937.16	935.08	1066.12	928.84
	Max	1513.32	1586.12	1496.68	1596.52	1554.92
	Mean	1260.22	1278.87	1250.85	1295.44	1298.13
Grade 11						
	N	17	15	19	13	16
	Min	436.00	640.00	556.00	660.00	820.00
	Max	1816.00	1612.00	1704.00	1700.00	1852.00
	Mean	1111.29	1154.13	1213.89	1328.31	1180.75