Alignment of MCAS Grade 10 English Language Arts and Mathematics Assessments with the Massachusetts Curriculum Frameworks and the Test Specifications

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Introduction

One of the common criticisms that is directed toward state assessment programs like the Massachusetts Comprehensive Assessment System (MCAS) is that they lead to a narrowing of the curricula that are actually taught to students. Presumably the criticism is that some teachers try to anticipate the content coverage on the assessments each year, and modify (that is, “narrow”) their curricula accordingly. Of course if they guess correctly, one might surmise that student assessment scores will likely be higher than they would have been had teachers taught the full curricula described in the Massachusetts curriculum frameworks because all the available instructional time can be focused on a lesser amount of content. A problem arises because the inferences made about student learning are tied to the curriculum frameworks but these inferences would be incorrect or biased if the assessments do not adequately sample the relevant domains of content. Regardless whether teachers guess correctly or incorrectly about assessment content, students will be “shortchanged” by not receiving the intended curricula mandated by the state. This failure to teach the required curricula may create more problems for students at higher grade levels, and leave them without the expected skills of high school graduates.

There is another negative consequence associated with assessments not reflecting the curriculum frameworks. It has often been noted that assessments drive or strongly influence what teachers teach, and so if the assessments are out of alignment with the curriculum frameworks, then the frameworks are less likely to be taught, and what is taught will be what teachers see on the assessments (e.g., Stecher, Barron, Chun, & Ross, 2000). Clearly, if educational reform is to succeed in Massachusetts and elsewhere, and if assessments are to be judged as content valid, assessment-curriculum alignment is essential. For more information on the methodology for these studies, and examples, readers are referred to Bhola, Impara, and Buckendahl (2003), Frisbie (2001), Li and Sireci (2004), Resnick, Rothman, Slattery, and Vranek (2003), and Webb (1999).

The solution to the problems just described is obvious: Ensure that each year the assessments adequately sample the curriculum frameworks and meet the test specifications. This alignment among the assessments, test specifications, and the curriculum frameworks should ensure that over time the assessments themselves will provide valid information about student progress. Presumably, the best way for teachers to maximize student learning and performance on the assessments, when the assessments are aligned with the test specifications and the curriculum frameworks is, basically, to teach the content described in the curriculum frameworks.

Are the MCAS assessments content valid? That is, are the assessments each year in alignment with the curriculum frameworks and the test specifications? The purpose of this study was to investigate assessment-test specifications-curriculum framework alignment for the grade 10 English language arts (ELA) and mathematics assessments. Numerous researchers today are describing approaches for investigating what is called “test-curriculum” alignment (see, for example, Webb, 1999). Our approach was straightforward—we began with the state’s own coding of the assessment items in relation to the learning standards, and investigated both the
extent to which the assessments matched the test specifications, and reflected variability in the selection of learning standards from one year to the next. In this study, we will not investigate the question about the extent to which the assessment items actually measure the learning standards to which they are matched. Item-objective congruence is addressed by the contractor, item development committees, item review committees, the item sensitivity review committees, and the Department itself.

Method

Test Content Specifications

Tables 1 and 2 contain the test content specifications at the strand level for the English language arts and mathematics assessments, respectively. The specifications are clear and straightforward. Three content strands are used in ELA and five content strands are used in mathematics. Up until 2001, geometry and measurement were in a single strand in the mathematics curriculum, and allocated 30% of the total points. Since 2001, geometry and measurement have been split into two strands, and the allocation of percent of points to each is 15%.

Table 1  Desired Distribution of Grade 10 English Language Arts Points Across Content Strands

<table>
<thead>
<tr>
<th>Content Strand</th>
<th>Percent of Total Points (n = 72)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language</td>
<td>8%</td>
</tr>
<tr>
<td>Reading and Literature</td>
<td>64%</td>
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<tr>
<td>Composition</td>
<td>28%</td>
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</table>

Table 2  Desired Distribution of Grade 10 Mathematics Points Across Content Strands

<table>
<thead>
<tr>
<th>Content Strand</th>
<th>Percent of Total Points (n = 60)</th>
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</thead>
<tbody>
<tr>
<td>Number Sense and Operations</td>
<td>20%</td>
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<tr>
<td>Patterns, Relations, and Algebra</td>
<td>30%</td>
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<tr>
<td>Geometry</td>
<td>15%</td>
</tr>
<tr>
<td>Measurement</td>
<td>15%</td>
</tr>
<tr>
<td>Data Analysis, Statistics, and Probability</td>
<td>20%</td>
</tr>
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</table>

In 2001, the Geometry and Measurement strand was split into two strands, with the same combined portion of the test.

English Language Arts and Mathematics Learning Standards

Appendix A contains the list of learning standards in ELA and the list of learning standards in mathematics. In ELA, learning standards 1 to 3, 7, 18, and 23 to 28 are excluded from the assessments. According to Christyan Mitchell (personal communication, May 20,
learning standards 1, 2, 3, 7, 18, and 23 to 28 are expected to be assessed at the local level because they are not appropriate for inclusion in large scale assessments.

The curriculum frameworks for ELA and Mathematics, which include the learning standards to be tested, underwent minor refinements and clarifications in 2000 (Mathematics) and 2001 (ELA). The references and data in both the text and tables of this report refer to the learning standards as refined and clarified in 2000 and 2001. That is, if an item used in 1998 was coded “Mathematical Structure,” but today would be coded 10.P.4, the item is coded as 10.P.4 in the tables. Further information regarding the refinements and clarifications to the Grade 10 Mathematics learning standards can be found in Appendix E [pp. 130-131] of the Overview of the 2001 MCAS Assessments. The ELA learning standards, including those assessed on MCAS and those assessed at the local level are found on pp. 13-86 of the Massachusetts English Language Arts Curriculum Framework, 2001.

Matching Task

Basically, we worked from information provided by the Massachusetts Department of Education. After several iterations of drafts of material, we were able to obtain two critically important pieces of information for the study: (1) the learning standard that each assessment item in grade 10 ELA and mathematics assessments (1998 to 2004) was designed to measure, and (2) the number of points associated with each assessment item. Complicating matters for this research was that the learning standard codes in ELA and mathematics were revised between 2000 and 2001. Assessment items measured by earlier learning standards have been recoded according to the current curriculum frameworks (by the Massachusetts Assessment Development Committees).

Results

Tables 3 and 4 provide information about the number of items (and score points) measuring each of the learning standards on the ELA and mathematics assessments, respectively, between 1998 and 2004. We will consider the ELA assessment first. Among the learning standards that are included in the assessments (1 to 3, 7, 18, and 23 to 28 are excluded, and these are expected to be assessed at the local level), learning standards 9 and 16 were assessed once. Otherwise, the evidence suggests that the remaining ELA learning standards are appearing from time to time in the yearly assessments and the emphases often changes substantially. For example, learning standard 13 varied in its contribution to the grade 10 ELA assessment from 3 points in 2000 to 22 points in 2002. More typical is learning standard 8 where the point spread ranges from 3 points in 2003 to 12 points in 1998.

Of the 17 learning standards that appear in the assessments, 10 have been assessed each year. Five of the remaining seven have appeared on the assessments between 3 and 6 times. As already mentioned, two of the learning standards appeared once.
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### Table 4
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(Number of Items/ Number of Points)

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<td>42/60</td>
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</table>

**Notes:**
In 1998, items 6 and 26, with maximum scores of 1 point, had no coding. Item 39 with a maximum score of 4 points had no coding. These 3 items were not included in the totals above. In 1999, item 40 with maximum score of 1 point had no coding, and was not included in the totals. In 2000, item 16 with 4 points had no coding; and items 27 and 30 each had a maximum score of 1 point, and had no coding. The 3 items were not included in the totals above.
The learning standards in ELA fall into three content strands: Language (1 to 6), Reading and Literature (8 to 18), and Composition (19 to 22). From Table 1 it is clear that 8%, 64%, and 28% of the total points on each year’s assessment should be coming from the three content strands, respectively. It is clear from Table 5, that except for 1998, there is very little variation from year to year in the allocation of points to the three content strands. Even in 1998, the first year of the program, the numbers are close to those that had been described in the test specifications (9.5% vs. 8%, 66.7% vs. 64%, and 23.8% vs. 28%).

Table 5
Grade 10 ELA Strands
(Percent of Total/Number of Points)

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<th>Strand, Standards</th>
<th>1998</th>
<th>1999</th>
<th>2000</th>
<th>Year</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
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<tr>
<td>Language 4-6</td>
<td>9.5%</td>
<td>12.5%</td>
<td>12.5%</td>
<td>9.9%</td>
<td>9.7%</td>
<td>11.1%</td>
<td>8%</td>
<td>6.9%</td>
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<td>Read/Lit. 8-17</td>
<td>66.7%</td>
<td>59.7%</td>
<td>59.7%</td>
<td>62.0%</td>
<td>62.5%</td>
<td>61.1%</td>
<td>44%</td>
<td>47%</td>
</tr>
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<td>Composition 19-22</td>
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<td>27.8%</td>
<td>27.8%</td>
<td>27.8%</td>
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<td>TOTAL</td>
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<td>72%</td>
<td>71%</td>
<td>72%</td>
<td>72%</td>
<td>72%</td>
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Table 6
Grade 10 Mathematics Strands
(Percent of Total/Number of Points)

<table>
<thead>
<tr>
<th>Strand, Standards</th>
<th>1998</th>
<th>1999</th>
<th>2000</th>
<th>Year</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
</tr>
</thead>
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<tr>
<td>Data Analysis, Statistics, and Probability 10.D.1-3, 8.D.3-4</td>
<td>20.4%</td>
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<td>18.6%</td>
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<td>20.0%</td>
<td>20.0%</td>
</tr>
<tr>
<td>Geometry 10.G.1-11</td>
<td>27.8%</td>
<td>23.7%</td>
<td>20.4%</td>
<td>16.9%</td>
<td>13.3%</td>
<td>15.0%</td>
<td>15.0%</td>
<td>9%</td>
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<td>Measurement 10.M.1-3</td>
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<td>8.5%</td>
<td>13.0%</td>
<td>11.9%</td>
<td>15.0%</td>
<td>15.0%</td>
<td>13.3%</td>
<td>8%</td>
</tr>
<tr>
<td>Number Sense and Operations 10.N.1-4, 8.N.2&amp;12</td>
<td>13.0%</td>
<td>11.9%</td>
<td>9.3%</td>
<td>20.3%</td>
<td>20.0%</td>
<td>20.0%</td>
<td>21.7%</td>
<td>13%</td>
</tr>
<tr>
<td>Patterns, Relations, and Algebra 10.P.1-8</td>
<td>25.9%</td>
<td>32.2%</td>
<td>44.4%</td>
<td>32.2%</td>
<td>31.7%</td>
<td>30.0%</td>
<td>30.0%</td>
<td>18%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>54%</td>
<td>59%</td>
<td>54%</td>
<td>59%</td>
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</table>
Next, we considered the information in Table 4 concerning the mathematics assessments between 1998 and 2004. Of the 33 mathematics learning standards, over the course of seven years, every learning standard appears in at least one of the assessments. In a typical year, more than 20 of the 30 learning standards are assessed (actually the numbers of learning standards measured per year across the seven years of assessments varies from 18 to 24, with a median of 21/assessment). Four of the learning standards (10.G.8, 8.D.3, 8.N.2., and 8.N.12) appear in one of the assessments and three of these four learning standards are coded at the 8th grade level. Four other learning standards (10.D.3, 10.G.2, 10.G.11, and 10.P.5) were assessed twice in the seven years of MCAS administrations. All the remaining learning standards (25) are assessed three or more times over the seven year period. The number of points per learning standard also varies substantially from year to year, for example, the largest range is 10 points (10.P.7).

The learning standards in mathematics are organized into five content strands: (1) Number Sense and Operations, (2) Patterns, Relationships, and Algebra, (3) Geometry, (4) Measurement, and (5) Data Analysis, Statistics, and Probability. The test specifications allocate 20%, 30%, 15%, 15%, and 20% of the score points, respectively, to the five content strands. Table 6 shows, that with the exception of some modest discrepancies in 1998 and 2000, the percent of score points allocated to each content strand is nearly completely consistent with the test content specifications. For the last three years, the allocation of score points across the five content strands meets the test content specifications almost exactly (never missing by more than one or two points).

Conclusions

The study, from our perspective at least, appears to be a worthwhile step in investigating the content validity and assessment-curriculum alignment of the MCAS grade 10 ELA and mathematics assessments. To answer the main questions of the study, it is clear that the grade 10 ELA and mathematics assessments over the last seven years have shown diversity of content and content that closely matches the test specifications. In both ELA and mathematics, the test content specifications are being met almost perfectly (especially in the last four years) and in both subjects, all or nearly all, of the learning standards have been included in the assessments. In the ELA assessment, perhaps a bit more coverage of several learning standards (they were identified in the last section) would have improved the content coverage of the curriculum framework. It remains for others such as policy-makers and curriculum specialists to judge the extent to which the observed diversity of content we reported in this study is sufficient for matching the curriculum frameworks, recognizing that not every learning standard can be assessed each year because of restrictions on test length and testing time. What can be said for sure is that there is definitely diversity of assessment content from year to year.

In subsequent studies, the extent to which assessments at other grade levels are in line with the test specifications and curriculum frameworks can be investigated. In fact, plans are underway to carry out alignment studies for ELA assessments in grades 4 and 7, and in Mathematics in grades 4, 6, and 8 for the years between 2001 and 2004. Perhaps the main shortcoming of this study is that the matching of assessment content to the test specifications is
only being done with items coded by the Department of Education Assessment Development Committees. In future studies, it might be desirable to independently verify the matching of the content codes assigned to items (by the Department of Education curriculum committees). This study could be carried out with other committees of qualified curriculum and measurement specialists. Again, plans are underway to evaluate the cognitive levels/complexity of items in subsequent alignment studies.

In passing, we would like to draw attention to the general level of the test specifications. In mathematics, for example, there are 33 learning standards at the grade 10 level but the test specifications are at the strand level and, currently, there are only five strands. In ELA, there are (up to) 17 learning standards being assessed, while the test specifications are at the strand level and there are only three. Though the results shown in Table 3 and 4 highlight the diversity of assessment content in the assessments from year to year, it may still be useful in the future to consider more detailed specifications at the level of the learning standards. This would create challenges for the assessment developers, but more test specifications at the learning standard level would guarantee that future assessments adequately reflect not only the content strands, but continue to reflect a representative sampling of the learning standards from one year to the next because the representativeness could be built into the test specifications. We believe, for example, that with test specifications at the learning standard level, a plan could be developed so that all learning standards over a period of years (perhaps three) would be included in an assessment.
References


Version: December 18, 2004
Appendix A

Massachusetts English Language Arts (ELA) Curriculum Framework, 2001

Massachusetts Mathematics Curriculum Framework, 2000
Grade 10 MCAS English Language Arts Learning Standards

<table>
<thead>
<tr>
<th>La 10</th>
<th>1</th>
<th>Use agreed-upon rules for informal and formal discussions in small and large groups.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>Pose questions, listen to the ideas of others, and contribute their own information or ideas in group discussions and interviews in order to acquire new knowledge.</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Make oral presentations that demonstrate appropriate consideration of audience, purpose, and the information to be conveyed.</td>
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<tr>
<td></td>
<td>4</td>
<td>Acquire and use correctly an advanced reading vocabulary of English words, identifying meanings through an understanding of word relationships.</td>
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<tr>
<td></td>
<td>5</td>
<td>Identify, describe, and apply knowledge of the structure of the English language and standard English conventions for sentence structure, usage, punctuation, capitalization, and spelling.</td>
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<tr>
<td></td>
<td>6</td>
<td>Describe and analyze how oral dialects differ from each other in English, how they differ from written standard English, and what role standard American English plays in informal and formal communications.</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Describe and analyze how the English language has developed and been influenced by other languages.</td>
</tr>
<tr>
<td>Li 10</td>
<td>8</td>
<td>Decode accurately and understand new words encountered in their reading materials, drawing on a variety of strategies as needed and then use these words accurately in speaking and writing.</td>
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<tr>
<td></td>
<td>9</td>
<td>Identify the basic facts and essential ideas in what they have read, heard, or viewed.</td>
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<td></td>
<td>10</td>
<td>Demonstrate an understanding of the characteristics of different genres.</td>
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<td></td>
<td>11</td>
<td>Identify, analyze, and apply knowledge of theme in literature and provide evidence from the text to support their understanding.</td>
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<tr>
<td></td>
<td>12</td>
<td>Identify, analyze, and apply knowledge of the structure and elements of fiction and provide evidence from the text to support their understanding.</td>
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<tr>
<td></td>
<td>13</td>
<td>Identify, analyze, and apply knowledge of the structure, elements, and theme of poetry fiction or informational material and provide evidence from the text to support their meaning.</td>
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<td></td>
<td>14</td>
<td>Identify, analyze, and apply knowledge of the structure, elements, and theme of poetry and provide evidence from the text to support their understanding.</td>
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<td></td>
<td>15</td>
<td>Identify and analyze how an author’s choice of words appeals to the senses, creates imagery, suggests mood, and sets tone.</td>
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<td></td>
<td>16</td>
<td>Compare and contrast similar myths and narratives from different cultures and geographic regions.</td>
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<td></td>
<td>17</td>
<td>Interpret the meaning of literary works, nonfiction, films, and media by using different critical lenses and analytic techniques.</td>
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<tr>
<td></td>
<td>18</td>
<td>Plan and present effective dramatic readings, recitations, and performances that demonstrate appropriate consideration of audience and purpose.</td>
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<tr>
<td>Co 10</td>
<td>19</td>
<td>Write compositions with a clear focus, logically related ideas to develop it, and adequate supporting detail.</td>
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<td></td>
<td>20</td>
<td>Select and use appropriate genres, modes of reasoning, and speaking styles when writing for different audiences and rhetorical purposes.</td>
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<tr>
<td></td>
<td>Improve organization, content, paragraph development, level of detail, style, tone, and word choice in revising their compositions.</td>
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<tr>
<td></td>
<td>Use their knowledge of standard English conventions for sentence structure, usage, punctuation, capitalization, and spelling to edit their writing.</td>
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<tr>
<td></td>
<td>Use self-generated questions, note-taking, summarizing, précis writing, and outlining to enhance learning when reading or writing.</td>
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<tr>
<td></td>
<td>Use open-ended research questions, different sources of information, and appropriate research methods to gather information for their research projects.</td>
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<tr>
<td></td>
<td>Develop and use rhetorical, logical, and stylistic criteria for assessing final versions of their compositions or research projects before presenting them to varied audiences.</td>
<td></td>
</tr>
<tr>
<td>Me 10</td>
<td>Obtain information by using a variety of media and evaluate the quality of the information obtained.</td>
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<tr>
<td></td>
<td>Explain how techniques used in electronic media modify traditional forms of discourse for different aesthetic and rhetorical purposes.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Design and create coherent media productions with a clear focus, adequate detail, and consideration of audience and purpose.</td>
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</tbody>
</table>

La = Language  
Li = Reading and Literature  
Co = Composition  
Me = Media
Grade 9-10 Mathematics Learning Standards

Number Sense and Operations

Students engage in problem solving, communicating, reasoning, connecting, and representing as they:

10.N.1 Identify and use the properties of operations on real numbers, including the associative, commutative, and distributive properties; the existence of the identity and inverse elements for addition and multiplication; the existence of \( n \)th roots of positive real numbers for any positive integer \( n \); and the inverse relationship between taking the \( n \)th root of and the \( n \)th power of a positive real number.

10.N.2 Simplify numerical expressions, including those involving positive integer exponents or the absolute value, e.g., \( 3(2^4 - 1) = 45, 4|3 - 5| + 6 = 14 \); apply such simplifications in the solution of problems.

10.N.3 Find the approximate value for solutions to problems involving square roots and cube roots without the use of a calculator, e.g., \( \sqrt[3]{8} \approx 2.0 \).

10.N.4 Use estimation to judge the reasonableness of results of computations and of solutions to problems involving real numbers.

Patterns, Relations, and Algebra

Students engage in problem solving, communicating, reasoning, connecting, and representing as they:

10.P.1 Describe, complete, extend, analyze, generalize, and create a wide variety of patterns, including iterative, recursive (e.g., Fibonacci Numbers), linear, quadratic, and exponential functional relationships.

10.P.2 Demonstrate an understanding of the relationship between various representations of a line. Determine a line’s slope and x- and y-intercepts from its graph or from a linear equation that represents the line. Find a linear equation describing a line from a graph or a geometric description of the line, e.g., by using the “point-slope” or “slope y-intercept” formulas. Explain the significance of a positive, negative, zero, or undefined slope.

10.P.3 Add, subtract, and multiply polynomials. Divide polynomials by monomials.

10.P.4 Demonstrate facility in symbolic manipulation of polynomial and rational expressions by rearranging and collecting terms; factoring (e.g., \( a^2 - b^2 = (a + b)(a - b) \), \( x^2 + 10x + 21 = (x + 3)(x + 7) \), \( 5x^4 + 10x^3 - 5x^2 = 5x^2(x^2 + 2x - 1) \)); identifying and canceling common factors in rational expressions; and applying the properties of positive integer exponents.

10.P.5 Find solutions to quadratic equations (with real roots) by factoring, completing the square, or using the quadratic formula. Demonstrate an understanding of the equivalence of the methods.

10.P.6 Solve equations and inequalities including those involving absolute value of linear expressions (e.g., \(|x - 2| > 5|\) and apply to the solution of problems.

10.P.7 Solve everyday problems that can be modeled using linear, reciprocal, quadratic, or
exponential functions. Apply appropriate tabular, graphical, or symbolic methods to the solution. Include compound interest, and direct and inverse variation problems. Use technology when appropriate.

10.P.8 Solve everyday problems that can be modeled using systems of linear equations or inequalities. Apply algebraic and graphical methods to the solution. Use technology when appropriate. Include mixture, rate, and work problems.

<table>
<thead>
<tr>
<th>Geometry</th>
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<tbody>
<tr>
<td><strong>Students engage in problem solving, communicating, reasoning, connecting, and representing as they:</strong></td>
</tr>
<tr>
<td>10.G.1 Identify figures using properties of sides, angles, and diagonals. Identify the figures’ type(s) of symmetry.</td>
</tr>
<tr>
<td>10.G.2 Draw congruent and similar figures using a compass, straightedge, protractor, and other tools such as computer software. Make conjectures about methods of construction. Justify the conjectures by logical arguments.</td>
</tr>
<tr>
<td>10.G.3 Recognize and solve problems involving angles formed by transversals of coplanar lines. Identify and determine the measure of central and inscribed angles and their associated minor and major arcs. Recognize and solve problems associated with radii, chords, and arcs within or on the same circle.</td>
</tr>
<tr>
<td>10.G.4 Apply congruence and similarity correspondences (e.g., ( \Delta ABC \cong \Delta XYZ )) and properties of the figures to find missing parts of geometric figures, and provide logical justification.</td>
</tr>
<tr>
<td>10.G.5 Solve simple triangle problems using the triangle angle sum property and/or the Pythagorean theorem.</td>
</tr>
<tr>
<td>10.G.6 Use the properties of special triangles (e.g., isosceles, equilateral, 30°–60°–90°, 45°–45°–90°) to solve problems.</td>
</tr>
<tr>
<td>10.G.7 Using rectangular coordinates, calculate midpoints of segments, slopes of lines and segments, and distances between two points, and apply the results to the solutions of problems.</td>
</tr>
<tr>
<td>10.G.8 Find linear equations that represent lines either perpendicular or parallel to a given line and through a point, e.g., by using the “point-slope” form of the equation.</td>
</tr>
<tr>
<td>10.G.9 Draw the results, and interpret transformations on figures in the coordinate plane, e.g., translations, reflections, rotations, scale factors, and the results of successive transformations. Apply transformations to the solutions of problems.</td>
</tr>
<tr>
<td>10G10 Demonstrate the ability to visualize solid objects and recognize their projections and cross sections.</td>
</tr>
<tr>
<td>10G11 Use vertex-edge graphs to model and solve problems.</td>
</tr>
</tbody>
</table>
### Measurement

**Understand measurable attributes** of objects and the units, systems, and processes of measurement

**Apply appropriate techniques, tools, and formulas** to determine measurements

<table>
<thead>
<tr>
<th>Students engage in problem solving, communicating, reasoning, connecting, and representing as they:</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.M.1 Calculate perimeter, circumference, and area of common geometric figures such as parallelograms, trapezoids, circles, and triangles.</td>
</tr>
<tr>
<td>10.M.2 Given the formula, find the lateral area, surface area, and volume of prisms, pyramids, spheres, cylinders, and cones, e.g., find the volume of a sphere with a specified surface area.</td>
</tr>
<tr>
<td>10.M.3 Relate changes in the measurement of one attribute of an object to changes in other attributes, e.g., how changing the radius or height of a cylinder affects its surface area or volume.</td>
</tr>
<tr>
<td>10.M.4 Describe the effects of approximate error in measurement and rounding on measurements and on computed values from measurements.</td>
</tr>
</tbody>
</table>

### Data Analysis, Statistics, and Probability

**Formulate questions** that can be addressed with data and collect, organize, and display relevant data to answer them

**Select and use** appropriate statistical methods to analyze data

**Develop and evaluate** inferences and predictions that are based on data

**Understand and apply** basic concepts of probability

<table>
<thead>
<tr>
<th>Students engage in problem solving, communicating, reasoning, connecting, and representing as they:</th>
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<tbody>
<tr>
<td>10.D.1 Select, create, and interpret an appropriate graphical representation (e.g., scatterplot, table, stem-and-leaf plots, box-and-whisker plots, circle graph, line graph, and line plot) for a set of data and use appropriate statistics (e.g., mean, median, range, and mode) to communicate information about the data. Use these notions to compare different sets of data.</td>
</tr>
<tr>
<td>10.D.2 Approximate a line of best fit (trend line) given a set of data (e.g., scatterplot). Use technology when appropriate.</td>
</tr>
<tr>
<td>10.D.3 Describe and explain how the relative sizes of a sample and the population affect the validity of predictions from a set of data.</td>
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</tbody>
</table>