

Alignment Study of the Ohio State Tests (OST)

English Language Arts

Mathematics

Science

Alignment Study Workshop-July 2017

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Section 1 - Introduction and Alignment Study Perspective

During the last two weeks of July 2017 Assessment and Evaluation Services (AES) in conjunction with the Ohio Department of Education (ODE) conducted an alignment study of the Ohio State Tests and published test standards. The alignment meetings were held in Columbus, Ohio. American Institute for Research (AIR) provided facilities, hardware support, and item bank access. ODE staff assisted the training and orientation of the alignment study reviewers. AES served as independent evaluator and directed the alignment study activities of the 109 educators selected as reviewers.

The purpose of the alignment study is to provide further documentation of content validity for the testing program. In previous alignment studies, Ohio has used the Webb Alignment Tool (Webb, 2005). The Webb method presented some limitations for alignment of the new Ohio State Tests (OST). This method is focused on test forms. The testing program needed to have the capability to move to adaptive assessment in the future.

This present alignment needed to focus on the item bank rather than particular test forms. The alignment of adaptive forms can be accomplished by selecting sample forms from the possible set of all adaptive forms. In theory if all items are aligned, alignment could be demonstrated for each individual set of items administered in an adaptive setting.

The alignment of the item bank provides a more complete picture. Not only will particular test forms be identified for needed changes, any entire item bank weaknesses will come into focus. Test forms can still be evaluated from the information provided by the bank review. The process becomes not a one-time evaluation of a few forms, but an ongoing alignment study.

Another limitation or criticism of the Webb model focuses on the role of the reviewers. The reviewers are asked to attend an alignment study for two-three days and with some training assign item content and cognitive complexity categories to the test items. Yet in the OST test development model those assignments have already been made through an item development process that spans almost two years.

This study uses reviews to validate the original classifications of the item development process. Validation review of content and Depth of Knowledge (DOK) classifications is a more appropriate task for reviewers. Reviewers are asked to attend a two-day session and look at between 100-300 test items for content and DOK classification. There is short time for training and the process of identifying the content standards and DOK level has already been completed.

The process of confirmation rather than classification can be said to be a “weaker” form of evidence for validity. However, that assumes that the reviewers have the same expertise and experiences with the items and standards as the original classifiers. Reviewers are more suited to critiquing already completed classifications than originating their own classifications.

Test item development procedures have been created with content validity in mind. Review of items and how they fit the standards is the focus of the development process. A post review like an alignment study strengthens the process, but the results of the study must be considered as a part of the process and not given undue importance because of its timing. Using a confirmation rather than classification approach for the post alignment study provides more weight to the original classifications.

This report is organized in six following sections. Section 2 details the review methodology, the reviewer characteristics, and test materials. Section 3 presents the findings of the study, while Sections 4, 5, and 6 go into more depth of results for English Language Arts, Mathematics, and Science. The final section, Section 7, presents some actions and areas for Ohio to consider for improvement of content validity.

Section 2 - Alignment Study Design

Alignment Study Process

In July 2017 Assessment and Evaluation Services in conjunction with the Ohio Department of Education conducted an alignment study to further establish the validity of the Ohio State Tests. The study was completed and data collected at AIR scoring facilities in Columbus Ohio on July 18 through July 28.

The purpose of the study was to provide further content validation of the Ohio State Tests (OST). Content reviewers from across Ohio were brought in to validate test item classifications made during the test development process. The reviewer groups spent 2 days becoming familiar with the task and completing their reviews. Reviewers were grouped by grade and subject according to the following organization:

July 18-19

English Language Arts Grades 3-4
English Language Arts Grades 7-8
Science Grade 5

July 20-21

English Language Arts Grades 5-6
English Language Arts 1 and 2 (High School)
Science Grade 8

July 24-25

Algebra/Integrated Math 1

July 25-26

Mathematics Grades 3-4
Mathematics Grades 7-8

July 26-27

Geometry/Integrated Math 2

July 27-28

Mathematics Grades 5-6
Biology

An example meeting agenda appears below:

ALIGNMENT STUDY COMMITTEE MEETING For ELA Grades 3 & 4

Agenda

Meeting Location:

AIR Processing Center (APC)
820 Freeway Dr. N
Columbus, OH 43229

Day 1 – Tuesday, July 18, 2017 from 8:30am – 4:30pm

- I. Welcome (Whole Group) – John Keene, Assessment & Evaluation Services (AES)
- II. Break into Individual Groups – ODE Staff & Participants
 - a. Welcome & Introductions
 - b. Sign Nondisclosure Form
 - c. Logistics Information (Sign-In Sheets, Forms, Lunch Places, etc.)
- III. Training - Presentation & Practice
 - a. Alignment of Test Items to Standards
 - b. Alignment of Test Items to Depth of Knowledge
- IV. Begin Review of Item Banks
- V. Adjourn

Day 2 – Wednesday, July 19, 2017 from 8:30am – 4:30pm

- I. Review Day 1 Training – Q & A, Clarifications, etc.
- II. Continue Review of Item Banks
- III. Wrap Up, Thank You & Adjourn

NOTE: All participants will receive a Certificate of Completion by August 4th

Reviewers met for two days. The first half-day was devoted to the introduction of the task and training for the task and the materials. Reviewers used the OST item banks to provide ratings for the alignment study. Each reviewer worked privately on a computer station. Paper materials were provided to facilitate looking up standards and item stimuli. Training was provided for use of the item banking system and the item classification process, which took place during test development for both standards and Depth of Knowledge.

During the test development process items were written to the standards. These items were reviewed by content committees and field-tested. The Depth of Knowledge categories were assigned to the items by the content committees during the development process. This alignment study collects information from the reviewers about the assignments of items to content standards and Depth of Knowledge criteria. The reviewers are asked to validate or challenge the item content standard classification and/or Depth of Knowledge classification made during the test development process.

Two questions were posed to the reviewers for each item in the OST item banks:

Question 1
Does this item align with the assigned content standard?
If you answered "No" to question 1, provide the number of the alternate standard.
If you answered "No" to question 1, provide a rationale.
Question 2
Is the Depth of Knowledge classification for the item appropriate?
If you answered "No" to question 2, provide an alternate classification.
If you answered "No" to question 2, provide a rationale.

Reviewers were allowed to work at their own pace and were asked not to discuss item classifications with other reviewers. Each reviewer answered Question 1 and 2 for all items in the test item bank at their respective grade and subject. Where item banks were smaller in number of items such as in Grade 3 Mathematics and Grade 4 through 8 ELA and Mathematics, reviewers in the groups were able to review all items for both grades. In Science, ELA Grade 3, and at the high school the item banks are larger and reviewers reviewed only their grade and subject. A total of 5-10 reviewers made judgments about each item.

Figure 1 below contains a portion of the content standards description sheets for Grade 5 Mathematics. Reviewers used these sheets to examine the assigned standard and search for alternate standards if they thought the test item did not represent the assigned standard. All the standard description sheets are provided in the Appendix.

Figure 1 - Ohio Grade 5 Mathematics Test Standard Sheet Example

Domain/ Conceptual Category	Standard	AES CODE	Original Standard GRADE 5 MATHEMATICS
Operations and Algebraic Thinking	5.OA.1	10	Write and interpret numerical expressions. 5.OA.1 Use parentheses, brackets, or braces in numerical expressions, and evaluate expressions with these symbols.
Operations and Algebraic Thinking	5.OA.2	11	Write and interpret numerical expressions. 5.OA.2 Write simple expressions that record calculations with numbers, and interpret numerical expressions without evaluating them. <i>For example, express the calculation “add 8 and 7, then multiply by 2” as $2 \times (8 + 7)$. Recognize that $3 \times (18,932 + 921)$ is three times as large as $18,932 + 921$, without having to calculate the indicated sum or product.</i>
Operations and Algebraic Thinking	5.OA.3	12	Analyze patterns and relationships. 5.OA.3 Generate two numerical patterns using two given rules. Identify apparent relationships between corresponding terms. Form ordered pairs consisting of corresponding terms from the two patterns, and graph the ordered pairs on a coordinate plane. <i>For example, given the rule “Add 3” and the starting number 0, and given the rule “Add 6” and the starting number 0, generate terms in the resulting sequences, and observe that the terms in one sequence are twice the corresponding terms in the other sequence. Explain informally why this is so.</i>
Numbers and Operations in Base Ten	5.NBT.1	13	Understand the place value system. 5.NBT.1 Recognize that in a multi-digit number, a digit in one place represents 10 times as much as it represents in the place to its right and 1/10 of what it represents in the place to its left.
Numbers and Operations in Base Ten	5.NBT.2	14	Understand the place value system. 5.NBT.2 Explain patterns in the number of zeros of the product when multiplying a number by powers of 10, and explain patterns in the placement of the decimal point when a decimal is multiplied or divided by a power of 10. Use whole-number exponents to denote powers of 10.

Reviewers used the following four categories of Depth of Knowledge (DOK) to validate the classification of the test items. For Mathematics and English Language Arts the cognitive complexity category is defined in terms of Depth of Knowledge as follows:

DOK 1 Recall & Reproduction

DOK 2 Skills & Concepts

DOK 3 Strategic Thinking & Reasoning

DOK 4 Extended Thinking

For Science, the cognitive complexity categories are called Cognitive Demand (CD) and have four categories as follows:

Cognitive Demand R-Recalling Accurate Science

Cognitive Demand C-Interpreting and Communicating Science Concepts

Cognitive Demand D-Demonstrating Science Knowledge

Cognitive Demand T-Designing Technological/Engineering Solutions Using Science Concepts

Reviewer Demographics

Over the two-week alignment study period a total 109 reviewers provided judgments about the fit of the test items to standards and the fit of the item DOK classification. Over 4900 test items were evaluated. Reviewers were selected in order to reflect the general distribution of Ohio K-12 educators. Table D1 provides the reviewer count by Ohio region. More reviewers come from the Central, Northeast, and Southwest areas because this is where the population is concentrated in Columbus, Cleveland/Akron, and Cincinnati areas respectively.

Table D1 - Reviewer District by Ohio Region

Region	Reviewers
Northeast	34
Northwest	8
Central	28
Southeast	7
Southwest	32
Total	109

Ohio also classifies its school districts by a “Typology” variable, which focuses on the rural/suburban/city dimension and the poverty level. Table D2 presents reviewer counts by Typology category. This group of reviewers was well distributed across this classification.

Table D2- Reviewer Ohio School District Typology

District Type	Reviewers
Rural-High Poverty	17
Rural Average Poverty	6
Small Town Low Poverty	14
Small Town High Poverty	5
Suburban Low Poverty	12
Suburban Very Low Poverty	16
Urban High Poverty	15
Urban Very High Poverty	9
Community School	4
Educational Service Center	6
Higher Education	3
Non Public School	2
Total	109

Finally, we also looked at the reviewer’s school position to get a sense of their experiences. In Table D3, it can be seen that 88 of the 109 reviewers are Grade 1-12 educators. The group also consisted of 8 Curriculum Specialists and a few administrators.

Table D3 - Reviewer Position Type

Position	Reviewers
Teacher Grade 1-12	88
Curriculum Specialist	8
Higher Education Faculty	1
K-12 Administrator	3
Early Childhood Specialist	2
Other	7
Total	109

Item Banks and Test Forms

Table D4 presents the test item counts for each item bank. In Mathematics, the Algebra and Geometry banks contain items that are also used for the Integrated Math 1 and Integrated Math 2 assessments. The high school level banks and Grade 3 ELA bank have almost three times as many items as the Grade 3 Mathematics and Grade 4-8 banks. One reason for this is that the high school tests and Grade 3 ELA are administered three times per year rather than just in the spring. The Science item banks are also large. The Science blueprint and assessments have been in place since 2015, while ELA and Mathematics banks were first used in 2017.

The focus of the reviewers was on the item bank and not particular test forms. Items were presented to reviewers in content order to make their task easier. The test form analyses are a focus of this alignment study and the reviewer’s responses to the questions for all items in the item bank allow us to analyze test forms that have been or will be administered.

Table D4 - Number of Items Reviewed by Subject Item Bank

Mathematics	Items	ELA	Items	Science	Items
Grade 3	147	Grade 3	333	Grade 5	455
Grade 4	123	Grade 4	157	Grade 8	457
Grade 5	142	Grade 5	136	Biology	508
Grade 6	150	Grade 6	191		
Grade 7	168	Grade 7	215		
Grade 8	148	Grade 8	180		
Algebra	424	ELA 1	515		
Geometry	275	ELA 2	446		
Total	1577	Total	1973	Total	1420

The chart in Table D5 shows the test forms that were analyzed as part of this alignment study. Each test form was examined for the extent to which its items matched the assigned standard and DOK. Test forms were also examined for their reporting category representation relative to published test blueprints. The number of standards measured and the breadth of the standard representation in each test was also examined.

A total of 43 test forms were analyzed: 18 for Mathematics, 12 for English Language Arts, and 13 for Science. This analysis is presented in the specific content area sections.

Table D5 - Test Forms Examined in Alignment Study

	Algebra		ELA			
	Mathematics	Geometry	ELA	Grade 3	Science	Biology
	Grades 3-8	Int Math 1	Grades 4-8	ELA 1	Grade 5	
		Int Math 2		ELA 2	Grade 8	
Spring 2015					1 Form	
Fall 2015						1 Form
Spring 2016					1 Form	1 Form
Summer 2016						1 Form
Fall 2016						1 Form
Spring 2017	1 Form	1 Form	1 Form	1 Form	1 Form	1 Form
Summer 2017		1 Form		1 Form		1 Form
Fall 2017		1 Form		1 Form		1 Form

Section 3. Alignment Study Findings

The purpose of this alignment study is to provide evidences of content validity. This section presents the major evidences for content validity as a result of the data collection and analysis of test forms used in the Ohio State Testing (OST) program. The study yielded eight validity evidences, which are presented below.

Validity Evidence 1 - Categorical Concurrence for the test item contents to standards for item banks

Table F1 presents the reviewer’s agreement percent with the assigned standards. This evidence is presented at the total item bank level. Reviewers agreed with the item/standard assignments made by the test development process to a large degree. Agreement percentages are 95% or greater.

Table F1 - Content Match Percentage for Item Banks

Content Match Percentage			
	ELA	Mathematics	Science
Grade 3	99.4%	98.6%	
Grade 4	99.5%	98.7%	
Grade 5	98.9%	99.1%	97.4%
Grade 6	99.6%	99.5%	
Grade 7	98.0%	99.3%	
Grade 8	98.8%	99.7%	99.7%
ELA 1	98.6%		
ELA 2	97.5%		
Algebra		97.5%	
Geometry		98.8%	
Biology			95.2%

Validity Evidence 2 - Categorical Concurrence for the test item cognitive complexity for item banks

Each item in the OST item banks is classified during the test development process by a cognitive complexity scale. In English Language Arts and Mathematics, a Depth of Knowledge classification is made. In Science, a Cognitive Demand scale, described in the previous section is used. Table F2 presents the percentage match between reviewers and the assignment made by the test development process. The percentage agreement is not as high as the content assignments in Table F1, but does range from 86% and 95%. This is a high level of agreement.

Table F2 - DOK/CD Percentage for Item Banks

DOK/CD Match Percentage			
	ELA	Mathematics	Science
Grade 3	93.3%	90.1%	
Grade 4	94.8%	90.8%	
Grade 5	95.4%	87.6%	94.9%
Grade 6	93.1%	87.4%	
Grade 7	92.7%	93.5%	
Grade 8	90.9%	97.0%	95.3%
ELA 1	86.6%		
ELA 2	89.4%		
Algebra		92.4%	
Geometry		90.3%	
Biology			94.9%

Validity Evidence 3 - Direction of cognitive level challenges by reviewers for the item bank

One aspect of the cognitive complexity scales (Depth of Knowledge/Cognitive Demand) is that they are ordinal in nature. A higher classification means a higher level of cognitive complexity. Table F3 looks at the challenges to the DOK/CD classifications and presents the percentage of challenges that suggested a higher DOK/CD classification. In the ELA and Science item banks, except in Grade 6 ELA, more than 50% of changes were in the higher classification direction. In Mathematics, the reverse is true, most were in the lower direction.

Table F3 - DOK/CD Challenge Increase Percentage

DOK/CD Challenge Increase Percentage			
	ELA	Mathematics	Science
Grade 3	72.1%	50.7%	
Grade 4	81.5%	47.3%	
Grade 5	60.0%	34.9%	63.1%
Grade 6	39.1%	29.7%	
Grade 7	65.7%	47.7%	
Grade 8	58.1%	54.3%	69.9%
ELA 1	69.0%		
ELA 2	58.1%		
Algebra		44.4%	
Geometry		60.5%	
Biology			74.4%

Validity Evidence 4 - Categorical Concurrence for the test item contents to standards for test forms

Tables F4 through F8 focus not on the total item bank, but on test forms, which have been used in the assessment program. Table F4 presents the content match between reviewers and test development process assignments for items used on the test forms. Where more than one test form was analyzed the percentages were averaged. The percentage matches are all above 95% and tend to be a little higher than for the item bank as a whole.

Table F4 - Content Match Percentage for Test Forms

Content Match Percentage			
	ELA	Mathematics	Science
Grade 3	99.2%	98.8%	
Grade 4	99.6%	99.3%	
Grade 5	97.9%	99.4%	97.7%
Grade 6	99.7%	99.4%	
Grade 7	98.0%	99.3%	
Grade 8	99.3%	99.8%	99.8%
ELA 1	98.7%		
ELA 2	97.7%		
Algebra		99.0%	
Geometry		99.3%	
Integrated Math 1		99.6%	
Integrated Math 2		97.3%	
Biology			95.4%

Validity Evidence 5 - Categorical Concurrence for the test item cognitive complexity for test forms

Table F5 presents the DOK/CD match percentages for test items that were used in the assessment program. These range from 88% to 96% and again are slightly higher than the percentage matches for the item bank. This upward bias is probably due to a selection bias by the test builders. Use the better items and hope to field test more.

Table F5-DOK/CD Match Percentage for Test Forms

DOK/CD Match Percentage			
	ELA	Mathematics	Science
Grade 3	91.4%	88.1%	
Grade 4	95.6%	92.7%	
Grade 5	95.7%	86.4%	96.4%
Grade 6	92.0%	85.8%	
Grade 7	92.7%	94.6%	
Grade 8	93.3%	96.9%	95.3%
ELA 1	89.1%		
ELA 2	93.2%		
Algebra		89.6%	
Geometry		94.1%	
Integrated Math 1		88.9%	
Integrated Math 2		96.3%	
Biology			94.9%

Validity Evidence 6 - Test Form Content Match to the Test Blueprint

Table F6 presents the extent to which the actual test forms conform to the test blueprints. The actual blueprint and test points are presented in the following sections. This table summarizes the tables in the specific content sections. To a large degree test forms conform to the test blueprint point ranges. This table looks at total test and reporting category blueprint point ranges and gives a conforming number of total possible test and reporting category instances. For example, in Mathematics at Grade 3 there is one test form that has a total test and four reporting categories. All the reporting categories conform to the test blueprint; the table shows 5 of 5 conforming.

All ELA tests conform to the blueprints. In Mathematics, the Grade 8 form has one fewer item point for Reporting Category 4. Also, this occurs for Reporting Category 1 in a Geometry and Integrated Math 1 form. In Science at Grade 5 there are two more points than specified in the blueprint for Reporting Category 2. Three Biology tests at the total test score have more points than specified by the test blueprint.

The point overages do not seem to be a large problem; they are usually one or two points on a 50 or more-point scale. The deficiency in score points is a bigger problem. Users have a right to expect the tests to be built within test blueprint ranges.

Note that all score reporting categories or subtests in the Ohio State Tests have 10 or more points.

Table F6 - Blueprint Content Score Category Match

Blueprint Content Score Category Match			
	ELA	Mathematics	Science
Grade 3	12 of 12	5 of 5	
Grade 4	4 of 4	4 of 4	
Grade 5	4 of 4	4 of 4	11 of 12
Grade 6	4 of 4	5 of 5	
Grade 7	4 of 4	5 of 5	
Grade 8	4 of 4	4 of 5	12 of 12
ELA 1	12 of 12		
ELA 2	12 of 12		
Algebra		12 of 12	
Geometry		14 of 15	
Integrated Math 1		14 of 15	
Integrated Math 2		15 of 15	
Biology			32 of 35

Validity Evidence 7 - Test Form Cognitive Complexity Match to the Test Blueprint

Each test item on the OST test forms is classified by the test development process for cognitive complexity. However, the OST test blueprints do not have any rules or ranges for levels of cognitive complexity on the test forms. The process for test form development does however have general guidelines for DOK composition in Mathematics and CD in Science. Generally, those guidelines are for 20% DOK 1, 60% DOK 2, and 20% DOK 3 and 4 for ELA and Mathematics. For Science, the guidelines are 30-40% for CD 1, 50-60% for CD 2, and 10-20% for CD 3 and 4.

Table F7 presents the upper category DOK/CD Category 3 and 4 percentage for test forms for each grade/subject. The following subject specific sections present the actual percentage by category for each test form. Examination of the DOK/CD percentage for test forms shows some deficiencies from the “unpublished” test construction guidelines.

Mathematics percentages range from 2.2% to 19.8%. At some grades the desired DOK/CD 3 and 4 percentage is almost attained. In Science, the percentages are 10% and lower. In ELA, the percentage in higher categories ranges from 41% to 56%. One reason the ELA test forms have such a large upper DOK component is that the Writing Exercises are classified as DOK 4 and contribute about one third of the points to the total score. It could be suggested that each Writing Exercise should be classified by its score components rather than as one item.

If DOK/CD is important to test construction and test composition it should be specified in the test blueprints. This omission is a clear weakness in the content validity.

Table F7 - DOK/CD Higher Level Percentage

DOK/CD Higher Level Percentage			
	ELA	Mathematics	Science
Grade 3	41.1%	12.2%	
Grade 4	42.5%	2.2%	
Grade 5	43.9%	6.1%	10.7%
Grade 6	44.7%	19.2%	
Grade 7	49.2%	15.4%	
Grade 8	56.5%	13.2%	6.0%
ELA 1	55.5%		
ELA 2	53.3%		
Algebra		19.8%	
Geometry		18.5%	
Integrated Math 1		19.7%	
Integrated Math 2		18.9%	
Biology			7.8%

Validity Evidence 8 - Test Form Content Standards Range and Representation

Test forms built for OST are intended to cover the standards for test subject. Table F8 presents the percentage of the number of standards represented by test items on each form. In ELA, the percentage of standards measured range from 72% to 84%. In Mathematics, the range is 66% to 96%. The percentage of standards covered is higher in Grades 3-8 and lower in the High School subjects. In Science, the percentage is 100%. Science only has 7, 10, and 11 standards in Grades 5, 8, High School Biology respectively. These numbers show that the tests do measure a majority of standards in each administration.

Table F8 - Proportion of Standards Measured

Proportion of Standards Measured			
	ELA	Mathematics	Science
Grade 3	78.1%	92.0%	
Grade 4	72.7%	96.4%	
Grade 5	84.8%	92.3%	100.0%
Grade 6	81.8%	89.7%	
Grade 7	75.8%	83.3%	
Grade 8	75.8%	92.9%	100.0%
ELA 1	78.1%		
ELA 2	77.1%		
Algebra		68.0%	
Geometry		79.8%	
Integrated Math 1		66.0%	
Integrated Math 2		67.9%	
Biology			100.0%

Section 4 - English Language Arts Results

The Ohio testing program assesses English Language Arts (ELA) in Grades 3 through 8 and in the High School. High school assessments are end of course based. The Grade 4-8 assessments are administered each spring as online fixed form assessments. Grade 3 ELA is administered in the spring, summer, and fall. The high school assessments are end of course based and presently include two levels of English Language Arts: ELA 1 and ELA 2. They are administered in the spring, summer, and fall.

This section contains a set of tables displaying the results of the alignment study for the ELA item banks. Ohio has created items banks for Grades 3 through 8, ELA 1, and ELA 2. Tables E1 through E3 present results based on the item bank. Tables E4 through E8 present results based on the test forms, which have been used while these standards have been in place. The present ELA standards have been in use since 2010. The 2017 test forms have been included in this analysis.

In Spring 2017 the OST program conducted an operational field testing for a new Reading/Writing test design. The test forms, which were administered online, were set up in a matrix design. Each grade had a large set of different possible item combinations. Thus, the online forms did not have a fixed form structure. In order to examine the match of item forms to the test blueprints the paper fixed forms have been analyzed for Spring 2017. Online forms for Grade 3, ELA 1, and ELA 2 for Summer 2017 and Fall 2017 were also analyzed.

Table E1 presents the percent match of the alignment study reviewer's item content to standard classification to the item development classification. Reviewers were in agreement with the development item/standard classification in the item bank. The lowest percent agreement for total bank was in ELA 2 and was still 97.5%. Reporting Category (RC) percent matches are in line with the total bank.

Table E1 - ELA Content Match for Grades 3-8, ELA 1, and ELA 2

		Item Bank	RC1	RC2	RC3
Grade 3	Percent Match	99.4%	99.2%	99.4%	100.0%
	N of items	333	137	185	11
	N of Reviewers	11	11	11	11
Grade 4	Percent Match	99.5%	99.6%	99.4%	100.0%
	N of items	157	46	102	9
	N of Reviewers	10	10	10	10
Grade 5	Percent Match	98.9%	98.8%	98.8%	100.0%
	N of items	136	71	58	7
	N of Reviewers	11	11	11	11
Grade 6	Percent Match	99.6%	99.9%	99.5%	100.0%
	N of items	191	75	108	8
	N of Reviewers	11	11	11	11
Grade 7	Percent Match	98.0%	98.0%	97.9%	98.9%
	N of items	215	65	137	13
	N of Reviewers	9	7	10	10
Grade 8	Percent Match	98.8%	98.7%	98.9%	99.1%
	N of items	180	68	104	8
	N of Reviewers	14	14	14	14
ELA 1	Percent Match	98.6%	98.6%	98.5%	99.0%
	N of items	515	145	349	21
	N of Reviewers	7	7	7	7
ELA 2	Percent Match	97.5%	99.0%	96.5%	100.0%
	N of items	446	149	274	23
	N of Reviewers	7	7	7	7

Table E2 presents the percent of reviewer agreement with the development DOK classifications. These are not as high as the content match agreements, but range from 86.6% in ELA 1 to 95.4% in Grade 5. Note that Reporting Category 3 is the Writing Exercises and tends to show a greater agreement.

Table E2 - ELA DOK Match for Grades 3-8, ELA 1, and ELA 2

		Item Bank	RC1	RC2	RC3
Grade 3	Percent Match	93.3%	92.8%	93.4%	98.2%
	N of items	333	137	185	11
	N of Reviewers	11	11	11	11
Grade 4	Percent Match	94.8%	95.5%	94.0%	100.0%
	N of items	157	46	102	9
	N of Reviewers	10	10	10	10
Grade 5	Percent Match	95.4%	95.3%	95.8%	94.3%
	N of items	136	71	58	7
	N of Reviewers	11	11	11	11
Grade 6	Percent Match	93.1%	92.4%	93.0%	100.0%
	N of items	191	75	108	8
	N of Reviewers	11	11	11	11
Grade 7	Percent Match	92.7%	92.3%	92.2%	100.0%
	N of items	215	65	137	13
	N of Reviewers	9	7	10	10
Grade 8	Percent Match	90.9%	88.3%	91.8%	100.0%
	N of items	180	68	104	8
	N of Reviewers	14	14	14	14
ELA 1	Percent Match	86.6%	85.4%	86.4%	97.4%
	N of items	515	145	349	21
	N of Reviewers	7	7	7	7
ELA 2	Percent Match	89.4%	89.6%	88.4%	99.1%
	N of items	446	149	274	23
	N of Reviewers	7	7	7	7

Table E3 looks at the mismatches for Depth of Knowledge. For each item the reviewers were asked if they agreed with the DOK assignment, if not they were to provide an alternate assignment. Table E3 presents the number of reviewer/item mismatches that the reviewers assigned to a higher or lower level of DOK. Because the DOK matches were between 87% and 95%, the table only looks at the remaining percent that the reviewers felt needed a different DOK assignment. The table shows that in all cases except Grade 6 the reviewers called for more increases in DOK classification. In Grade 6 reviewers only called for 39% to be increased.

Table E3 - DOK Reviewer Reclassification

	Form	DOK Increase	DOK Decrease
Grade 3	Number	165	64
	Per Cent	72.1%	27.9%
Grade 4	Number	66	15
	Per Cent	81.5%	18.5%
Grade 5	Number	36	24
	Per Cent	60.0%	40.0%
Grade 6	Number	52	81
	Per Cent	39.1%	60.9%
Grade 7	Number	69	36
	Per Cent	65.7%	34.3%
Grade 8	Number	132	95
	Per Cent	58.1%	41.9%
ELA 1	Number	256	115
	Per Cent	69.0%	31.0%
ELA 2	Number	150	108
	Per Cent	58.1%	41.9%

The remaining tables in this section focus on the test forms rather than the total item bank. Table E4A shows the percent content classification matches for items on particular test forms for Grades 3-8. As with the item bank analysis the level of content match is very high, ranging from 97.9% in Grade 5 to 99.7% for Form 3E32A in Grade 3.

Table E4A - Content Match of Test Form Items to Standards for Grades 3-8

	Test Form		Test	RC1	RC2	RC3
Grade 3	3E31C	Percent Match	99.4%	99.4%	99.3%	100.0%
		N of items	28	14	13	1
		N of Reviewers	11	11	11	7
	3E32A	Percent Match	99.7%	99.4%	100.0%	100.0%
		N of items	28	14	13	1
		N of Reviewers	11	11	11	11
	3E33A	Percent Match	98.6%	98.6%	98.5%	100.0%
		N of items	26	13	12	1
		N of Reviewers	11	11	11	11
Grade 4	4E31C	Percent Match	99.6%	100.0%	99.3%	100.0%
		N of items	27	12	14	1
		N of Reviewers	10	10	10	10
Grade 5	5E31C	Percent Match	97.9%	95.8%	99.3%	100.0%
		N of items	28	12	15	1
		N of Reviewers	11	10	10	11
Grade 6	6E31C	Percent Match	99.7%	100.0%	99.4%	100.0%
		N of items	30	13	15	2
		N of Reviewers	11	9	11	9
Grade 7	7E31C	Percent Match	98.0%	96.4%	99.2%	100.0%
		N of items	36	16	18	2
		N of Reviewers	10	7	10	7
Grade 8	8E31C	Percent Match	99.3%	98.6%	100.0%	100.0%
		N of items	32	15	15	2
		N of Reviewers	14	14	14	14

Table E4B presents the percent content match information for the High School test forms. These are very high ranging from 96.2% for one ELA 2 form to 100% for an ELA 1 form. The test forms seem to show slightly higher match than the overall bank.

Table E4B - Content Match of Test Form Items to Standards for High School

Test Form		Test	RC1	RC2	RC3	
ELA 1	9E31C	Percent Match	100.0%	100.0%	100.0%	100.0%
		N of items	31	11	18	2
		N of Reviewers	7	7	7	7
	9E32A	Percent Match	97.9%	100.0%	97.5%	90.0%
		N of items	36	12	22	2
		N of Reviewers	7	7	7	7
	9E33A	Percent Match	98.4%	98.5%	98.3%	100.0%
		N of items	38	13	23	2
		N of Reviewers	7	7	7	7
ELA 2	10E31C	Percent Match	98.9%	98.5%	99.0%	100.0%
		N of items	35	13	20	2
		N of Reviewers	7	7	5	5
	10E32A	Percent Match	96.2%	98.6%	94.3%	100.0%
		N of items	37	14	21	2
		N of Reviewers	5	5	5	5
	10E33A	Percent Match	98.0%	98.7%	97.5%	100.0%
		N of items	41	15	24	2
		N of Reviewers	5	5	5	5

The percent match for DOK classification for Grade 3-8 test forms is presented in Table E5A. The percent matches range from 88.2% to 95.6%. All items in Reporting Category 3 (Writing) show perfect agreement.

Table E5A - DOK Match of Test Form Items for Grades 3-8

Test Form		Test	RC1	RC2	RC3	
Grade 3	3E31C	Percent Match	88.2%	88.1%	87.4%	100.0%
		N of items	28	14	13	1
		N of Reviewers	11	11	11	7
	3E32A	Percent Match	93.4%	90.1%	96.5%	100.0%
		N of items	28	14	13	1
		N of Reviewers	11	11	11	11
	3E33A	Percent Match	92.7%	91.6%	93.2%	100.0%
		N of items	26	13	12	1
		N of Reviewers	11	11	11	11
Grade 4	4E31C	Percent Match	95.6%	97.6%	93.6%	100.0%
		N of items	27	12	14	1
		N of Reviewers	10	10	10	10
Grade 5	5E31C	Percent Match	95.7%	95.8%	95.3%	100.0%
		N of items	28	12	15	1
		N of Reviewers	11	10	10	11
Grade 6	6E31C	Percent Match	92.0%	90.6%	92.1%	100.0%
		N of items	30	13	15	2
		N of Reviewers	11	9	11	9
Grade 7	7E31C	Percent Match	92.7%	89.3%	94.9%	100.0%
		N of items	36	16	18	2
		N of Reviewers	10	7	10	7
Grade 8	8E31C	Percent Match	93.3%	89.0%	96.6%	100.0%
		N of items	32	15	15	2
		N of Reviewers	14	14	14	14

Table E5B presents DOK percent match for the High School test forms. The matches range between 88% and 94%.

Table E5B - DOK Match of Test Form Items for High School

Test Form		Test	RC1	RC2	RC3	
ELA 1	9E31C	Percent Match	91.5%	93.0%	89.7%	100.0%
		N of items	31	11	18	2
		N of Reviewers	7	7	7	7
	9E32A	Percent Match	88.3%	86.7%	89.1%	90.0%
		N of items	36	12	22	2
		N of Reviewers	7	7	7	7
	9E33A	Percent Match	87.4%	85.3%	87.6%	100.0%
		N of items	38	13	23	2
		N of Reviewers	7	7	7	7
ELA 2	10E31C	Percent Match	92.5%	95.2%	90.0%	100.0%
		N of items	35	13	20	2
		N of Reviewers	7	7	5	5
	10E32A	Percent Match	93.0%	94.3%	91.4%	100.0%
		N of items	37	14	21	2
		N of Reviewers	5	5	5	5
	10E33A	Percent Match	94.1%	96.0%	92.5%	100.0%
		N of items	41	15	24	2
		N of Reviewers	5	5	5	5

Table E6A presents the content composition in terms of Reporting Category test points to the test blueprint specification for Grades 3-8 test forms. All Reporting Categories and Total Test groupings are within the blueprint specifications.

Table E6A - Test Blueprint Content Comparison for Grades 3-8

Test Points					
	Form	Test	RC1	RC2	RC3
Grade 3	BLUEPRINT	40-42	14-16	14-16	10
	3E31C	42	16	16	10
	3E32A	40	16	14	10
	3E33A	40	16	14	10
Grade 4	BLUEPRINT	40-42	14-16	14-16	10
	4E31C	40	15	15	10
Grade 5	BLUEPRINT	40-42	14-16	14-16	10
	5E31C	41	15	16	10
Grade 6	BLUEPRINT	60-62	16-20	20-24	20
	6E31C	60	18	22	20
Grade 7	BLUEPRINT	60-62	16-20	20-24	20
	7E31C	61	19	22	20
Grade 8	BLUEPRINT	60-62	16-20	20-24	20
	8E31C	62	19	23	20

Table E6B presents the content composition in terms of Reporting Category test points to the test blueprint specification for High School test forms. All Reporting Categories and Total Test groupings are within the blueprint specifications.

Table E6B - Test Blueprint Content Comparison for High School

Test Points					
	Form	Test	RC1	RC2	RC3
ELA 1	BLUEPRINT	60-62	14-18	22-26	20
	9E31C	60	15	25	20
	9E32A	62	16	26	20
	9E33A	62	16	26	20
ELA 2	BLUEPRINT	60-62	14-18	22-26	20
	10E31C	60	17	23	20
	10E32A	62	16	26	20
	10E33A	62	16	26	20

Table E7A presents the percent test point score composition for Depth of Knowledge. The percentages are provided for total test and reporting category. The test blueprints for English Language Arts do not have a DOK composition specification. Where mathematics and science both have development guidelines for percentage of DOK per test form, the English Language Arts does not use specific development guidelines. It should be noted that because of the Writing Exercises (RC3) the DOK composition in English Language Arts is biased toward the higher levels.

Table E7A - DOK Composition of Test Forms for Grade 3-8

Test Form		Test	RC1	RC2	RC3	
Grade 3	3E31C	DOK 1	7.1%	12.5%	6.3%	0.0%
		DOK 2	57.1%	75.0%	75.0%	0.0%
		DOK 3	11.9%	12.5%	18.8%	0.0%
		DOK 4	23.8%	0.0%	0.0%	100.0%
3E32A	DOK 1	DOK 1	12.5%	12.5%	21.4%	0.0%
		DOK 2	42.5%	62.5%	50.0%	0.0%
		DOK 3	20.0%	25.0%	28.6%	0.0%
		DOK 4	25.0%	0.0%	0.0%	100.0%
3E33A	DOK 1	DOK 1	5.0%	0.0%	14.3%	0.0%
		DOK 2	52.5%	75.0%	64.3%	0.0%
		DOK 3	17.5%	25.0%	21.4%	0.0%
		DOK 4	25.0%	0.0%	0.0%	100.0%
Grade 4	4E31C	DOK 1	7.5%	6.6%	13.3%	0.0%
		DOK 2	50.0%	60.0%	73.3%	0.0%
		DOK 3	17.5%	33.3%	13.3%	0.0%
		DOK 4	25.0%	0.0%	0.0%	100.0%
Grade 5	5E31C	DOK 1	7.3%	6.7%	12.5%	0.0%
		DOK 2	48.8%	66.7%	62.5%	0.0%
		DOK 3	19.5%	26.7%	25.0%	0.0%
		DOK 4	24.4%	0.0%	0.0%	100.0%
Grade 6	6E31C	DOK 1	3.3%	0.0%	9.1%	0.0%
		DOK 2	51.7%	72.2%	81.8%	0.0%
		DOK 3	11.7%	27.8%	9.1%	0.0%
		DOK 4	33.0%	0.0%	0.0%	100.0%
Grade 7	7E31C	DOK 1	0.0%	0.0%	0.0%	0.0%
		DOK 2	50.8%	73.7%	77.3%	0.0%
		DOK 3	16.4%	26.3%	22.7%	0.0%
		DOK 4	32.8%	0.0%	0.0%	100.0%
Grade 8	8E31C	DOK 1	1.6%	5.3%	0.0%	0.0%
		DOK 2	41.9%	63.2%	65.2%	0.0%
		DOK 3	24.2%	31.6%	34.8%	0.0%
		DOK 4	32.3%	0.0%	0.0%	100.0%

The High School ELA forms also have a large component in DOK 3 and 4. For the six test forms in 2017 the composition of DOK 3 and 4 item points is greater than 50%. This is the case because the Writing Exercises make up about a third of test points and all are considered DOK 4.

Table E7B - DOK Composition of Test Forms for High School

Test Form			Test	RC1	RC2	RC3
ELA 1	9E31C	DOK 1	3.3%	6.7%	8.0%	0.0%
		DOK 2	36.7%	60.0%	48.0%	0.0%
		DOK 3	26.7%	33.3%	44.0%	0.0%
		DOK 4	33.3%	0.0%	0.0%	100.0%
	9E32A	DOK 1	9.7%	18.8%	11.5%	0.0%
		DOK 2	35.5%	50.0%	53.8%	0.0%
		DOK 3	22.6%	31.3%	34.6%	0.0%
		DOK 4	32.3%	0.0%	0.0%	100.0%
	9E33A	DOK 1	4.8%	6.3%	7.7%	0.0%
		DOK 2	43.5%	62.5%	65.4%	0.0%
		DOK 3	19.4%	31.3%	26.9%	0.0%
		DOK 4	32.3%	0.0%	0.0%	100.0%
ELA 2	10E31C	DOK 1	3.3%	0.0%	8.7%	0.0%
		DOK 2	43.3%	64.7%	65.2%	0.0%
		DOK 3	20.0%	35.3%	26.1%	0.0%
		DOK 4	33.3%	0.0%	0.0%	100.0%
	10E32A	DOK 1	1.6%	0.0%	3.8%	0.0%
		DOK 2	46.8%	43.8%	84.6%	0.0%
		DOK 3	19.4%	56.3%	11.5%	0.0%
		DOK 4	32.3%	0.0%	0.0%	100.0%
	10E33A	DOK 1	0.0%	0.0%	0.0%	0.0%
		DOK 2	45.2%	75.0%	61.5%	0.0%
		DOK 3	22.6%	25.0%	38.5%	0.0%
		DOK 4	32.3%	0.0%	0.0%	100.0%

Table E8A presents the percent of standards measured within total test and reporting category for Grades 3-8. The proportion of standards measured in ELA for the total test ranges approximately from 75% to 85%.

Table E8A - Proportion of Standards Measured by Form and Reporting Category for Grade 3-8

			Standards Measured			
Test Form		Test	RC1	RC2	RC3	
Grade 3		Blueprint	32	10	11	11
	3E31C	Number	25	7	7	11
		Percent	78.1%	70.0%	63.6%	100.0%
		Blueprint	32	10	11	11
	3E32A	Number	24	7	6	11
		Percent	75.0%	70.0%	54.5%	100.0%
		Blueprint	32	10	11	11
	3E33A	Number	26	7	8	11
		Percent	81.3%	70.0%	72.7%	100.0%
Grade 4		Blueprint	33	10	11	12
	4E31C	Number	24	6	6	12
		Percent	72.7%	60.0%	54.5%	100.0%
Grade 5		Blueprint	33	10	11	12
	5E31C	Number	28	7	9	12
		Percent	84.8%	70.0%	81.8%	100.0%
Grade 6		Blueprint	33	10	11	12
	6E31C	Number	27	7	8	12
		Percent	81.8%	70.0%	72.7%	100.0%
Grade 7		Blueprint	33	10	11	12
	7E31C	Number	25	6	7	12
		Percent	75.8%	60.0%	63.6%	100.0%
Grade 8		Blueprint	33	10	11	12
	8E31C	Number	25	6	7	12
		Percent	75.8%	60.0%	63.6%	100.0%

The proportion of assessable standards that are assessed by the High School test forms is presented in Table E8B. The percentages for total test range from 75% to 85%. The Writing contributes to the higher percentage because the nature of the Writing Exercises covers all standards within that reporting category.

TABLE E8B - Proportion of Standards Measured by Form and Reporting Category for High School

Test Form		Test	Standards Measured			
			RC1	RC2	RC3	
ELA 1	9E31C	Blueprint	32	10	11	11
		Number	25	7	7	11
		Percent	78.1%	70.0%	63.6%	100.0%
	9E32A	Blueprint	32	10	11	11
		Number	26	7	8	11
		Percent	81.3%	70.0%	72.7%	100.0%
	9E33A	Blueprint	32	10	11	11
		Number	24	6	7	11
		Percent	75.0%	60.0%	63.6%	100.0%
ELA 2	10E31C	Blueprint	32	10	11	11
		Number	25	7	7	11
		Percent	78.1%	70.0%	63.6%	100.0%
	10E32A	Blueprint	32	10	11	11
		Number	25	7	7	11
		Percent	78.1%	70.0%	63.6%	100.0%
	10E33A	Blueprint	32	10	11	11
		Number	24	6	7	11
		Percent	75.0%	60.0%	63.6%	100.0%

Section 5 - Mathematics Results

The Ohio testing program assesses Mathematics in Grades 3 through 8 and in the High School. High school assessments are end of course based. The Grade 3 through 8 assessments are administered each spring as online fixed form assessments. The high school assessments are end of course based and they include: Algebra, Geometry, Integrated Math 1 and Integrated Math 2. Students select the Algebra/Geometry course track or the Integrated Math series.

This section contains a set of tables displaying the results of the alignment study for the mathematics item banks. Ohio has created items banks for each Grade 3 through 8 and for Algebra and Geometry separately. The Integrated Math 1 and 2 assessments take their items from the Algebra and Geometry banks. Tables M1 through M3 present results based on the item bank. Tables M4 through M8 present results based on the test forms, which have been used while these standards have been in place.

Math Table M1A presents the results of the review of the match of items to standards for Grades 3-8. The table provides the percent match to standard, number of items, and number of reviewers. These variables are provided by total item bank and score reporting categories for each bank. Percent match ranges between 95.4% for Reporting Category 3 in Grade 4 to 100% in some of the Reporting Category areas. Bank content matches are 98% or better.

Table M1A - Mathematics Content Match for Grades 3-8

		Item Bank	RC1	RC2	RC3	RC4
Grade 3	Percent Match	98.6%	98.4%	99.1%	98.9%	98.1%
	N of items	147	45	34	36	32
	N of Reviewers	10	10	10	10	10
Grade 4	Percent Match	98.7%	99.0%	100.0%	95.4%	
	N of items	123	51	48	24	
	N of Reviewers	10	10	10	10	
Grade 5	Percent Match	99.1%	99.4%	99.4%	98.1%	
	N of items	142	52	53	37	
	N of Reviewers	10	10	10	10	
Grade 6	Percent Match	99.5%	99.7%	99.8%	98.7%	99.4%
	N of items	150	36	51	30	33
	N of Reviewers	10	10	10	10	10
Grade 7	Percent Match	99.3%	98.9%	99.1%	100.0%	99.3%
	N of items	168	46	54	31	37
	N of Reviewers	8	8	8	8	8
Grade 8	Percent Match	99.7%	100.0%	100.0%	99.5%	99.6%
	N of items	148	31	34	49	34
	N of Reviewers	8	8	8	8	8

Table M1B presents the same data as Table M1A for the high school assessment item banks. The item banks are assigned to Algebra and Geometry respectively, but also provide assessment items for Integrated Math 1 and Integrated Math 2, each of these assessments draws on both Algebra and Geometry bank items. The content match results are similar to the Grades 3-8 content match results. Over 97.5% of reviewers for Algebra and 98.8% of reviewers for Geometry agreed with the standard assigned by the item development committees.

Table M1B - Mathematics Content Match for High School

		Item Bank	RC1	RC2	RC3	RC4
Algebra	Percent Match	97.5%	96.9%	97.2%	100.0%	
	N of items	424	133	229	62	
	N of Reviewers	10	10	10	10	
Geometry	Percent Match	98.8%	99.2%	99.6%	99.7%	93.4%
	N of items	275	98	84	61	32
	N of Reviewers	10	10	10	10	10

The following two tables present the same structure as Tables M1A and M1B. Tables M2A and M2B present the results of the reviewers second task, which was evaluating the match of the item to DOK level. Items were assigned DOK levels during the test development process.

The DOK classifications do not match as well as the content classifications in mathematics. The overall item bank matches for DOK in Grades 3-8 range from 87.4% in Grade 6 to 97% in Grade 8. This is not unexpected as DOK classification is usually more difficult than content classification and reviewer experience in this area is more limited.

Table M2A - Mathematics DOK Match for Grades 3-8

		Item Bank	RC1	RC2	RC3	RC4
Grade 3	Percent Match	90.1%	89.1%	90.0%	88.3%	93.7%
	N of items	147	45	34	36	32
	N of Reviewers	10	10	10	10	10
Grade 4	Percent Match	90.8%	89.4%	92.1%	91.2%	
	N of items	123	51	48	24	
	N of Reviewers	10	10	10	10	
Grade 5	Percent Match	87.6%	86.2%	87.2%	90.3%	
	N of items	142	52	53	37	
	N of Reviewers	10	10	10	10	
Grade 6	Percent Match	87.4%	92.2%	86.7%	87.0%	83.6%
	N of items	150	36	51	30	33
	N of Reviewers	10	10	10	10	10
Grade 7	Percent Match	93.5%	93.8%	92.6%	92.3%	95.6%
	N of items	168	46	54	31	37
	N of Reviewers	8	8	8	8	8
Grade 8	Percent Match	97.0%	95.6%	98.2%	96.9%	97.4%
	N of items	148	31	34	49	34
	N of Reviewers	8	8	8	8	8

Table M2B presents the DOK match data for the Algebra and Geometry item banks. The results are in line with Grades 3-8. For Algebra the DOK match is 92.4% across all items and in Geometry the DOK match is 90.3% across all items.

Table M2B - Mathematics DOK Match for High School

		Item Bank	RC1	RC2	RC3	RC4
Algebra	Percent Match	92.4%	91.6%	92.0%	95.6%	
	N of items	424	133	229	62	
	N of Reviewers	10	10	10	10	
Geometry	Percent Match	90.3%	88.9%	94.2%	88.2%	88.1%
	N of items	275	98	84	61	32
	N of Reviewers	10	10	10	10	10

Reviewers were tasked with examining the content match and the DOK match for all test items in the item banks. When the reviewer decided that the content did not match they were asked to provide a standard that matched to the item in their view. When the reviewer decided that the item development DOK assignment was not correct they were asked to provide an alternate DOK assignment. Table M3 provides a look at the reviewer assignments of DOK given they did not agree with the assignment determined during test development. The reviewers either provided a higher level or lower level of DOK reassignment. The table indicates the number of DOK increases or decreases by item/reviewer. Note that this is not the number of items that had decreased or increased DOK assignments, but the number of reviews, which showed increases or decreases. For Mathematics, there were 8-10 reviewers for each item.

Table M3 shows that the increases and decreases were balanced across grades and subjects. Outliers were Grade 6 where 70.3% of reassignments were decreases to Geometry where only 39.5% of reassignments were decreases.

Table M3 - DOK Reviewer Reclassification

	Form	DOK Increase	DOK Decrease
Grade 3	Number	72	70
	Per Cent	50.7%	49.3%
Grade 4	Number	52	58
	Per Cent	47.3%	52.7%
Grade 5	Number	61	114
	Per Cent	34.9%	65.1%
Grade 6	Number	54	128
	Per Cent	29.7%	70.3%
Grade 7	Number	41	45
	Per Cent	47.7%	52.3%
Grade 8	Number	19	16
	Per Cent	54.3%	45.7%
Algebra	Number	124	155
	Per Cent	44.4%	55.6%
Geometry	Number	159	104
	Per Cent	60.5%	39.5%

The remaining tables present reviewer results by test form. In Grades 3-8 the mathematics tests were given in the spring of 2017. In high school the Algebra, Geometry, Integrated Math 1, and Integrated Math 2 end of course tests were given in the spring, summer, and fall of 2017.

Table M4A presents test item match to standard for the Grade 3 through 8 Spring 2017 assessments. The table shows percent item match, the number of items, and number of reviewers by total test and reporting categories. Item content matches for the tests are high and range from 98.8% in Grade 3 to 99.8% in Grade 8.

Table M4A - Content Match of Test Form Items to Standards for Grades 3-8

Test Form			Test	RC1	RC2	RC3	RC4
Grade 3	3M31	Percent Match	98.8%	97.5%	99.2%	99.1%	100.0%
		N of items	43	12	12	11	8
		N of Reviewers	10	10	10	10	10
Grade 4	4M31	Percent Match	99.3%	98.1%	100.0%	100.0%	
		N of items	44	16	17	11	
		N of Reviewers	10	10	10	10	
Grade 5	5M31	Percent Match	99.4%	99.4%	98.9%	100.0%	
		N of items	47	18	18	11	
		N of Reviewers	10	10	10	10	
Grade 6	6M31	Percent Match	99.4%	100.0%	99.4%	99.1%	99.0%
		N of items	50	13	16	11	10
		N of Reviewers	10	10	10	10	10
Grade 7	7M31	Percent Match	99.3%	97.7%	100.0%	100.0%	100.0%
		N of items	51	16	12	11	12
		N of Reviewers	8	8	8	8	8
Grade 8	8M31	Percent Match	99.8%	100.0%	100.0%	99.2%	100.0%
		N of items	52	14	13	15	10
		N of Reviewers	8	8	8	8	8

Table M4B presents the same variable data for the high school tests. Each end of course subject had 3 tests administered in 2017. Item content matches are also high at the high school level. All tests had item matches above 97%.

Table M4B - Content Match of Test Form Items to Standards for High School

Test Form			Test	RC1	RC2	RC3	RC4
Algebra	10M31	Percent Match	99.1%	100.0%	97.9%	100.0%	
		N of items	49	18	21	10	
		N of Reviewers	10	10	10	10	
Algebra	10M32	Percent Match	99.1%	100.0%	97.9%	100.0%	
		N of items	49	19	21	9	
		N of Reviewers	10	10	10	10	
Algebra	10M33	Percent Match	98.7%	99.4%	97.4%	100.0%	
		N of items	50	18	21	11	
		N of Reviewers	9	9	9	8	
Geometry	11M31	Percent Match	99.0%	99.5%	98.6%	98.9%	98.8%
		N of items	50	19	14	9	8
		N of Reviewers	10	10	10	10	10
Geometry	11M32	Percent Match	99.4%	100.0%	98.6%	100.0%	98.8%
		N of items	50	18	14	10	8
		N of Reviewers	10	10	10	10	10
Geometry	11M33	Percent Match	99.4%	99.5%	100.0%	98.8%	98.9%
		N of items	50	19	14	8	9
		N of Reviewers	10	10	10	10	10

Table M4B - Content Match of Test Form Items to Standards for High School
(continued)

Test Form			Test	RC1	RC2	RC3	RC4
Integrated	12M31	Percent Match	99.6%	100.0%	98.9%	100.0%	100.0%
Math 1		N of items	52	11	20	11	10
		N of Reviewers	10	10	10	10	10
Integrated	12M32	Percent Match	99.6%	100.0%	98.7%	100.0%	100.0%
Math 1		N of items	50	12	17	11	10
		N of Reviewers	10	10	10	10	10
Integrated	12M33	Percent Match	99.6%	100.0%	98.7%	100.0%	100.0%
Math 1		N of items	51	12	17	11	11
		N of Reviewers	9	9	9	10	8
Integrated	13M31	Percent Match	97.6%	95.7%	97.8%	98.4%	98.8%
Math 2		N of items	50	13	10	19	8
		N of Reviewers	10	10	10	10	10
Integrated	13M32	Percent Match	97.5%	95.7%	96.7%	98.8%	98.8%
Math 2		N of items	47	13	10	16	8
		N of Reviewers	10	10	10	10	10
Integrated	13M33	Percent Match	97.1%	93.7%	96.7%	99.4%	98.9%
Math 2		N of items	49	14	10	16	9
		N of Reviewers	10	10	9	10	10

Table M5A presents the DOK match for Grades 3 through 8 by test form in a similar manner to Table M4A. DOK classification matches are lower than content matches as indicated previously in the item bank results tables. The DOK matches range from 85.8% at Grade 6 total test to 96.9% for Grade 8. Reporting Category DOK matches vary within grade, but none are lower than 82%.

Table M5A - Match of Test Form Items to DOK for Grades 3-8

Test Form		Test	RC1	RC2	RC3	RC4	
Grade 3	3M31	Percent Match	88.1%	89.2%	88.3%	82.7%	93.8%
		N of items	43	12	12	11	8
		N of Reviewers	10	10	10	10	10
Grade 4	4M31	Percent Match	92.7%	89.4%	94.1%	95.5%	
		N of items	44	16	17	11	
		N of Reviewers	10	10	10	10	
Grade 5	5M31	Percent Match	86.4%	86.1%	82.8%	92.7%	
		N of items	47	18	18	11	
		N of Reviewers	10	10	10	10	
Grade 6	6M31	Percent Match	85.8%	89.2%	85.6%	85.5%	82.0%
		N of items	50	13	16	11	10
		N of Reviewers	10	10	10	10	10
Grade 7	7M31	Percent Match	94.6%	95.3%	91.7%	96.6%	94.8%
		N of items	51	16	12	11	12
		N of Reviewers	8	8	8	8	8
Grade 8	8M31	Percent Match	96.9%	97.3%	98.1%	94.2%	98.8%
		N of items	52	14	13	15	10
		N of Reviewers	8	8	8	8	8

The DOK test form match for High School is presented in Table M5B. The percent match varies from 86.8% in an Integrated Math 1 test form to 97.1% for an Integrated Math 2 test form. Matches in Reporting Categories vary around the test values and none are lower than 82%.

Table M5B - Match of Test Form Items to DOK for High School

Test Form			Test	RC1	RC2	RC3	RC4
Algebra	10M31	Percent Match	90.6%	92.2%	88.7%	91.8%	
		N of items	49	18	21	10	
		N of Reviewers	10	10	10	10	
Algebra	10M32	Percent Match	90.2%	89.6%	90.6%	90.8%	
		N of items	49	19	21	9	
		N of Reviewers	10	10	10	10	
Algebra	10M33	Percent Match	87.9%	87.5%	85.5%	93.2%	
		N of items	50	18	21	11	
		N of Reviewers	9	9	9	8	
Geometry	11M31	Percent Match	93.8%	90.0%	95.7%	94.4%	98.8%
		N of items	50	19	14	9	8
		N of Reviewers	10	10	10	10	10
Geometry	11M32	Percent Match	94.0%	90.6%	95.7%	94.0%	98.8%
		N of items	50	18	14	10	8
		N of Reviewers	10	10	10	10	10
Geometry	11M33	Percent Match	94.6%	90.5%	97.1%	95.0%	98.9%
		N of items	50	19	14	8	9
		N of Reviewers	10	10	10	10	10

Table M5B - Content Match of Test Form Items to DOK for High School
(continued)

Test Form			Test	RC1	RC2	RC3	RC4
Integrated	12M31	Percent Match	88.5%	86.5%	88.7%	87.3%	91.8%
Math 1		N of items	52	11	20	11	10
		N of Reviewers	10	10	10	10	10
Integrated	12M32	Percent Match	88.5%	82.7%	90.3%	87.3%	93.8%
Math 1		N of items	50	12	17	11	10
		N of Reviewers	10	10	10	10	10
Integrated	12M33	Percent Match	86.8%	85.0%	85.0%	85.5%	93.2%
Math 1		N of items	51	12	17	11	11
		N of Reviewers	9	9	9	10	8
Integrated	13M31	Percent Match	97.1%	95.0%	95.9%	98.4%	98.8%
Math 2		N of items	50	13	10	19	8
		N of Reviewers	10	10	10	10	10
Integrated	13M32	Percent Match	96.0%	92.6%	96.9%	96.9%	98.8%
Math 2		N of items	47	13	10	16	8
		N of Reviewers	10	10	10	10	10
Integrated	13M33	Percent Match	95.8%	89.6%	98.9%	97.5%	98.9%
Math 2		N of items	49	14	10	16	9
		N of Reviewers	10	10	9	10	10

One aspect of test alignment is whether the test form conforms to the test blueprint. Table M6A provides information about the number of points assigned by the test blueprint and the corresponding number of points on the actual test form. The table presents points by total test and reporting category for Grades 3 through 8. All mathematics test forms for Grades 3 through 8 conform to the blueprint ranges as indicated in Table M6A. In one case at Grade 3 Reporting Category 2 the number of points is one above the blueprint range.

Table M6A - Test Blueprint Content Comparison Grades 3-8

Test Points						
	Form	Test	RC1	RC2	RC3	RC4
Grade 3	BLUEPRINT	49-51	12-16	11-13	11-13	11-13
	3M31	49	13	14	11	11
Grade 4	BLUEPRINT	49-51	17-21	17-21	11-13	
	4M31	49	18	20	11	
Grade 5	BLUEPRINT	49-51	17-21	17-21	11-13	
	5M31	49	18	19	12	
Grade 6	BLUEPRINT	52-54	13-17	17-23	11-13	11-13
	6M31	52	13	17	11	11
Grade 7	BLUEPRINT	52-54	12-16	15-19	11-13	12-15
	7M31	52	14	15	11	12
Grade 8	BLUEPRINT	52-54	11-15	11-15	15-19	11-13
	8M31	53	15	13	15	10

Table M6B presents the same results as Table M6A for the high school assessments. The tests mostly conform to the blueprint. In two instances in Reporting Category two for Geometry form 11M32 and in Integrated Math form 12M31 the number of points is one point less than the specified range of points in the blueprint.

Table M6B - Test Blueprint Content Comparison High School

Test Points						
	Form	Test	RC1	RC2	RC3	RC4
Algebra	BLUEPRINT	54-56	19-22	23-27	10-12	
	10M31	54	20	23	11	
	10M32	54	20	24	10	
	10M33	54	19	23	12	
Geometry	BLUEPRINT	54-56	19-21	13-19	10-13	10-12
	11M31	54	19	15	10	10
	11M32	54	18	15	11	10
	11M33	54	19	15	10	10
Integrated Math 1	BLUEPRINT	54-56	13-15	18-21	11-13	10-12
	12M31	55	12	21	11	11
	12M32	54	13	19	11	11
	12M33	54	13	18	11	12
Integrated Math 2	BLUEPRINT	54-56	14-18	11-13	17-22	10-12
	13M31	56	15	11	20	10
	13M32	54	15	11	18	10
	13M33	54	14	11	19	10

Table M7A presents the DOK composition of the Grade 3 through 8 Mathematics tests. Ohio has not yet approved DOK composition blueprint specifications. The published test blueprints do not specify any DOK composition for the test forms. However, the mathematics test building process uses a guideline for DOK composition: DOK 1-20%, DOK 2-60%, and DOK 3 and above-20%. Given these guidelines for form development the Grade 3-8 mathematics tests generally conform. They are low in DOK 3, which makes up less than 10% for Grades 3-5 and between 10% and 20% for Grades 6-8. Most of the missing DOK 3 is made up by DOK 1 items.

Table M7A - DOK Point Composition of Test Forms for Grade 3-8

Test Form			Test	RC1	RC2	RC3	RC4
Grade 3	3M31	DOK 1	26.5%	30.8%	28.6%	27.3%	18.2%
		DOK 2	61.2%	61.5%	57.1%	63.6%	63.6%
		DOK 3	12.2%	7.7%	14.3%	9.1%	18.2%
		DOK 4	0.0%	0.0%	0.0%	0.0%	0.0%
Grade 4	4M31	DOK 1	24.5%	16.7%	30.0%	27.3%	
		DOK 2	73.5%	77.8%	70.0%	72.7%	
		DOK 3	2.0%	5.6%	0.0%	0.0%	
		DOK 4	0.0%	0.0%	0.0%	0.0%	
Grade 5	5M31	DOK 1	24.5%	21.1%	38.9%	8.3%	
		DOK 2	69.4%	78.9%	50.0%	83.3%	
		DOK 3	6.1%	0.0%	11.1%	8.3%	
		DOK 4	0.0%	0.0%	0.0%	0.0%	
Grade 6	6M31	DOK 1	25.0%	15.4%	23.5%	27.3%	36.4%
		DOK 2	55.8%	69.2%	58.8%	54.5%	36.4%
		DOK 3	19.2%	15.4%	17.6%	18.2%	27.3%
		DOK 4	0.0%	0.0%	0.0%	0.0%	0.0%
Grade 7	7M31	DOK 1	26.9%	17.6%	41.7%	27.3%	25.0%
		DOK 2	57.7%	52.9%	41.7%	72.7%	66.7%
		DOK 3	15.4%	29.4%	16.7%	0.0%	8.3%
		DOK 4	0.0%	0.0%	0.0%	0.0%	0.0%
Grade 8	8M31	DOK 1	26.4%	26.7%	38.5%	26.7%	10.0%
		DOK 2	60.4%	53.3%	53.8%	60.0%	80.0%
		DOK 3	13.2%	20.0%	7.7%	13.3%	10.0%
		DOK 4	0.0%	0.0%	0.0%	0.0%	0.0%

Table M7B presents the DOK composition of the high school tests. The 20%/60%/20% DOK1/DOK2/DOK3 guideline applies generally, however like Grade 3 through 8, the high school tests have generally less DOK 3 item points than DOK 1.

Table M7B - DOK Point Composition of Test Forms for High School

Test Form			Test	RC1	RC2	RC3	RC4
Algebra	10M31	DOK 1	24.1%	35.0%	8.7%	36.4%	
		DOK 2	57.4%	60.0%	65.2%	36.4%	
		DOK 3	18.5%	5.0%	26.1%	27.3%	
		DOK 4	0.0%	0.0%	0.0%	0.0%	
	10M32	DOK 1	27.8%	35.0%	20.8%	30.0%	
		DOK 2	51.9%	60.0%	50.0%	40.0%	
		DOK 3	20.4%	5.0%	29.2%	30.0%	
		DOK 4	0.0%	0.0%	0.0%	0.0%	
	10M33	DOK 1	20.4%	31.6%	21.7%	0.0%	
		DOK 2	59.3%	52.6%	56.5%	75.0%	
		DOK 3	20.4%	15.8%	21.7%	25.0%	
		DOK 4	0.0%	0.0%	0.0%	0.0%	
Geometry	11M31	DOK 1	24.1%	15.8%	40.0%	30.0%	10.0%
		DOK 2	57.4%	63.2%	46.7%	50.0%	70.0%
		DOK 3	18.5%	21.1%	13.3%	20.0%	20.0%
		DOK 4	0.0%	0.0%	0.0%	0.0%	0.0%
	11M32	DOK 1	22.2%	22.2%	33.3%	18.2%	10.0%
		DOK 2	59.3%	55.6%	53.3%	63.6%	70.0%
		DOK 3	18.5%	22.2%	13.3%	18.2%	20.0%
		DOK 4	0.0%	0.0%	0.0%	0.0%	0.0%
	11M33	DOK 1	20.4%	15.8%	33.3%	30.0%	0.0%
		DOK 2	61.1%	63.2%	53.3%	30.0%	100.0%
		DOK 3	18.5%	21.1%	13.3%	40.0%	0.0%
		DOK 4	0.0%	0.0%	0.0%	0.0%	0.0%

Table M7B - DOK Point Composition of Test Forms for High School
(continued)

Test Form			Test	RC1	RC2	RC3	RC4
Integrated	12M31	DOK 1	27.3%	41.7%	19.0%	27.3%	27.3%
Math 1		DOK 2	54.5%	50.0%	61.9%	54.5%	45.5%
		DOK 3	18.2%	8.3%	19.0%	18.2%	27.3%
		DOK 4	0.0%	0.0%	0.0%	0.0%	0.0%
	12M32	DOK 1	25.9%	30.8%	15.8%	36.4%	27.3%
		DOK 2	53.7%	61.5%	57.9%	45.5%	45.5%
		DOK 3	20.4%	7.7%	26.3%	18.2%	27.3%
		DOK 4	0.0%	0.0%	0.0%	0.0%	0.0%
	12M33	DOK 1	20.4%	30.8%	22.2%	27.3%	0.0%
		DOK 2	59.3%	46.2%	61.1%	54.5%	75.0%
		DOK 3	20.4%	23.1%	16.7%	18.2%	25.0%
		DOK 4	0.0%	0.0%	0.0%	0.0%	0.0%
Integrated	13M31	DOK 1	23.2%	20.0%	18.2%	35.0%	10.0%
Math 2		DOK 2	57.1%	66.7%	63.6%	40.0%	70.0%
		DOK 3	19.6%	13.3%	18.2%	25.0%	20.0%
		DOK 4	0.0%	0.0%	0.0%	0.0%	0.0%
	13M32	DOK 1	18.5%	13.3%	18.2%	27.8%	10.0%
		DOK 2	61.1%	73.3%	63.6%	44.4%	70.0%
		DOK 3	20.4%	13.3%	18.2%	27.8%	20.0%
		DOK 4	0.0%	0.0%	0.0%	0.0%	0.0%
	13M33	DOK 1	20.4%	35.7%	9.1%	26.3%	0.0%
		DOK 2	63.0%	64.3%	72.7%	36.8%	100.0%
		DOK 3	16.7%	0.0%	18.2%	36.8%	0.0%
		DOK 4	0.0%	0.0%	0.0%	0.0%	0.0%

Table M8A presents information about the range and percent of standards represented in each test form for Grades 3 through 8. The table shows the number of standards in the blueprint for total test and each reporting category. The table also shows the number of standards that were used for each test and the percent of the total standards in the blueprint.

The percent of standards used on the tests range from 83.3% for Grade 7 to 96.4% for Grade 4. The percentages for the Reporting Categories do not vary much from the total test percent.

TABLE M8A - Proportion of Standards Measured by Form and Reporting Category for Grades 3-8

		Standards Measured					
Test Form		Test	RC1	RC2	RC3	RC4	
Grade 3	3M31	Blueprint	25	10	5	6	4
		Number	23	9	5	6	3
		Percent	92.0%	90.0%	100.0%	100.0%	75.0%
Grade 4	4M31	Blueprint	28	13	9	6	
		Number	27	12	9	6	
		Percent	96.4%	92.3%	100.0%	100.0%	
Grade 5	5M31	Blueprint	26	8	10	8	
		Number	24	7	10	7	
		Percent	92.3%	87.5%	100.0%	87.5%	
Grade 6	6M31	Blueprint	29	3	9	10	7
		Number	26	3	9	8	6
		Percent	89.7%	100.0%	100.0%	80.0%	85.7%
Grade 7	7M31	Blueprint	24	3	7	6	8
		Number	20	3	6	5	6
		Percent	83.3%	100.0%	85.7%	83.3%	75.0%
Grade 8	8M31	Blueprint	28	8	5	9	6
		Number	26	8	4	8	6
		Percent	92.9%	100.0%	80.0%	88.9%	100.0%

The high school test blueprint information for standard representation is presented in Table M8B. Total test standard representation ranges from 58.3% for Algebra form 10M33 to 86.0% for Geometry form 11M32. The overall percentages are lower than in Grades 3 through 8. This may be due to the larger number of standards measured in the high school tests.

TABLE M8B - Proportion of Standards Measured by Form and Reporting Category for High School

Test Form		Blueprint	Test	Standards Measured			
				RC1	RC2	RC3	RC4
Algebra	10M31	Blueprint	48	15	24	9	
		Number	35	12	16	7	
		Percent	72.9%	80.0%	66.7%	77.8%	
	10M32	Blueprint	48	15	24	9	
		Number	35	12	16	7	
		Percent	72.9%	80.0%	66.7%	77.8%	
	10M33	Blueprint	48	15	24	9	
		Number	28	10	12	6	
		Percent	58.3%	66.7%	50.0%	66.7%	
Geometry	11M31	Blueprint	43	17	11	8	7
		Number	36	14	10	6	6
		Percent	83.7%	82.4%	90.9%	75.0%	85.7%
	11M32	Blueprint	43	17	11	8	7
		Number	37	13	10	8	6
		Percent	86.0%	76.5%	90.9%	100.0%	85.7%
	11M33	Blueprint	43	17	11	8	7
		Number	30	11	8	6	5
		Percent	69.8%	64.7%	72.7%	75.0%	71.4%

TABLE M8B - Proportion of Standards Measured by Form and Reporting Category for High School (continued)

Test Form		Standards Measured					
		Test	RC1	RC2	RC3	RC4	
Integrated Math 1	12M31	Blueprint	51	10	20	13	8
		Number	36	7	13	9	7
		Percent	70.6%	70.0%	65.0%	69.2%	87.5%
		Blueprint	51	10	20	13	8
	12M32	Number	34	7	13	8	6
		Percent	66.7%	70.0%	65.0%	61.5%	75.0%
		Blueprint	51	10	20	13	8
	12M33	Number	31	7	11	7	6
		Percent	60.8%	70.0%	55.0%	53.8%	75.0%
Integrated Math 2	13M31	Blueprint	53	15	10	21	7
		Number	36	9	7	14	6
		Percent	67.9%	60.0%	70.0%	66.7%	85.7%
		Blueprint	53	15	10	21	7
	13M32	Number	40	11	8	15	6
		Percent	75.5%	73.3%	80.0%	71.4%	85.7%
		Blueprint	53	15	10	21	7
	13M33	Number	32	10	6	11	5
		Percent	60.4%	66.7%	60.0%	52.4%	71.4%

Section 6 - Science Results

The Ohio testing program assesses Science in Grades 5 and 8 and in the High School. High school assessments are end of course based. The Grade 5 and 8 assessments are administered each spring as online fixed form assessments. The high school assessments are end of course based and presently include just Biology.

This section contains a set of tables displaying the results of the alignment study for the science item banks. Ohio has created items banks for Grade 5, Grade 8 and Biology. Tables S1 through S3 present results based on the item bank. Tables S4 through S8 present results based on the test forms, which have been used while these standards have been in place. The present Science standards have been in use since 2015. Three years of science test forms have been included in this analysis.

Table S1 presents the percent of item/standard match based on the development committee assignment of standard to items and the reviewers' validation of that assignment. The agreement of the reviewers with the development committee assignment is high, ranging from 95.2% for Biology to 99.7% at Grade 8. The percent match for the reporting categories is in line with the totals.

Table S1 - Science Item Content to Standard Match for Grades 5, 8, and Biology

		Item Bank	RC1	RC2	RC3	RC4
Grade 5						
Percent Match		97.4%	98.3%	94.2%	99.9%	
N of items		455	149	156	150	
N of Reviewers		5	5	5	5	
Grade 8						
Percent Match		99.7%	99.8%	99.7%	99.7%	
N of items		457	205	128	124	
N of Reviewers		5	5	5	5	
Biology						
Percent Match		95.2%	92.3%	94.3%	98.9%	95.6%
N of items		508	147	118	136	107
N of Reviewers		7	7	7	7	7

Science defines the test item cognitive complexity in terms of Cognitive Demand instead of Depth of Knowledge. There are four categories: R - Recalling Accurate Science, C - Interpreting and Communicating Science Concepts, D - Demonstrating Science Knowledge, and T - Designing Technological/Engineering Solutions Using Science Concepts.

Table S2 shows the percent match between the development committee assignment of Cognitive Demand and the reviewer’s validations. The matches are high, all above 94% for the total banks and above 92% for Reporting Categories. These are not quite as high as the content matches.

Table S2 - Science Cognitive Demand Match for Grades 5, 8, and Biology

		Item Bank	RC1	RC2	RC3	RC4
Grade 5	Percent Match	94.9%	95.0%	93.7%	96.0%	
	N of items	455	149	156	150	
	N of Reviewers	5	5	5	5	
Grade 8	Percent Match	95.3%	96.0%	96.6%	92.9%	
	N of items	457	205	128	124	
	N of Reviewers	5	5	5	5	
Biology	Percent Match	94.8%	92.7%	96.2%	95.5%	95.2%
	N of items	508	147	118	136	107
	N of Reviewers	7	7	7	7	7

Table S3 looks at the mismatches for Cognitive Demand. For each item the reviewers were asked if they agreed with the Cognitive Demand assignment, if not they were to provide an alternate assignment. Table S3 presents the number of reviewer/item mismatches that the reviewer assigned to a higher or lower level of Cognitive Demand. Because the Cognitive Demand matches were about 95%, the table only looks at the remaining 5% that the reviewers felt needed a different Cognitive Demand assignment. The table shows that 63% to 74% of reviewer assignments were to a higher Cognitive Demand level. This result was strongest in Biology with 74.4% of reviewer assignments calling for a higher Cognitive Demand assignment.

Table S3 - Cognitive Demand (CD) Reviewer Reclassification

	Form	CD Increase	CD Decrease
Grade 5	Number	70	41
	Per Cent	63.1%	36.9%
Grade 8	Number	72	31
	Per Cent	69.9%	30.1%
Biology	Number	134	46
	Per Cent	74.4%	25.6%

Tables S4 through S8 focus on the test forms that were administered in 2015, 2016, and 2017. In these tables only items that appeared on the test form and contributed to a student’s score are included in the analysis.

Table S4A presents the content match of items to standards for Grade 5 and 8 test forms. The table presents the percent of matches between the development committee assignment of standard and the reviewers validation, the number of items, and the number of reviewers that reviewed the item. The reviewer/development committee match is high for the items that were used on test forms. Percent Match ranges from 95% to 100% for total test and reporting categories.

Table S4A - Content Match of Test Form Items to Standards for Grades 5 and 8

Test Form		Test	RC1	RC2	RC3	
Grade 5	5S11	Percent Match	98.0%	98.6%	95.8%	100.0%
		N of items	51	14	19	18
		N of Reviewers	5	5	5	5
	5S21	Percent Match	97.1%	95.7%	95.0%	100.0%
		N of items	49	14	16	19
		N of Reviewers	5	5	5	5
	5S31	Percent Match	98.1%	100.0%	95.0%	100.0%
		N of items	43	12	16	15
		N of Reviewers	5	5	5	5
Grade 8	8S11	Percent Match	100.0%	100.0%	100.0%	100.0%
		N of items	48	17	16	15
		N of Reviewers	5	5	5	5
	8S21	Percent Match	100.0%	100.0%	100.0%	100.0%
		N of items	47	16	16	15
		N of Reviewers	5	5	5	5
	8S31	Percent Match	99.5%	100.0%	100.0%	98.5%
		N of items	43	16	14	13
		N of Reviewers	5	5	5	5

Table S4B presents the item content to standard match for the High School Biology Tests. The matches range between 87.1% for RC1 Form 10S33 to 100% for three categories. The Biology percent matches are not quite as high as Grade 5 and 8. This was also the case for the total item bank.

Table S4B - Content Match of Test Form Items to Standards for High School

Test Form		Test	RC1	RC2	RC3	RC4	
Biology	10S13	Percent Match	95.0%	94.0%	92.3%	100.0%	93.2%
		N of items	52	12	13	14	13
		N of Reviewers	7	7	7	7	7
	10S21	Percent Match	94.2%	97.6%	90.7%	97.2%	90.5%
		N of items	44	12	9	11	12
		N of Reviewers	7	7	7	7	7
	10S22	Percent Match	94.4%	94.8%	89.7%	97.6%	95.6%
		N of items	48	11	12	12	13
		N of Reviewers	7	7	7	7	7
	10S23	Percent Match	95.2%	94.3%	92.2%	98.7%	95.5%
		N of items	42	10	11	11	10
		N of Reviewers	7	7	7	7	7
	10S31	Percent Match	97.3%	96.4%	98.6%	100.0%	94.5%
		N of items	48	12	12	11	13
		N of Reviewers	7	7	7	7	7
	10S32	Percent Match	96.6%	94.8%	97.1%	100.0%	94.8%
		N of items	42	11	10	10	11
		N of Reviewers	7	7	7	7	7
	10S33	Percent Match	95.2%	87.1%	94.0%	98.8%	100.0%
		N of items	45	10	12	12	11
		N of Reviewers	7	7	7	7	7

Tables S5A and S5B present the percent match for the Cognitive Demand assignment. The results for Grade 5 and 8 test forms appear in Table S5A. The Cognitive Demand percent matches are all at 95% or better for the Grade 5 and 8 test forms. Reporting Category matches vary from 92% to 98%.

Table S5A - Cognitive Demand Match of Test Form Items for Grades 5 and 8

Test Form		Test	RC1	RC2	RC3	
Grade 5	5S11	Percent Match	96.9%	94.3%	97.9%	97.8%
		N of items	51	14	19	18
		N of Reviewers	5	5	5	5
	5S21	Percent Match	95.5%	95.7%	98.8%	92.6%
		N of items	49	14	16	19
		N of Reviewers	5	5	5	5
	5S31	Percent Match	96.7%	96.7%	96.2%	97.3%
		N of items	43	12	16	15
		N of Reviewers	5	5	5	5
Grade 8	8S11	Percent Match	95.0%	98.8%	97.5%	88.0%
		N of items	48	17	16	15
		N of Reviewers	5	5	5	5
	8S21	Percent Match	95.3%	97.5%	96.3%	92.0%
		N of items	47	16	16	15
		N of Reviewers	5	5	5	5
	8S31	Percent Match	95.8%	98.8%	92.9%	95.4%
		N of items	43	16	14	13
		N of Reviewers	5	5	5	5

Table S5B presents the Cognitive Demand matches for the High School Biology tests. Total test matches range from 93.2% to 95.9% across Biology test forms. Reporting Category percent matches are slightly more variable.

Table S5B - Cognitive Demand Match of Test Form Items for High School

Test Form			Test	RC1	RC2	RC3	RC4
Biology	10S13	Percent Match	94.0%	92.9%	92.3%	95.9%	94.5%
		N of items	52	12	13	14	13
		N of Reviewers	7	7	7	7	7
	10S21	Percent Match	95.9%	91.1%	98.4%	97.4%	97.6%
		N of items	44	12	9	11	12
		N of Reviewers	7	7	7	7	7
	10S22	Percent Match	95.8%	94.6%	100.0%	94.0%	94.5%
		N of items	48	11	12	12	13
		N of Reviewers	7	7	7	7	7
	10S23	Percent Match	93.9%	90.0%	94.8%	92.2%	98.6%
		N of items	42	10	11	11	10
		N of Reviewers	7	7	7	7	7
	10S31	Percent Match	95.4%	96.0%	97.6%	93.5%	94.5%
		N of items	48	12	12	11	13
		N of Reviewers	7	7	7	7	7
	10S32	Percent Match	93.2%	93.5%	87.1%	94.3%	97.4%
		N of items	42	11	10	10	11
		N of Reviewers	7	7	7	7	7
	10S33	Percent Match	95.9%	97.1%	100.0%	94.0%	92.2%
		N of items	45	10	12	12	11
		N of Reviewers	7	7	7	7	7

Tables S6A and S6B present the test content comparison between test forms and the test blueprint for Grades 5 and 8, and Biology respectively. In Grades 5 and 8, all reporting categories and totals conform to the blueprints except for one extra point in RC1 for Test Form 5S31. For Biology presented in Table S6B, all reporting categories conform. Two test forms have one and two points above the specification range.

Table S6A: Test Blueprint Content Comparison for Grades 5 and 8

Test Points					
	Form	Test	RC1	RC2	RC3
Grade 5	BLUEPRINT	54-56	15-17	19-21	19-21
	5S11	56	17	20	19
	5S21	58	15	23	20
	5S31	56	18	19	19
Grade 8	BLUEPRINT	54-56	21-23	16-18	16-18
	8S11	56	22	16	18
	8S21	56	22	18	16
	8S31	55	21	17	17

Table S6B - Test Blueprint Content Comparison for High School

Test Points						
	Form	Test	RC1	RC2	RC3	RC4
Biology	BLUEPRINT	54-56	13-15	13-15	13-15	13-15
	10S13	56	13	15	15	13
	10S21	56	14	13	15	14
	10S22	57	13	15	14	15
	10S23	55	13	15	14	13
	10S31	58	14	15	15	14
	10S32	56	14	14	15	13
	10S33	57	13	15	15	14

Tables S7A and S7B present the item point composition of Cognitive Demand for each of the test forms at Grades 5, 8, and Biology. The Ohio State Test blueprints for Science do not provide published guidelines for Cognitive Demand composition for test forms. Test development guidelines are provided, but these are not part of the blueprint specification. The test development guidance for Cognitive Demand in Science test forms is as follows:

Recalling Accurate Science (R)	30% - 40%
Interpreting and Communicating Science Concepts (C)	50% - 60%
Demonstrating Science Knowledge (D)	10% - 20%
And	
Designing Technological/Engineering Solutions Using Science Concepts (T)	

Table S7A presents the Cognitive Demand composition percentages for Grades 5 and 8. In general the composition is weighted heavily in the R and C categories, as are the guidelines. However, depending on the test the composition of test forms and reporting categories bounce around between the R and C Cognitive Demand categories.

Table S7A - Cognitive Demand (CD) Point Composition of Test Forms for Grades 5 and 8

Test Form			Test	RC1	RC2	RC3
Grade 5	5S11	CD- R	44.6%	52.9%	40.0%	42.1%
		CD- C	48.2%	41.2%	55.0%	47.4%
		CD- D	3.6%	5.9%	5.0%	0.0%
		CD- T	3.6%	0.0%	0.0%	10.5%
	5S21	CD- R	46.6%	60.0%	26.1%	60.0%
		CD- C	48.3%	40.0%	73.9%	25.0%
		CD- D	0.0%	0.0%	0.0%	0.0%
		CD- T	5.2%	0.0%	0.0%	15.0%
	5S31	CD- R	33.9%	61.1%	15.8%	26.3%
		CD- C	46.4%	27.8%	73.7%	36.8%
		CD- D	16.1%	11.1%	10.5%	26.3%
		CD- T	3.6%	0.0%	0.0%	10.5%
Grade 8	8S11	CD- R	51.8%	54.5%	56.3%	44.4%
		CD- C	41.1%	45.5%	43.8%	33.3%
		CD- D	0.0%	0.0%	0.0%	0.0%
		CD- T	7.1%	0.0%	0.0%	22.2%
	8S21	CD- R	42.9%	36.4%	33.3%	62.5%
		CD- C	57.1%	63.6%	66.7%	37.5%
		CD- D	0.0%	0.0%	0.0%	0.0%
		CD- T	0.0%	0.0%	0.0%	0.0%
	8S31	CD- R	29.1%	38.1%	29.4%	17.6%
		CD- C	60.0%	61.9%	70.6%	47.1%
		CD- D	7.3%	0.0%	0.0%	23.5%
		CD- T	3.6%	0.0%	0.0%	11.8%

In Biology, the Cognitive Demand composition is more stable across total test forms. Cognitive Demand categories R and C conform to the guidelines. The composition of the two higher Cognitive Demand categories is lower than the guidelines.

Table S7B - Cognitive Demand Composition of Test Forms for High School

Test Form		Test	RC1	RC2	RC3	RC4	
Biology	10S13	CD- R	33.9%	38.5%	26.7%	6.7%	69.2%
		CD- C	60.7%	61.5%	53.3%	93.3%	30.8%
		CD- D	5.4%	0.0%	20.0%	0.0%	0.0%
		CD- T	0.0%	0.0%	0.0%	0.0%	0.0%
	10S21	CD- R	35.7%	35.7%	15.4%	26.7%	64.3%
		CD- C	55.4%	64.3%	53.8%	66.7%	35.7%
		CD- D	8.9%	0.0%	30.8%	6.7%	0.0%
		CD- T	0.0%	0.0%	0.0%	0.0%	0.0%
	10S22	CD- R	24.6%	30.8%	6.7%	21.4%	40.0%
		CD- C	66.7%	61.5%	73.3%	78.6%	53.3%
		CD- D	8.8%	7.7%	20.0%	0.0%	6.7%
		CD- T	0.0%	0.0%	0.0%	0.0%	0.0%
	10S23	CD- R	36.4%	46.2%	13.3%	21.4%	69.2%
		CD- C	58.2%	53.8%	66.7%	78.6%	30.8%
		CD- D	5.5%	0.0%	20.0%	0.0%	0.0%
		CD- T	0.0%	0.0%	0.0%	0.0%	0.0%
	10S31	CD- R	36.2%	35.7%	20.0%	33.3%	57.1%
		CD- C	48.3%	42.9%	53.3%	66.7%	28.6%
		CD- D	15.5%	21.4%	26.7%	0.0%	14.3%
		CD- T	0.0%	0.0%	0.0%	0.0%	0.0%
	10S32	CD- R	35.7%	50.0%	14.3%	6.7%	76.9%
		CD- C	58.9%	50.0%	64.3%	93.3%	23.1%
		CD- D	5.4%	0.0%	21.4%	0.0%	0.0%
		CD- T	0.0%	0.0%	0.0%	0.0%	0.0%
	10S33	CD- R	31.6%	23.1%	20.0%	20.0%	64.3%
		CD- C	63.2%	76.9%	73.3%	66.7%	35.7%
		CD- D	5.3%	0.0%	6.7%	13.3%	0.0%
		CD- T	0.0%	0.0%	0.0%	0.0%	0.0%

Table S8A presents the proportion of standards measured by each test form. The proportions are provided by test and reporting categories. The Grade 5 and Grade 8 Science standards are small in number, with 8 at Grade 5 and 10 at Grade 8. All standards are assessed by test items for the total and each reporting category.

Table S8A - Proportion of Standards Measured by Form and Reporting Category for Grades 5 and 8

Test Form		Test	Standards Measured			
			RC1	RC2	RC3	
Grade 5	5S11	Blueprint	8	3	2	2
		Number	8	3	2	2
		Percent	100.0%	100.0%	100.0%	100.0%
	5S21	Blueprint	8	3	2	2
		Number	8	3	2	2
		Percent	100.0%	100.0%	100.0%	100.0%
	5S31	Blueprint	8	3	2	2
		Number	8	3	2	2
		Percent	100.0%	100.0%	100.0%	100.0%
Grade 8	8S11	Blueprint	10	4	3	3
		Number	10	4	3	3
		Percent	100.0%	100.0%	100.0%	100.0%
	8S21	Blueprint	10	4	3	3
		Number	10	4	3	3
		Percent	100.0%	100.0%	100.0%	100.0%
	8S31	Blueprint	10	4	3	3
		Number	10	4	3	3
		Percent	100.0%	100.0%	100.0%	100.0%

Table S8B presents the proportion of standards assessed by each Biology form. Biology has only 11 content standards so in all cases but one all of the standards are assessed on each test form. In the case of Test Form 10S13 only 4 of 5 standards in Reporting Category 1 are assessed by the test form.

TABLE S8B - Proportion of Standards Measured by Form and Reporting Category for High School

Test Form		Standards Measured					
		Test	RC1	RC2	RC3	RC4	
Biology	10S13	Blueprint	11	5	2	2	2
		Number	10	4	2	2	2
		Percent	90.9%	80.0%	100.0%	100.0%	100.0%
	10S21	Blueprint	11	5	2	2	2
		Number	11	5	2	2	2
		Percent	100.0%	100.0%	100.0%	100.0%	100.0%
	10S22	Blueprint	11	5	2	2	2
		Number	11	5	2	2	2
		Percent	100.0%	100.0%	100.0%	100.0%	100.0%
	10S23	Blueprint	11	5	2	2	2
		Number	11	5	2	2	2
		Percent	100.0%	100.0%	100.0%	100.0%	100.0%
	10S31	Blueprint	11	5	2	2	2
		Number	11	5	2	2	2
		Percent	100.0%	100.0%	100.0%	100.0%	100.0%
	10S32	Blueprint	11	5	2	2	2
		Number	11	5	2	2	2
		Percent	100.0%	100.0%	100.0%	100.0%	100.0%
	10S33	Blueprint	11	5	2	2	2
		Number	11	5	2	2	2
		Percent	100.0%	100.0%	100.0%	100.0%	100.0%

Section 7 - Considerations Based on the Alignment Study

Section 7 provides some areas of consideration where the testing system content validity could be improved. These arise from the alignment study results and analyses that were done.

Consideration 1

The results of the reviewer's examination of item/standard and item/cognitive complexity classification showed very high concurrence with those classifications. The long and well thought out process to develop these assessments provides the strong content validity evidenced in the ratings.

Ohio should continue to use its test development designs and procedures. Hopefully, the results of this alignment study and the reviewer challenges to item classifications can be incorporated into the development process. More items will be developed and assigned content and cognitive complexity categories and further alignment studies should be undertaken.

Consideration 2

The cognitive complexity balance of the assessments is confused. The OST blueprints do not specify DOK/CD composition for total test or reporting categories. These are some "development guidelines". If cognitive complexity of test items is an important attribute of the assessments, then the composition of cognitive complexity for the tests should be specified and available for the users.

Consideration 3

There are a few inconsistencies between the test blueprint content weighting recommendations and actual test forms. These are minor and only vary by two test points or less. However, the blueprint does use ranges and the tests should always conform to the blueprint. Hopefully, as more items are developed the test builders will not be as constrained by blueprint requirements and be able to fit a set of items within the specified ranges.

Consideration 4

The Writing Exercises are a large component of the English Language Arts assessments. In Grades 3-5 the maximum score is 10 points, where in Grades 6-8 and High School there are two exercises that result in 20 maximum points. Essentially the Writing score makes up about 25-33% of the English Language Arts test score.

The classification of content and cognitive complexity for the exercises is made at the total exercise level. For example, the DOK for writing exercise is assigned at Level 4. This means essentially upper level tests all have approximately 33% of points at the highest level of cognitive complexity.

The Writing exercises are scored by a 3-part rubric. It is not obvious that all the components evaluated in the rubric are at the highest cognitive complexity levels. It may be necessary to classify the Writing according to the scoring parts rather than the total exercise. This would result in a more honest cognitive complexity component result for the English Language Arts tests.

Consideration 5

The Science content standards are few in number. There are 8 for Grade 5, 10 for Grade 8, and 11 for High School Biology. In fact, on the test blueprint they are referred to as “topics”. The items are classified by topic, which results in fewer standard categories than ELA (32-33) and Mathematics (25-50).

If the Science items were content classified at a more fine grain level for test specification, the blueprint would be more useable. The three subjects would be more in line in terms of content specification.

References

Webb, N. L., Alt, M., Ely, R., & Vesperman, B. (2005). *Web alignment tool (WAT): Training manual draft 1.1*. Madison: University of Wisconsin, Center for Educational Research.

Appendices

Appendix A - Panelist Demographic Information

Appendix B - Affidavit of Non-Disclosure

Appendix C - Item Development Sequence

Appendix D - Mathematics Standards Coding Sheet

Appendix E - ELA Standards Coding Sheet

Appendix F - Science Standards Coding Sheet

Appendix G - Science Cognitive Demand Classification

Appendix A-Panelist Demographic Information

HS English Language Arts II	47175	Cardinal Local	Public District	Geauga	NE	Region 4	1	1-12 Teacher		
HS English Language Arts II	52514	Cincinnati Archdio	Higher ed	Hamilton	SW	Higher ed	Higher ed	1-12 Teacher	r	
HS English Language Arts II	44305	Maple Heights City	Public District	Cuyahoga	NE	Region 3	7	1-12 Teacher		
HS English Language Arts II	47589	Liberty Center Local	Public District	Henry	NW	Region 1	2	1-12 Teacher		
HS English Language Arts II	43968	Fairborn City	Public District	Greene	SW	Region 10	7	1-12 Teacher		
G5 Science	45591	Rittman Exempted	Public District	Wayne	NE	Region 9	1	1-12 Teacher		
G5 Science	44800	South-Western City	Public District	Franklin	Central	Region 11	7	1-12 Teacher		
G5 Science	43844	Dayton City	Public District	Montgom	SW	Region 10	8	1-12 Teacher		
G5 Science	48480	Mahoning County	ESC	Mahoning	NE	ESC	ESC	Curriculum Specialist/Coordinator		
G5 Science	45583	Perrysburg Exempt	Public District	Wood	NW	Region 1	6	1-12 Teacher		
G8 Science	46201	Triad Local	Public District	Champaig	SW	Region 6	2	1-12 Teacher		
G8 Science	50500	Warren Local	Public District	Washingt	SE	Region 16	1	1-12 Teacher		
G8 Science	44180	Kettering City	Public District	Montgom	SW	Region 10	5	1-12 Teacher		
G5 Science	48480	Mahoning County	ESC	Mahoning	NE	ESC	ESC	Curriculum Specialist/Coordinator		
G8 Science	43786	Cleveland Municipi	Public District	Cuyahoga	NE	Region 3	8	1-12 Teacher		
Biology	52514	Cincinnati Archdio	Higher ed	Hamilton	SW	Higher ed	Higher ed	1-12 Teacher		
Biology	45906	Alexander Local	Public District	Athens	SE	Region 16	2	1-12 Teacher		
Biology	48074	Benjamin Logan Lo	Public District	Logan	SW	Region 6	3	1-12 Teacher		
Biology	133413	Electronic Classroom	Community School	Franklin	Central	Community S	Community Sch	1-12 Teacher		
Biology	044800	South-Western City	Public District	Franklin	Central	Region 11	7	1-12 Teacher		
Biology	047027	Dublin City	Public District	Franklin	Central	Region 11	6	1-12 Teacher		
Biology	49502	Huntington Local	Public District	Ross	Central	Region 15	2	1-12 Teacher		
G3 Math	52555	Toledo Diocese	Non-public District			Non-public	Non-public Dis	K, Pre-K or Early Childhood Teacher/Administrator		
G3 Math	48314	Canfield Local	Public District	Mahoning	NE	Region 5	5	1-12 Teacher		
G3 Math	43612	Berea City	Public District	Cuyahoga	NE	Region 3	7	1-12 Teacher		
G3 Math	48363	South Range Local	Public District	Mahoning	NE	Region 5	3	1-12 Teacher		
G3 Math	46094	Edgewood City	Public District	Butler	SW	Region 13	3	1-12 Teacher		
G4 Math	44180	Kettering City	Public District	Montgom	SW	Region 10	5	Curriculum Specialist/Coordinator		
G4 Math	44602	Oregon City	Public District	Lucas	NW	Region 1	4	Other Title Math		
G4 Math	46250	Northeastern Local	Public District	Clark	SW	Region 10	3	1-12 Teacher		
G4 Math	49759	Anna Local	Public District	Shelby	SW	Region 6	3	1-12 Teacher		
G4 Math	47324	Hamilton County E	ESC	Hamilton	SW	ESC	ESC	Curriculum Specialist/Coordinator	Instructional Coa	
G5 Math	1E+05	Brice Christian Aca	Nonpublic School	Franklin	Central	Nonpublic S	Nonpublic Sch	1-12 Teacher		
G5 Math	48165	Keystone Local	Public District	Lorain	NE	Region 2	3	1-12 Teacher		
G5 Math	44792	South Euclid-Lyndh	Public District	Cuyahoga	NE	Region 3	5	1-12 Teacher		
G5 Math	48389	West Branch Local	Public District	Mahoning	NE	Region 5	1	1-12 Teacher	Grade five math	
G5 Math	43752	Cincinnati City	Public District	Hamilton	SW	Region 13	8	K-12 Administrator	Curriculum Specialist/Coordin	
G6 Math	43950	Euclid City	Public District	Cuyahoga	NE	Region 3	7	Curriculum Specialist/Coordinator		
G6 Math	48363	South Range Local	Public District	Mahoning	NE	Region 5	3	1-12 Teacher		
G6 Math	48777	Morgan Local	Public District	Morgan	SE	Region 12	1	1-12 Teacher		
G6 Math	50427	Springboro Commu	Public District	Warren	SW	Region 13	6	1-12 Teacher		

G6 Math	46037	Eastern Local	Public District	Brown	SW	Region 14	2	1-12 Teacher		
G7 Math	46920	Miami Trace Local	Public District	Fayette	Central	Region 14	1	1-12 Teacher	K-12 Administrator	
G7 Math	46607	Solon City	Public District	Cuyahoga	NE	Region 3	6	1-12 Teacher		
G7 Math	44479	New Lexington City	Public District	Perry	SE	Region 16	1	1-12 Teacher		
G7 Math	50427	Springboro Commu	Public District	Warren	SW	Region 13	6	1-12 Teacher		
G8 Math	44115	Heath City	Public District	Licking	Central	Region 11	4	1-12 Teacher		
G8 Math	46938	ESC of Central Ohio	ESC	Franklin	Central	ESC	ESC	Other Substitute Teacher		
G8 Math	236	Ohio Connections	Community School	Cuyahoga	NE	Community	Community Sch	1-12 Teacher		
G8 Math	44842	Strongsville City	Public District	Cuyahoga	NE	Region 3	5	1-12 Teacher	Curriculum Specialist/Coordinator	
Algebra I/Integrated Math I	43802	Columbus City Sch	Public District	Franklin	Central	Region 11	8	1-12 Teacher		
Algebra I/Integrated Math I	46995	New Albany-Plain	Public District	Franklin	Central	Region 11	6	1-12 Teacher		
Algebra I/Integrated Math I	50682	Elmwood Local	Public District	Wood	NW	Region 1	2	1-12 Teacher		
Algebra I/Integrated Math I	46672	Mississinawa Valle	Public District	Darke	SW	Region 10	1	1-12 Teacher		
Algebra I/Integrated Math I	47340	Forest Hills Local	Public District	Hamilton	SW	Region 13	6	1-12 Teacher		
Algebra I/Integrated Math I	47787	Buckeye Local	Public District	Jefferson	NE	Region 12	1	1-12 Teacher		
Algebra I/Integrated Math I	1E+05	Ross -Pike ESC	ESC	Ross	Central	ESC	ESC	Curriculum Specialist/Coordinator		
Algebra I/Integrated Math I	50567	Norwayne Local	Public District	Wayne	NE	Region 9	3	1-12 Teacher		
Algebra I/Integrated Math I	43653	Brooklyn City	Public District	Cuyahoga	NE	Region 3	7	K-12 Administrator	Curriculum Specialist/Coordin	
Geometry/Integrated Math II	46920	Miami Trace Local	Public District	Fayette	Central	Region 14	1	1-12 Teacher		
Geometry/Integrated Math II	44750	Shaker Heights City	Public District	Cuyahoga	NE	Region 3	6	1-12 Teacher		
Geometry/Integrated Math II	63099	University of Toled	Higher ed	Lucas	NW	Higher ed	Higher ed	Higher Education Faculty Member		
Geometry/Integrated Math II	50641	North Central Loca	Public District	Williams	NW	Region 1	1	1-12 Teacher		
Geometry/Integrated Math II	48728	Northmont City	Public District	Montgom	SW	Region 10	5	1-12 Teacher		
Geometry/Integrated Math II	47696	West Holmes Local	Public District	Holmes	NE	Region 9	1	1-12 Teacher		
Geometry/Integrated Math II	47787	Buckeye Local	Public District	Jefferson	NE	Region 12	1	1-12 Teacher		
Geometry/Integrated Math II	45047	Westerville City	Public District	Franklin	Central	Region 11	6	Curriculum Specialist/Coordinator		
Geometry/Integrated Math II	44305	Maple Heights City	Public District	Cuyahoga	NE	Region 3	7	1-12 Teacher		
Geometry/Integrated Math II	47365	Northwest Local	Public District	Hamilton	SW	Region 13	5	1-12 Teacher		

Appendix B-Affidavit of Non-Disclosure

AFFIDAVIT OF NONDISCLOSURE

Ohio Assessments

Alignment Study for Peer Review

Grade Level/Course: _____

(Name)

(Job Title)

(Organization, State or local agency or
instrumentality)

I, _____, do solemnly swear (or affirm) that in the process of
developing material for the Ohio Assessments, I

- (i) will not reveal bibliographic information or content of any passages considered for use on the Ohio Assessments;
- (ii) will not reveal the content of any tasks or items developed by me or others for use on the Ohio Assessments;
- (iii) will not reveal the content of any secure material from the Ohio Assessments;
- (iv) will not make any improper disclosure whereby an examinee or survey respondent or their related data (including “individuals” or “schools”) could be identified, which includes, but is not limited to, information collected from the pilot and field tests for the Ohio Assessments;
- (v) am participating as an independent consultant, not as an employee of ODE, and all ownership of materials delivered by me shall be vested in ODE.

(Date)

(Signature)

Appendix C-Item Development Sequence

KEY



Who fulfills this role?



What is involved in this step?

DRAFTING OF NEW ITEMS



Ohio Department of Education (ODE) and American Institute for Research (AIR)



ODE and the vendor work together to set item development goals. Then the vendor creates items from the Ohio Learning Standards based on test blueprints.

REVIEW OF NEW ITEMS



Content Advisory Committee



Ohio educators review test items to ensure that the questions are valid and appropriate measures of the content standards for each subject area and grade level.

FIELD TESTING OF NEW ITEMS



ODE, AIR and Ohio Students



Reviewed items are placed on the operational tests to check the quality and appropriateness of the items. These items do not count towards a student's overall score.

SCORING OF FIELD TESTED ITEMS



ODE and AIR



During this stage, field tested items are scored and data are compiled to be sent for review.

BUILDING OPERATIONAL TESTS



ODE and AIR



Test forms are built based on the test blueprint using the eligible items from the test bank.

REVISION OF NEW ITEMS



ODE



ODE content and assessment specialists review and revise the initial drafts of test items.

REVIEW OF NEW ITEMS*



Fairness Committee



This committee of Ohio educators, parents, and community members review and evaluate test questions to ensure that each question is fair, unbiased, and does not promote individual moral values.

RUBRIC VALIDATION & RANGE-FINDING OF FIELD TESTED ITEMS



Range-finding Committee



A committee of Ohio educators review student responses and scoring guidelines for open-ended questions. The committee uses a rubric to establish the range of acceptable responses for each question.

DATA REVIEW OF FIELD TESTED ITEMS



ODE and AIR



Content and fairness review processes evaluate the field test performance of each item. Items that perform well on the field test are accepted into the test bank. Items that perform poorly are either removed or are edited and repeat the development process.

**High school items go through an additional review by college experts before field testing.*

Appendix D-Mathematics Standards Coding Sheet

Domain/ Conceptual Category	Standard	AES CODE	Original Standard	GRADE 3 MATHEMATICS
Operations and Algebraic Thinking	3.OA.1	10	Represent and solve problems involving multiplication and division. 3.OA.1 Interpret products of whole numbers, e.g., interpret 5×7 as the total number of objects in 5 groups of 7 objects each. <i>For example, describe a context in which a total number of objects can be expressed as 5×7.</i>	
Operations and Algebraic Thinking	3.OA.2	11	Represent and solve problems involving multiplication and division. 3.OA.2 Interpret whole-number quotients of whole numbers, e.g., interpret $56 \div 8$ as the number of objects in each share when 56 objects are partitioned equally into 8 shares, or as a number of shares when 56 objects are partitioned into equal shares of 8 objects each. <i>For example, describe a context in which a number of shares or a number of groups can be expressed as $56 \div 8$.</i>	
Operations and Algebraic Thinking	3.OA.3	12	Represent and solve problems involving multiplication and division. 3.OA.3 Use multiplication and division within 100 to solve word problems in situations involving equal groups, arrays, and measurement quantities, e.g., by using drawings and equations with a symbol for the unknown number to represent the problem.	
Operations and Algebraic Thinking	3.OA.4	13	Represent and solve problems involving multiplication and division. 3.OA.4 Determine the unknown whole number in a multiplication or division equation relating three whole numbers. <i>For example, determine the unknown number that makes the equation true in each of the equations $8 \times _ = 48$, $5 = _ \div 3$, $6 \times 6 = _$.</i>	
Operations and Algebraic Thinking	3.OA.5	14	Understand properties of multiplication and the relationship between multiplication and division. 3.OA.5 Apply properties of operations as strategies to multiply and divide. <i>Examples: If $6 \times 4 = 24$ is known, then $4 \times 6 = 24$ is also known. (Commutative property of multiplication.) $3 \times 5 \times 2$ can be found by $3 \times 5 = 15$, then $15 \times 2 = 30$, or by $5 \times 2 = 10$, then $3 \times 10 = 30$. (Associative property of multiplication.) Knowing that $8 \times 5 = 40$ and $8 \times 2 = 16$, one can find 8×7 as $8 \times (5 + 2) = (8 \times 5) + (8 \times 2) = 40 + 16 = 56$. (Distributive property.)</i>	
Operations and Algebraic Thinking	3.OA.6	15	Understand properties of multiplication and the relationship between multiplication and division. 3.OA.6 Understand division as an unknown-factor problem. <i>For example, find $32 \div 8$ by finding the number that makes 32 when multiplied by 8.</i>	
Operations and Algebraic Thinking	3.OA.7	16	Multiply and divide within 100. 3.OA.7 Fluently multiply and divide within 100, using strategies such as the relationship between multiplication and division (e.g., knowing that $8 \times 5 = 40$, one knows $40 \div 5 = 8$) or properties of operations. By the end of Grade 3, know from memory all products of two one-digit numbers.	

Operations and Algebraic Thinking	3.OA.8	17	<p>Solve problems involving the four operations, and identify and explain patterns in arithmetic.</p> <p>3.OA.8 Solve two-step word problems using the four operations. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding.</p>
Operations and Algebraic Thinking	3.OA.9	18	<p>Solve problems involving the four operations, and identify and explain patterns in arithmetic.</p> <p>3.OA.9 Identify arithmetic patterns (including patterns in the addition table or multiplication table), and explain them using properties of operations. <i>For example, observe that 4 times a number is always even, and explain why 4 times a number can be decomposed into two equal addends.</i></p>
Numbers and Operations in Base Ten	3.NBT.1	19	<p>Use place value understanding and properties of operations to perform multi-digit arithmetic.</p> <p>3.NBT.1 Use place value understanding to round whole numbers to the nearest 10 or 100.</p>
Numbers and Operations in Base Ten	3.NBT.2	20	<p>Use place value understanding and properties of operations to perform multi-digit arithmetic.</p> <p>3.NBT.2 Fluently add and subtract within 1000 using strategies and algorithms based on place value, properties of operations, and/or the relationship between addition and subtraction.</p>
Numbers and Operations in Base Ten	3.NBT.3	21	<p>Use place value understanding and properties of operations to perform multi-digit arithmetic.</p> <p>3.NBT.3 Multiply one-digit whole numbers by multiples of 10 in the range 10–90, e.g., 9×80, 5×60 using strategies based on place value and properties of operations.</p>
Numbers and Operations–Fractions	3.NF.1	22	<p>Develop understanding of fractions as numbers.</p> <p>3.NF.1 Understand a fraction $1/b$ as the quantity formed by 1 part when a whole is partitioned into b equal parts; understand a fraction a/b as the quantity formed by a parts of size $1/b$.</p>
Numbers and Operations–Fractions	3.NF.2	23	<p>Develop understanding of fractions as numbers.</p> <p>3.NF.2 Understand a fraction as a number on the number line; represent fractions on a number line diagram.</p> <p>a. Represent a fraction $1/b$ on a number line diagram by defining the interval from 0 to 1 as the whole and partitioning it into b equal parts. Recognize that each part has size $1/b$ and that the endpoint of the part based at 0 locates the number $1/b$ on the number line.</p> <p>b. Represent a fraction a/b on a number line diagram by marking off a lengths $1/b$ from 0. Recognize that the resulting interval has size a/b and that its endpoint locates the number a/b on the number line.</p>

Numbers and Operations– Fractions	3.NF.3	24	<p>Develop understanding of fractions as numbers.</p> <p>3.NF.3 Explain equivalence of fractions in special cases, and compare fractions by reasoning about their size.</p> <p>a. Understand two fractions as equivalent (equal) if they are the same size or the same point on a number line.</p> <p>b. Recognize and generate simple equivalent fractions, e.g., $1/2 = 2/4$, $4/6 = 2/3$. Explain why the fractions are equivalent, e.g., by using a visual fraction model.</p> <p>c. Express whole numbers as fractions, and recognize fractions that are equivalent to whole numbers. <i>Examples: Express 3 in the form $3 = 3/1$; recognize that $6/1 = 6$; locate $4/4$ and 1 at the same point of a number line diagram.</i></p> <p>d. Compare two fractions with the same numerator or the same denominator by reasoning about their size. Recognize that comparisons are valid only when the two fractions refer to the same whole. Record the results of comparisons with the symbols $>$, $=$, or $<$, and justify the conclusions, e.g., by using a visual fraction model.</p>
Measurement and Data	3.MD.1	25	<p>Solve problems involving measurement and estimation of intervals of time, liquid volumes, and masses of objects.</p> <p>3.MD.1 Tell and write time to the nearest minute and measure time intervals in minutes. Solve word problems involving addition and subtraction of time intervals in minutes, e.g., by representing the problem on a number line diagram.</p>
Measurement and Data	3.MD.2	26	<p>Solve problems involving measurement and estimation of intervals of time, liquid volumes, and masses of objects.</p> <p>3.MD.2 Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l). Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem.</p>
Measurement and Data	3.MD.3	27	<p>Represent and interpret data.</p> <p>3.MD.3 Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step “how many more” and “how many less” problems using information presented in scaled bar graphs. <i>For example, draw a bar graph in which each square in the bar graph might represent 5 pets.</i></p>

Measurement and Data	3.MD.4	28	<p>Represent and interpret data.</p> <p>3.MD.4 Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch. Show the data by making a line plot, where the horizontal scale is marked off in appropriate units—whole numbers, halves, or quarters.</p>
Measurement and Data	3.MD.5	29	<p>Geometric measurement: understand concepts of area and relate area to multiplication and to addition.</p> <p>3.MD.5 Recognize area as an attribute of plane figures and understand concepts of area measurement.</p> <p>a. A square with side length 1 unit, called “a unit square,” is said to have “one square unit” of area, and can be used to measure area.</p> <p>b. A plane figure which can be covered without gaps or overlaps by n unit squares is said to have an area of n square units.</p>
Measurement and Data	3.MD.6	30	<p>Geometric measurement: understand concepts of area and relate area to multiplication and to addition.</p> <p>3.MD.6 Measure areas by counting unit squares (square cm, square m, square in, square ft, and improvised units).</p>
Measurement and Data	3.MD.7	31	<p>Geometric measurement: understand concepts of area and relate area to multiplication and to addition.</p> <p>3.MD.7 Relate area to the operations of multiplication and addition.</p> <p>a. Find the area of a rectangle with whole-number side lengths by tiling it, and show that the area is the same as would be found by multiplying the side lengths.</p> <p>b. Multiply side lengths to find areas of rectangles with whole-number side lengths in the context of solving real world and mathematical problems, and represent whole-number products as rectangular areas in mathematical reasoning.</p> <p>c. Use tiling to show in a concrete case that the area of a rectangle with whole-number side lengths a and $b + c$ is the sum of $a \times b$ and $a \times c$. Use area models to represent the distributive property in mathematical reasoning.</p> <p>d. Recognize area as additive. Find areas of rectilinear figures by decomposing them into non-overlapping rectangles and adding the areas of the non-overlapping parts, applying this technique to solve real world problems.</p>
Measurement and Data	3.MD.8	32	<p>Geometric measurement: recognize perimeter as an attribute of plane figures and distinguish between linear and area measures.</p> <p>3.MD.8 Solve real world and mathematical problems involving perimeters of polygons, including finding the perimeter given the side lengths, finding an unknown side length, and exhibiting rectangles with the same perimeter and different areas or with the same area and different perimeters.</p>

Geometry	3.G.1	33	<p>Reason with shapes and their attributes.</p> <p>3.G.1 Understand that shapes in different categories (e.g., rhombuses, rectangles, and others) may share attributes (e.g., having four sides), and that the shared attributes can define a larger category (e.g., quadrilaterals). Recognize rhombuses, rectangles, and squares as examples of quadrilaterals, and draw examples of quadrilaterals that do not belong to any of these subcategories.</p>
Geometry	3.G.2	34	<p>Reason with shapes and their attributes.</p> <p>3.G.2 Partition shapes into parts with equal areas. Express the area of each part as a unit fraction of the whole. <i>For example, partition a shape into 4 parts with equal area, and describe the area of each part as 1/4 of the area of the shape.</i></p>

Domain/ Conceptual Category	Standard	AES CODE	Original Standard	GRADE 4 MATHEMATICS
Operations and Algebraic Thinking	4.OA.1	10	Use the four operations with whole numbers to solve problems. 4.OA.1 Interpret a multiplication equation as a comparison, e.g., interpret $35 = 5 \times 7$ as a statement that 35 is 5 times as many as 7 and 7 times as many as 5. Represent verbal statements of multiplicative comparisons as multiplication equations.	
Operations and Algebraic Thinking	4.OA.2	11	Use the four operations with whole numbers to solve problems. 4.OA.2 Multiply or divide to solve word problems involving multiplicative comparison, e.g., by using drawings and equations with a symbol for the unknown number to represent the problem, distinguishing multiplicative comparison from additive comparison.	
Operations and Algebraic Thinking	4.OA.3	12	Use the four operations with whole numbers to solve problems. 4.OA.3 Solve multistep word problems posed with whole numbers and having whole-number answers using the four operations, including problems in which remainders must be interpreted. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation	
Operations and Algebraic Thinking	4.OA.4	13	Gain familiarity with factors and multiples. 4.OA.4 Find all factor pairs for a whole number in the range 1-100. Recognize that a whole number is a multiple of each of its factors. Determine whether a given whole number in the range 1-100 is a multiple of a given one-digit number. Determine whether a given whole	
Operations and Algebraic Thinking	4.OA.5	14	Generate and analyze patterns. 4.OA.5 Generate a number or shape pattern that follows a given rule. Identify apparent features of the pattern that were not explicit in the rule itself. <i>For example, given the rule "Add 3" and the starting number 1, generate terms in the resulting sequence and observe that the terms appear to alternate between odd and even numbers. Explain informally why the numbers</i>	
Numbers and Operations in Base Ten	4.NBT.1	15	Generalize place value understanding for multi-digit whole numbers. 4.NBT.1 Recognize that in a multi-digit whole number, a digit in one place represents ten times what it represents in the place to its right. <i>For example, recognize that $700 \div 70 = 10$ by applying concepts of place value and division.</i>	
Numbers and Operations in Base Ten	4.NBT.2	16	Generalize place value understanding for multi-digit whole numbers. 4.NBT.2 Read and write multi-digit whole numbers using base-ten numerals, number names, and expanded form. Compare two multi-digit numbers based on meanings of the digits in each place, using $>$, $=$, and $<$ symbols to record the results of comparisons.	
Numbers and Operations in Base Ten	4.NBT.3	17	Generalize place value understanding for multi-digit whole numbers. 4.NBT.3 Use place value understanding to round multi-digit whole numbers to any place.	

Numbers and Operations in Base Ten	4.NBT.4	18	<p>4.NBT.4 Use place value understanding and properties of operations to perform multi-digit arithmetic. Fluently add and subtract multi-digit whole numbers using the standard algorithm.</p>
Numbers and Operations in Base Ten	4.NBT.5	19	<p>Use place value understanding and properties of operations to perform multi-digit arithmetic. 4.NBT.5 Multiply a whole number of up to four digits by a one-digit whole number, and multiply two two-digit numbers, using strategies based on place value and the properties of operations.</p>
Numbers and Operations in Base Ten	4.NBT.6	20	<p>Use place value understanding and properties of operations to perform multi-digit arithmetic. 4.NBT.6 Find whole-number quotients and remainders with up to four-digit dividends and one-digit divisors, using strategies based on place value, the properties of operations, and/or the relationship between multiplication and division. Illustrate and explain the calculation by using</p>
Numbers and Operations—Fractions	4.NF.1	21	<p>Extend understanding of fraction equivalence and ordering. 4.NF.1 Explain why a fraction a/b is equivalent to a fraction $(n \times a)/(n \times b)$ by using visual fraction models, with attention to how the number and size of the parts differ even though the two fractions themselves are the same size. Use this principle to recognize and generate</p>
Numbers and Operations—Fractions	4.NF.2	22	<p>Extend understanding of fraction equivalence and ordering. 4.NF.2 Compare two fractions with different numerators and different denominators, e.g., by creating common denominators or numerators, or by comparing to a benchmark fraction such as $1/2$. Recognize that comparisons are valid only when the two fractions refer to the same whole. Record the results of comparisons with symbols $>$, $=$, or $<$, and justify the conclusions,</p>
Numbers and Operations—Fractions	4.NF.3	23	<p>Build fractions from unit fractions by applying and extending previous understandings of operations on whole numbers. 4.NF.3 Understand a fraction a/b with $a > 1$ as a sum of fractions $1/b$.</p> <p>a. Understand addition and subtraction of fractions as joining and separating parts referring to the same whole.</p> <p>b. Decompose a fraction into a sum of fractions with the same denominator in more than one way, recording each decomposition by an equation. Justify decompositions, e.g., by using a visual fraction model. <i>Examples:</i> $3/8 = 1/8 + 1/8 + 1/8$; $3/8 = 1/8 + 2/8$; $2 \frac{1}{8} = 1 + 1 + 1/8 = 8/8 + 8/8 + 1/8$.</p> <p>c. Add and subtract mixed numbers with like denominators, e.g., by replacing each mixed number with an equivalent fraction, and/or by using properties of operations and the relationship between addition and subtraction.</p> <p>d. Solve word problems involving addition and subtraction of fractions referring to the same whole and having like denominators, e.g., by using visual fraction models and equations to</p>

Numbers and Operations– Fractions	4.NF.4	24	<p>Build fractions from unit fractions by applying and extending previous understandings of operations on whole numbers.</p> <p>4.NF.4 Apply and extend previous understandings of multiplication to multiply a fraction by a whole number.</p> <p>a. Understand a fraction a/b as a multiple of $1/b$. For example, use a visual fraction model to represent $5/4$ as the product $5 \times (1/4)$, recording the conclusion by the equation $5/4 = 5 \times (1/4)$.</p> <p>b. Understand a multiple of a/b as a multiple of $1/b$, and use this understanding to multiply a fraction by a whole number. For example, use a visual fraction model to express $3 \times (2/5)$ as $6 \times (1/5)$, recognizing this product as $6/5$. (In general, $n \times (a/b) = (n \times a)/b$.)</p> <p>c. Solve word problems involving multiplication of a fraction by a whole number, e.g., by using visual fraction models and equations to represent the problem. For example, if each person at a party will eat $3/8$ of a pound of roast beef, and there will be 5 people at the party, how many pounds of roast beef will be needed? Between what two whole numbers does your answer lie?</p>
Numbers and Operations– Fractions	4.NF.5	25	<p>Understand decimal notation for fractions, and compare decimal fractions.</p> <p>4.NF.5 Express a fraction with denominator 10 as an equivalent fraction with denominator 100, and use this technique to add two fractions with respective denominators 10 and 100. For example, express $3/10$ as $30/100$, and add $3/10 + 4/100 = 34/100$.</p>
Numbers and Operations– Fractions	4.NF.6	26	<p>Understand decimal notation for fractions, and compare decimal fractions.</p> <p>4.NF.6 Use decimal notation for fractions with denominators 10 or 100. For example, rewrite 0.62 as $62/100$; describe a length as 0.62 meters; locate 0.62 on a number line diagram.</p>
Numbers and Operations– Fractions	4.NF.7	27	<p>Understand decimal notation for fractions, and compare decimal fractions.</p> <p>4.NF.7 Compare two decimals to hundredths by reasoning about their size. Recognize that comparisons are valid only when the two decimals refer to the same whole. Record the results of comparisons with the symbols $>$, $=$, or $<$, and justify the conclusions, e.g., by using a visual</p>
Measurement and Data	4.MD.1	28	<p>Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit.</p> <p>4.MD.1 Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two-column table. For example, know that 1 ft is 12 times as long as 1 in. Express the length of a 4 ft snake as 48 in. Generate a conversion table for feet and inches listing the number pairs</p>
Measurement and Data	4.MD.2	29	<p>Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit.</p> <p>4.MD.2 Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line</p>

Measurement and Data	4.MD.3	30	<p>Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit.</p> <p>4.MD.3 Apply the area and perimeter formulas for rectangles in real world and mathematical problems. <i>For example, find the width of a rectangular room given the area of the flooring and the length, by viewing the area formula as a multiplication equation with an unknown factor.</i></p>
Measurement and Data	4.MD.4	31	<p>Represent and interpret data.</p> <p>4.MD.4 Make a line plot to display a data set of measurements in fractions of a unit ($\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$). Solve problems involving addition and subtraction of fractions by using information presented in line plots. <i>For example, from a line plot find and interpret the difference in length between the longest and shortest specimens in an insect collection.</i></p>
Measurement and Data	4.MD.5	32	<p>Geometric measurement: understand concepts of angle and measure angles.</p> <p>4.MD.5 Recognize angles as geometric shapes that are formed wherever two rays share a common endpoint, and understand concepts of angle measurement.</p> <p>a. Understand an angle is measured with reference to a circle with its center at the common endpoint of the rays, by considering the fraction of the circular arc between the points where the two rays intersect the circle. An angle that turns through $\frac{1}{360}$ of a circle is called a “one-degree angle,” and can be used to measure angles.</p> <p>b. Understand an angle that turns through n one-degree angles is said to have an angle measure of n degrees.</p>
Measurement and Data	4.MD.6	33	<p>Geometric measurement: understand concepts of angle and measure angles.</p> <p>4.MD.6 Measure angles in whole-number degrees using a protractor. Sketch angles of</p>
Measurement and Data	4.MD.7	34	<p>Geometric measurement: understand concepts of angle and measure angles.</p> <p>4.MD.7 Recognize angle measure as additive. When an angle is decomposed into non-overlapping parts, the angle measure of the whole is the sum of the angle measures of the parts. Solve addition and subtraction problems to find unknown angles on a diagram in real world and mathematical problems, e.g., by using an equation with a symbol for the unknown</p>
Geometry	4.G.1	35	<p>Draw and identify lines and angles, and classify shapes by properties of their lines and angles.</p> <p>4.G.1 Draw points, lines, line segments, rays, angles (right, acute, and obtuse), and</p>
Geometry	4.G.2	36	<p>Draw and identify lines and angles, and classify shapes by properties of their lines and angles.</p> <p>4.G.2 Classify two-dimensional figures based on the presence or absence of parallel or perpendicular lines, or the presence or absence of angles of a specified size. Recognize right</p>
Geometry	4.G.3	37	<p>Draw and identify lines and angles, and classify shapes by properties of their lines and angles.</p> <p>4.G.3 Recognize a line of symmetry for a two-dimensional figure as a line across the figure such that the figure can be folded along the line into matching parts. Identify line-symmetric</p>

Domain/ Conceptual Category	Standard	AES CODE	Original Standard	GRADE 5 MATHEMATICS
Operations and Algebraic Thinking	5.OA.1	10	Write and interpret numerical expressions. 5.OA.1 Use parentheses, brackets, or braces in numerical expressions, and evaluate expressions with these symbols.	
Operations and Algebraic Thinking	5.OA.2	11	Write and interpret numerical expressions. 5.OA.2 Write simple expressions that record calculations with numbers, and interpret numerical expressions without evaluating them. <i>For example, express the calculation “add 8 and 7, then multiply by 2” as $2 \times (8 + 7)$. Recognize that $3 \times (18,932 + 921)$ is three times as large as $18,932 + 921$, without having to calculate the indicated sum or product.</i>	
Operations and Algebraic Thinking	5.OA.3	12	Analyze patterns and relationships. 5.OA.3 Generate two numerical patterns using two given rules. Identify apparent relationships between corresponding terms. Form ordered pairs consisting of corresponding terms from the two patterns, and graph the ordered pairs on a coordinate plane. <i>For example, given the rule “Add 3” and the starting number 0, and given the rule “Add 6” and the starting number 0, generate terms in the resulting sequences, and observe that the terms in one sequence are twice the corresponding terms in the other sequence. Explain informally why this is so.</i>	
Numbers and Operations in Base Ten	5.NBT.1	13	Understand the place value system. 5.NBT.1 Recognize that in a multi-digit number, a digit in one place represents 10 times as much as it represents in the place to its right and 1/10 of what it represents in the place to its	
Numbers and Operations in Base Ten	5.NBT.2	14	Understand the place value system. 5.NBT.2 Explain patterns in the number of zeros of the product when multiplying a number by powers of 10, and explain patterns in the placement of the decimal point when a decimal is multiplied or divided by a power of 10. Use whole-number exponents to denote powers of 10.	
Numbers and Operations in Base Ten	5.NBT.3	15	Understand the place value system. 5.NBT.3 Read, write, and compare decimals to thousandths. a. Read and write decimals to thousandths using base-ten numerals, number names, and expanded form, e.g., $347.392 = 3 \times 100 + 4 \times 10 + 7 \times 1 + 3 \times (1/10) + 9 \times (1/100) + 2 \times (1/1000)$. b. Compare two decimals to thousandths based on meanings of the digits in each place, using	
Numbers and Operations in Base Ten	5.NBT.4	16	Understand the place value system. 5.NBT.4 Use place value understanding to round decimals to any place.	
Numbers and Operations in Base Ten	5.NBT.5	17	Perform operations with multi-digit whole numbers and with decimals to hundredths. 5.NBT.5 Fluently multiply multi-digit whole numbers using the standard algorithm.	

Numbers and Operations in Base Ten	5.NBT.6	18	<p>Perform operations with multi-digit whole numbers and with decimals to hundredths.</p> <p>5.NBT.6 Find whole-number quotients of whole numbers with up to four-digit dividends and two-digit divisors, using strategies based on place value, the properties of operations, and/or the relationship between multiplication and division. Illustrate and explain the calculation by using equations, rectangular arrays, and/or area models.</p>
Numbers and Operations in Base Ten	5.NBT.7	19	<p>Perform operations with multi-digit whole numbers and with decimals to hundredths.</p> <p>5.NBT.7 Add, subtract, multiply, and divide decimals to hundredths, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the</p>
Numbers and Operations—Fractions	5.NF.1	20	<p>Use equivalent fractions as a strategy to add and subtract fractions.</p> <p>5.NF.1 Add and subtract fractions with unlike denominators (including mixed numbers) by replacing given fractions with equivalent fractions in such a way as to produce an equivalent sum or difference of fractions with like denominators. <i>For example, $2/3 + 5/4 = 8/12 + 15/12 =$</i></p>
Numbers and Operations—Fractions	5.NF.2	21	<p>Use equivalent fractions as a strategy to add and subtract fractions.</p> <p>5.NF.2 Solve word problems involving addition and subtraction of fractions referring to the same whole, including cases of unlike denominators, e.g., by using visual fraction models or equations to represent the problem. Use benchmark fractions and number sense of fractions to estimate mentally and assess the reasonableness of answers. <i>For example, recognize an incorrect result $2/5 + 1/2 = 3/7$, by observing that $3/7 < 1/2$.</i></p>
Numbers and Operations—Fractions	5.NF.3	22	<p>Apply and extend previous understandings of multiplication and division to multiply and divide fractions.</p> <p>5.NF.3 Interpret a fraction as division of the numerator by the denominator ($a/b = a \div b$). Solve word problems involving division of whole numbers leading to answers in the form of fractions or mixed numbers, e.g., by using visual fraction models or equations to represent the problem. <i>For example, interpret $3/4$ as the result of dividing 3 by 4, noting that $3/4$ multiplied by 4 equals 3, and that when 3 wholes are shared equally among 4 people each person has a share of size $3/4$. If 9 people want to share a 50-pound sack of rice equally by weight, how many pounds of rice should each person get? Between what two whole numbers does your answer lie?</i></p>

Numbers and Operations– Fractions	5.NF.4	23	<p>Apply and extend previous understandings of multiplication and division to multiply and divide fractions.</p> <p>5.NF.4 Apply and extend previous understandings of multiplication to multiply a fraction or whole number by a fraction.</p> <p>a. Interpret the product $(a/b) \times q$ as a parts of a partition of q into b equal parts, equivalently, as the result of a sequence of operations $a \times q \div b$. <i>For example, use a visual fraction model to show $(2/3) \times 4 = 8/3$, and create a story context for this equation. Do the same with $(2/3) \times (4/5) = 8/15$. (In general, $(a/b) \times (c/d) = ac/bd$.)</i></p> <p>b. Find the area of a rectangle with fractional side lengths by tiling it with unit squares of the appropriate unit fraction side lengths, and show that the area is the same as would be found by multiplying the side lengths. Multiply fractional side lengths to find areas of rectangles, and represent fraction products as rectangular areas.</p>
Numbers and Operations– Fractions	5.NF.5	24	<p>Apply and extend previous understandings of multiplication and division to multiply and divide fractions.</p> <p>5.NF.5 Interpret multiplication as scaling (resizing).</p> <p>a. Compare the size of a product to the size of one factor on the basis of the size of the other factor, without performing the indicated multiplication.</p> <p>b. Explain why multiplying a given number by a fraction greater than 1 results in a product greater than the given number (recognizing multiplication by whole numbers greater than 1 as a familiar case); explaining why multiplying a given number by a fraction less than 1 results in a product smaller than the given number; and relating the principle of fraction equivalence $a/b =$</p>
Numbers and Operations– Fractions	5.NF.6	25	<p>Apply and extend previous understandings of multiplication and division to multiply and divide fractions.</p> <p>5.NF.6 Solve real world problems involving multiplication of fractions and mixed numbers, e.g., by using visual fraction models or equations to represent the problem.</p>

Numbers and Operations– Fractions	5.NF.7	26	<p>Apply and extend previous understandings of multiplication and division to multiply and divide fractions.</p> <p>5.NF.7 Apply and extend previous understandings of division to divide unit fractions by whole numbers and whole numbers by unit fractions.</p> <p>a. Interpret division of a unit fraction by a non-zero whole number, and compute such quotients. <i>For example, create a story context for $(1/3) \div 4$, and use a visual fraction model to show the quotient. Use the relationship between multiplication and division to explain that $(1/3) \div 4 = 1/12$ because $(1/12) \times 4 = 1/3$.</i></p> <p>b. Interpret division of a whole number by a unit fraction, and compute such quotients. <i>For example, create a story context for $4 \div (1/5)$, and use a visual fraction model to show the quotient. Use the relationship between multiplication and division to explain that $4 \div (1/5) = 20$ because $20 \times (1/5) = 4$.</i></p> <p>c. Solve real world problems involving division of unit fractions by non-zero whole numbers and division of whole numbers by unit fractions, e.g., by using visual fraction models and equations</p>
Measurement and Data	5.MD.1	27	<p>Convert like measurement units within a given measurement system.</p> <p>5.MD.1 Convert among different-sized standard measurement units within a given measurement system (e.g., convert 5 cm to 0.05 m), and use these conversions in solving multi-</p>
Measurement and Data	5.MD.2	28	<p>Represent and interpret data.</p> <p>5.MD.2 Make a line plot to display a data set of measurements in fractions of a unit ($1/2$, $1/4$, $1/8$). Use operations on fractions for this grade to solve problems involving information presented in line plots. <i>For example, given different measurements of liquid in identical beakers, find the amount of liquid each beaker would contain if the total amount in all the beakers were</i></p>
Measurement and Data	5.MD.3	29	<p>Geometric measurement: understand concepts of volume and relate volume to multiplication and to addition.</p> <p>5.MD.3 Recognize volume as an attribute of solid figures and understand concepts of volume measurement.</p> <p>a. A cube with side length 1 unit, called a “unit cube,” is said to have “one cubic unit” of volume, and can be used to measure volume.</p> <p>b. A solid figure which can be packed without gaps or overlaps using n unit cubes is said to have a volume of n cubic units.</p>
Measurement and Data	5.MD.4	30	<p>Geometric measurement: understand concepts of volume and relate volume to multiplication and to addition.</p> <p>5.MD.4 Measure volumes by counting unit cubes, using cubic cm, cubic in, cubic ft, and</p>

Measurement and Data	5.MD.5	31	<p>Geometric measurement: understand concepts of volume and relate volume to multiplication and to addition.</p> <p>5.MD.5 Relate volume to the operations of multiplication and addition and solve real world and mathematical problems involving volume.</p> <p>a. Find the volume of a right rectangular prism with whole-number side lengths by packing it with unit cubes, and show that the volume is the same as would be found by multiplying the edge lengths, equivalently by multiplying the height by the area of the base. Represent threefold whole-number products as volumes, e.g., to represent the associative property of multiplication.</p> <p>b. Apply the formulas $V = l \times w \times h$ and $V = b \times h$ for rectangular prisms to find volumes of right rectangular prisms with whole-number edge lengths in the context of solving real world and mathematical problems.</p> <p>c. Recognize volume as additive. Find volumes of solid figures composed of two non-overlapping right rectangular prisms by adding the volumes of the non-overlapping parts.</p>
Geometry	5.G.1	32	<p>Graph points on the coordinate plane to solve real-world and mathematical problems.</p> <p>5.G.1 Use a pair of perpendicular number lines, called axes, to define a coordinate system, with the intersection of the lines (the origin) arranged to coincide with the 0 on each line and a given point in the plane located by using an ordered pair of numbers, called its coordinates. Understand that the first number indicates how far to travel from the origin in the direction of one axis, and the second number indicates how far to travel in the direction of the second axis, with the convention that the names of the two axes and the coordinates correspond, e.g., x-axis</p>
Geometry	5.G.2	33	<p>Graph points on the coordinate plane to solve real-world and mathematical problems.</p> <p>5.G.2 Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation.</p>
Geometry	5.G.3	34	<p>Classify two-dimensional figures into categories based on their properties.</p> <p>5.G.3 Understand that attributes belonging to a category of two-dimensional figures also belong to all subcategories of that category. <i>For example, all rectangles have four right angles and squares are rectangles, so all squares have four right angles.</i></p>
Geometry	5.G.4	35	<p>Classify two-dimensional figures into categories based on their properties.</p> <p>5.G.4 Classify two-dimensional figures in a hierarchy based on properties.</p>

Domain/ Conceptual Category	Standard	AES CODE	Original Standard GRADE 6 MATHEMATICS
Ratios and Proportional Relationships	6.RP.1	10	<p>Understand ratio concepts and use ratio reasoning to solve problems. 6.RP.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. <i>For example, “The ratio of wings to beaks in the bird house at the zoo was 2:1, because for every 2 wings there was 1 beak.” “For every vote candidate A received, candidate C received nearly three votes.”</i></p>
	6.RP.2	11	<p>Understand ratio concepts and use ratio reasoning to solve problems. 6.RP.2 Understand the concept of a unit rate a/b associated with a ratio $a:b$ with $b \neq 0$, and use rate language in the context of a ratio relationship. <i>For example, “This recipe has a ratio of 3 cups of flour to 4 cups of sugar, so there is $3/4$ cup of flour for each cup of sugar.” “We paid \$75 for 15 hamburgers, which is a rate of \$5 per hamburger.”</i></p>
	6.RP.3	12	<p>Understand ratio concepts and use ratio reasoning to solve problems. 6.RP.3 Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations. a. Make tables of equivalent ratios relating quantities with whole-number measurements, find missing values in the tables, and plot the pairs of values on the coordinate plane. Use tables to compare ratios.</p>
			<p>b. Solve unit rate problems including those involving unit pricing and constant speed. For example, if it took 7 hours to mow 4 lawns, then at that rate, how many lawns could be mowed in 35 hours? At what rate were lawns being mowed?</p>
<p>c. Find a percent of a quantity as a rate per 100, e.g., 30% of a quantity means $30/100$ times the quantity; solve problems involving finding the whole, given a part and the percent.</p>			
<p>d. Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities.</p>			
The Number System	6.NS.1	13	<p>Apply and extend previous understandings of multiplication and division to divide fractions by fractions. 6.NS.1 Interpret and compute quotients of fractions, and solve word problems involving division of fractions by fractions, e.g., by using visual fraction models and equations to represent the problem. <i>For example, create a story context for $(2/3) \div (3/4)$ and use a visual fraction model to show the quotient; use the relationship between multiplication and division to explain that $(2/3) \div (3/4) = 8/9$ because $3/4$ of $8/9$ is $2/3$. (In general, $(a/b) \div (c/d) = ad/bc$.) How much chocolate will each person get if 3 people share $1/2$ lb of chocolate equally? How many $3/4$-cup servings are in $2/3$ of a cup of yogurt? How wide is</i></p>

6.NS.2	14	Compute fluently with multi-digit numbers and find common factors and multiples. 6.NS.2 Fluently divide multi-digit numbers using the standard algorithm.
6.NS.3	15	Compute fluently with multi-digit numbers and find common factors and multiples. 6.NS.3 Fluently add, subtract, multiply, and divide multi-digit decimals using the standard algorithm for each operation.
6.NS.4	16	Compute fluently with multi-digit numbers and find common factors and multiples. 6.NS.4 Find the greatest common factor of two whole numbers less than or equal to 100 and the least common multiple of two whole numbers less than or equal to 12. Use the distributive property to express a sum of two whole numbers 1–100 with a common factor as a multiple of a sum of two whole numbers with no common factor. <i>For example,</i>
6.NS.5	17	Apply and extend previous understandings of numbers to the system of rational numbers. 6.NS.5 Understand that positive and negative numbers are used together to describe quantities having opposite directions or values, e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge; use
6.NS.6	18	Apply and extend previous understandings of numbers to the system of rational numbers. 6.NS.6 Understand a rational number as a point on the number line. Extend number line diagrams and coordinate axes familiar from previous grades to represent points on the line and in the plane with negative number coordinates. a. Recognize opposite signs of numbers as indicating locations on opposite sides of 0 on the number line; recognize that the opposite of the opposite of a number is the number itself, e.g., $-(-3) = 3$, and that 0 is its own opposite.
		b. Understand signs of numbers in ordered pairs as indicating locations in quadrants of the coordinate plane; recognize that when two ordered pairs differ only by signs, the locations of the points are related by reflections across one or both axes.
		c. Find and position integers and other rational numbers on a horizontal or vertical number line diagram; find and position pairs of integers and other rational numbers on a
6.NS.7	19	Apply and extend previous understandings of numbers to the system of rational numbers. 6.NS.7 Understand ordering and absolute value of rational numbers. a. Interpret statements of inequality as statements about the relative position of two numbers on a number line diagram. <i>For example, interpret $-3 > -7$ as a statement that -3 is located to the right of -7 on a number line oriented from left to right.</i>
		b. Write, interpret, and explain statements of order for rational numbers in real-world contexts. For example, write $-3\text{ }^{\circ}\text{C} > -7\text{ }^{\circ}\text{C}$ to express the fact that $-3\text{ }^{\circ}\text{C}$ is warmer than

			<p>c. Understand the absolute value of a rational number as its distance from 0 on the number line; interpret absolute value as magnitude for a positive or negative quantity in a real-world situation. For example, for an account balance of -30 dollars, write $-30 = 30$ to describe the size of the debt in dollars.</p> <p>d. Distinguish comparisons of absolute value from statements about order. For example, recognize that an account balance less than -30 dollars represents a debt greater than 30</p>
	6.NS.8	20	<p>Apply and extend previous understandings of numbers to the system of rational numbers.</p> <p>6.NS.8 Solve real-world and mathematical problems by graphing points in all four quadrants of the coordinate plane. Include use of coordinates and absolute value to find</p>
Expressions and Equations	6.EE.1	21	<p>Apply and extend previous understandings of arithmetic to algebraic expressions.</p> <p>6.EE.1 Write and evaluate numerical expressions involving whole-number exponents.</p>
	6.EE.2	22	<p>Apply and extend previous understandings of arithmetic to algebraic expressions.</p> <p>6.EE.2 Write, read, and evaluate expressions in which letters stand for numbers.</p> <p>a. Write expressions that record operations with numbers and with letters standing for numbers. <i>For example, express the calculation "Subtract y from 5" as $5 - y$.</i></p>
			<p>b. Identify parts of an expression using mathematical terms (sum, term, product, factor, quotient, coefficient); view one or more parts of an expression as a single entity. For example, describe the expression $2(8 + 7)$ as a product of two factors; view $(8 + 7)$ as both a single entity and a sum of two terms.</p>
			<p>c. Evaluate expressions at specific values of their variables. Include expressions that arise from formulas used in real-world problems. Perform arithmetic operations, including those involving whole-number exponents, in the conventional order when there are no parentheses to specify a particular order (Order of Operations). For example, use the formulas $V = s^3$ and $A = 6s^2$ to find the volume and surface area of a cube with sides of</p>
	6.EE.3	23	<p>Apply and extend previous understandings of arithmetic to algebraic expressions.</p> <p>6.EE.3 Apply the properties of operations to generate equivalent expressions. <i>For example, apply the distributive property to the expression $3(2 + x)$ to produce the equivalent expression $6 + 3x$; apply the distributive property to the expression $24x + 18y$ to produce the equivalent expression $6(4x + 3y)$; apply properties of operations to $y + y +$</i></p>
6.EE.4	24	<p>Apply and extend previous understandings of arithmetic to algebraic expressions.</p> <p>6.EE.4 Identify when two expressions are equivalent, i.e., when the two expressions name the same number regardless of which value is substituted into them. <i>For example, the expressions $y + y + y$ and $3y$ are equivalent because they name the same number</i></p>	
6.EE.5	25	<p>Reason about and solve one-variable equations and inequalities.</p> <p>6.EE.5 Understand solving an equation or inequality as a process of answering a question: which values from a specified set, if any, make the equation or inequality true? Use substitution to determine whether a given number in a specified set makes an</p>	

	6.EE.6	26	<p>Reason about and solve one-variable equations and inequalities.</p> <p>6.EE.6 Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set.</p>
	6.EE.7	27	<p>Reason about and solve one-variable equations and inequalities.</p> <p>6.EE.7 Solve real-world and mathematical problems by writing and solving equations of the form $x + p = q$ and $px = q$ for cases in which p, q, and x are all nonnegative rational</p>
	6.EE.8	28	<p>Reason about and solve one-variable equations and inequalities.</p> <p>6.EE.8 Write an inequality of the form $x > c$ or $x < c$ to represent a constraint or condition in a real-world or mathematical problem. Recognize that inequalities of the form $x > c$ or $x < c$ have infinitely many solutions; represent solutions of such inequalities on number line</p>
	6.EE.9	29	<p>Represent and analyze quantitative relationships between dependent and independent variables.</p> <p>6.EE.9 Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. <i>For example, in a problem involving motion at constant speed, list and graph ordered pairs of distances and times, and write the</i></p>
Geometry	6.G.1	30	<p>Solve real-world and mathematical problems involving area, surface area, and volume.</p> <p>6.G.1 Find the area of right triangles, other triangles, special quadrilaterals, and polygons by composing into rectangles or decomposing into triangles and other shapes; apply</p>
	6.G.2	31	<p>Solve real-world and mathematical problems involving area, surface area, and volume.</p> <p>6.G.2 Find the volume of a right rectangular prism with fractional edge lengths by packing it with unit cubes of the appropriate unit fraction edge lengths, and show that the volume is the same as would be found by multiplying the edge lengths of the prism. Apply the formulas $V = lwh$ and $V = bh$ to find volumes of right rectangular prisms with fractional</p>
	6.G.3	32	<p>Solve real-world and mathematical problems involving area, surface area, and volume.</p> <p>6.G.3 Draw polygons in the coordinate plane given coordinates for the vertices; use coordinates to find the length of a side joining points with the same first coordinate or the</p>
	6.G.4	33	<p>Solve real-world and mathematical problems involving area, surface area, and volume.</p> <p>6.G.4 Represent three-dimensional figures using nets made up of rectangles and triangles, and use the nets to find the surface area of these figures. Apply these</p>

Statistics and Probability	6.SP.1	34	<p>Develop understanding of statistical variability.</p> <p>6.SP.1 Recognize a statistical question as one that anticipates variability in the data related to the question and accounts for it in the answers. <i>For example, “How old am I?” is not a statistical question, but “How old are the students in my school?” is a statistical question because one anticipates variability in students’ ages.</i></p>
	6.SP.2	35	<p>Develop understanding of statistical variability.</p> <p>6.SP.2 Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape.</p>
	6.SP.3	36	<p>Develop understanding of statistical variability.</p> <p>6.SP.3 Recognize that a measure of center for a numerical data set summarizes all of its values with a single number, while a measure of variation describes how its values vary</p>
	6.SP.4	37	<p>Summarize and describe distributions.</p> <p>6.SP.4 Display numerical data in plots on a number line, including dot plots, histograms,</p>
	6.SP.5	38	<p>Summarize and describe distributions.</p> <p>6.SP.5 Summarize numerical data sets in relation to their context, such as by:</p> <p>a. Reporting the number of observations.</p> <p>b. Describing the nature of the attribute under investigation, including how it was measured and its units of measurement.</p> <p>c. Giving quantitative measures of center (median and/or mean) and variability (interquartile range and/or mean absolute deviation), as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in</p> <p>d. Relating the choice of measures of center and variability to the shape of the data distribution and the context in which the data were gathered.</p>

Domain/ Conceptual Category	Standard	AES CODE	Original Standard GRADE 7 MATHEMATICS
Ratios and Proportional Relationships	7.RP.1	10	<p>Analyze proportional relationships and use them to solve real-world and mathematical problems.</p> <p>7.RP.1 Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units. <i>For example, if a person walks 1/2 mile in each 1/4 hour, compute the unit rate as the complex fraction $\frac{1/2}{1/4}$ miles</i></p>
	7.RP.2	11	<p>Analyze proportional relationships and use them to solve real-world and mathematical problems.</p> <p>7.RP.2 Recognize and represent proportional relationships between quantities.</p> <p>a. Decide whether two quantities are in a proportional relationship, e.g., by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin.</p> <p>b. Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams, and verbal descriptions of proportional relationships.</p> <p>c. Represent proportional relationships by equations. For example, if total cost t is proportional to the number n of items purchased at a constant price p, the relationship between the total cost and the number of items can be expressed as $t = pn$.</p> <p>d. Explain what a point (x, y) on the graph of a proportional relationship means in terms of the situation, with special attention to the points $(0, 0)$ and $(1, r)$ where r is the unit rate.</p>
	7.RP.3	12	<p>Analyze proportional relationships and use them to solve real-world and mathematical problems.</p> <p>7.RP.3 Use proportional relationships to solve multistep ratio and percent problems. <i>Examples: simple interest, tax, markups and markdowns, gratuities and commissions, fees, percent increase and decrease, percent error.</i></p>
	7.NS.1	13	<p>Apply and extend previous understandings of operations with fractions to add, subtract, multiply, and divide rational numbers.</p> <p>7.NS.1 Apply and extend previous understandings of addition and subtraction to add and subtract rational numbers; represent addition and subtraction on a horizontal or vertical number line diagram.</p> <p>a. Describe situations in which opposite quantities combine to make 0. <i>For example, a hydrogen atom has 0 charge because its two constituents are oppositely charged.</i></p>

			<p>b. Understand $p + q$ as the number located a distance q from p, in the positive or negative direction depending on whether q is positive or negative. Show that a number and its opposite have a sum of 0 (are additive inverses). Interpret sums of rational</p> <p>c. Understand subtraction of rational numbers as adding the additive inverse, $p - q = p + (-q)$. Show that the distance between two rational numbers on the number line is the absolute value of their difference, and apply this principle in real-world contexts.</p> <p>d. Apply properties of operations as strategies to add and subtract rational numbers.</p>
	7.NS.2	14	<p>Apply and extend previous understandings of operations with fractions to add, subtract, multiply, and divide rational numbers.</p> <p>7.NS.2 Apply and extend previous understandings of multiplication and division and of fractions to multiply and divide rational numbers.</p> <p>a. Understand that multiplication is extended from fractions to rational numbers by requiring that operations continue to satisfy the properties of operations, particularly the distributive property, leading to products such as $(-1)(-1) = 1$ and the rules for multiplying signed numbers. Interpret products of rational numbers by describing real-world contexts.</p> <p>b. Understand that integers can be divided, provided that the divisor is not zero, and every quotient of integers (with non-zero divisor) is a rational number. If p and q are integers, then $-(p/q) = (-p)/q = p/(-q)$. Interpret quotients of rational numbers by</p> <p>c. Apply properties of operations as strategies to multiply and divide rational numbers.</p> <p>d. Convert a rational number to a decimal using long division; know that the decimal form of a rational number terminates in 0s or eventually repeats.</p>
	7.NS.3	15	<p>Apply and extend previous understandings of operations with fractions to add, subtract, multiply, and divide rational numbers.</p> <p>7.NS.3 Solve real-world and mathematical problems involving the four operations with</p>
Expressions and Equations	7.EE.1	16	<p>Use properties of operations to generate equivalent expressions.</p> <p>7.EE.1 Apply properties of operations as strategies to add, subtract, factor, and expand linear expressions with rational coefficients.</p>
	7.EE.2	17	<p>Use properties of operations to generate equivalent expressions.</p> <p>7.EE.2 Understand that rewriting an expression in different forms in a problem context can shed light on a problem and how its quantities in it are related. <i>For example, $a + 0.05a = 1.05a$ means that “increase by 5%” is the same as “multiply by 1.05.”</i></p>

	7.EE.3	18	<p>Solve real-life and mathematical problems using numerical and algebraic expressions and equations.</p> <p>7.EE.3 Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. <i>For example: If a woman making \$25 an hour gets a 10% raise, she will make an additional 1/10 of her salary an hour, or \$2.50, for a new salary of \$27.50. If you want to place a towel bar 9 3/4 inches long in the center of a door that is 27 1/2 inches wide, you will need to place the bar about 9 inches from each</i></p>
	7.EE.4	19	<p>Solve real-life and mathematical problems using numerical and algebraic expressions and equations.</p> <p>7.EE.4 Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities.</p> <p>a. Solve word problems leading to equations of the form $px + q = r$ and $p(x + q) = r$, where p, q, and r are specific rational numbers. Solve equations of these forms fluently. Compare an algebraic solution to an arithmetic solution, identifying the sequence of the operations used in each approach. <i>For example, the perimeter of a rectangle is 54 cm. Its length is 6 cm. What is its width?</i></p> <p>b. Solve word problems leading to inequalities of the form $px + q > r$ or $px + q < r$, where p, q, and r are specific rational numbers. Graph the solution set of the inequality and interpret it in the context of the problem. <i>For example, as a salesperson, you are paid \$50 per week plus \$3 per sale. This week you want your pay to be at least \$100. Write an inequality for the number of sales you need to make, and describe the solutions.</i></p>
Geometry	7.G.1	20	<p>Draw, construct, and describe geometrical figures and describe the relationships between them.</p> <p>7.G.1 Solve problems involving scale drawings of geometric figures, including computing</p>
	7.G.2	21	<p>Draw, construct, and describe geometrical figures and describe the relationships between them.</p> <p>7.G.2 Draw (freehand, with ruler and protractor, and with technology) geometric shapes with given conditions. Focus on constructing triangles from three measures of angles or</p>
	7.G.3	22	<p>Draw, construct, and describe geometrical figures and describe the relationships between them.</p> <p>7.G.3 Describe the two-dimensional figures that result from slicing three-dimensional</p>

	7.G.4	23	<p>Solve real-life and mathematical problems involving angle measure, area, surface area, and volume.</p> <p>7.G.4 Know the formulas for the area and circumference of a circle and use them to solve problems; give an informal derivation of the relationship between the circumference and</p>
	7.G.5	24	<p>Solve real-life and mathematical problems involving angle measure, area, surface area, and volume.</p> <p>7.G.5 Use facts about supplementary, complementary, vertical, and adjacent angles in a multi-step problem to write and solve simple equations for an unknown angle in a figure.</p>
	7.G.6	25	<p>Solve real-life and mathematical problems involving angle measure, area, surface area, and volume.</p> <p>7.G.6 Solve real-world and mathematical problems involving area, volume, and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals,</p>
Statistics and Probability	7.SP.1	26	<p>Use random sampling to draw inferences about a population.</p> <p>7.SP.1 Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of that population. Understand that random sampling tends to produce representative samples and support valid inferences.</p>
	7.SP.2	27	<p>Use random sampling to draw inferences about a population.</p> <p>7.SP.2 Use data from a random sample to draw inferences about a population with an unknown characteristic of interest. Generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates or predictions. <i>For example, estimate the mean word length in a book by randomly sampling words from the book; predict the winner of a school election based on randomly sampled survey data. Gauge how far off</i></p>
	7.SP.3	28	<p>Draw informal comparative inferences about two populations.</p> <p>7.SP.3 Informally assess the degree of visual overlap of two numerical data distributions with similar variabilities, measuring the difference between the centers by expressing it as a multiple of a measure of variability. <i>For example, the mean height of players on the basketball team is 10 cm greater than the mean height of players on the soccer team, about twice the variability (mean absolute deviation) on either team; on a dot plot, the</i></p>
	7.SP.4	29	<p>Draw informal comparative inferences about two populations.</p> <p>7.SP.4 Use measures of center and measures of variability for numerical data from random samples to draw informal comparative inferences about two populations. <i>For example, decide whether the words in a chapter of a seventh-grade science book are generally longer than the words in a chapter of a fourth-grade science book.</i></p>

7.SP.5	30	<p>Investigate chance processes and develop, use, and evaluate probability models.</p> <p>7.SP.5 Understand that the probability of a chance event is a number between 0 and 1 that expresses the likelihood of the event occurring. Larger numbers indicate greater likelihood. A probability near 0 indicates an unlikely event; a probability around 1/2 indicates an event that is neither unlikely nor likely; and a probability near 1 indicates a</p>
7.SP.6	31	<p>Investigate chance processes and develop, use, and evaluate probability models.</p> <p>7.SP.6 Approximate the probability of a chance event by collecting data on the chance process that produces it and observing its long-run relative frequency, and predict the approximate relative frequency given the probability. <i>For example, when rolling a number cube 600 times, predict that a 3 or 6 would be rolled roughly 200 times, but probably not</i></p>
7.SP.7	32	<p>Investigate chance processes and develop, use, and evaluate probability models.</p> <p>7.SP.7 Develop a probability model and use it to find probabilities of events. Compare probabilities from a model to observed frequencies; if the agreement is not good, explain possible sources of the discrepancy.</p> <p>a. Develop a uniform probability model by assigning equal probability to all outcomes, and use the model to determine probabilities of events. <i>For example, if a student is selected at random from a class, find the probability that Jane will be selected and the probability that a girl will be selected.</i></p> <p>b. Develop a probability model (which may not be uniform) by observing frequencies in data generated from a chance process. For example, find the approximate probability that a spinning penny will land heads up or that a tossed paper cup will land open-end down. Do the outcomes for the spinning penny appear to be equally likely based on the</p>
7.SP.8	33	<p>Investigate chance processes and develop, use, and evaluate probability models.</p> <p>7.SP.8 Find probabilities of compound events using organized lists, tables, tree diagrams, and simulation.</p> <p>a. Understand that, just as with simple events, the probability of a compound event is the fraction of outcomes in the sample space for which the compound event occurs.</p> <p>b. Represent sample spaces for compound events using methods such as organized lists, tables and tree diagrams. For an event described in everyday language, e.g., "rolling double sixes," identify the outcomes in the sample space which compose the event.</p> <p>c. Design and use a simulation to generate frequencies for compound events. For example, use random digits as a simulation tool to approximate the answer to the question: If 40% of donors have type A blood, what is the probability that it will take at least 4 donors to find one with type A</p>

Domain/ Conceptual Category	Standard	AES CODE	Original Standard	GRADE 8 MATHEMATICS
The Number System	8.NS.1	10	<p>Know that there are numbers that are not rational, and approximate them by rational numbers.</p> <p>8.NS.1 Know that numbers that are not rational are called irrational. Understand informally that every number has a decimal expansion; for rational numbers show that the decimal</p>	
	8.NS.2	11	<p>Know that there are numbers that are not rational, and approximate them by rational numbers.</p> <p>8.NS.2 Use rational approximations of irrational numbers to compare the size of irrational numbers, locate them approximately on a number line diagram, and estimate the value of expressions, e.g., π^2. <i>For example, by truncating the decimal expansion of $\sqrt{2}$, show that $\sqrt{2}$</i></p>	
Expressions and Equations	8.EE.1	12	<p>Work with radicals and integer exponents.</p> <p>8.EE.1 Know and apply the properties of integer exponents to generate equivalent numerical expressions. <i>For example, $3^2 \times 3^{-5} = 3^{-3} = 1/3^3 = 1/27$</i></p>	
	8.EE.2	13	<p>Work with radicals and integer exponents.</p> <p>8.EE.2 Use square root and cube root symbols to represent solutions to equations of the form $x^2 = p$ and $x^3 = p$, where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that $\sqrt{2}$ is irrational.</p>	
	8.EE.3	14	<p>Work with radicals and integer exponents.</p> <p>8.EE.3 Use numbers expressed in the form of a single digit times an integer power of 10 to estimate very large or very small quantities and to express how many times as much one is than the other. <i>For example, estimate the population of the United States as 3×10^8; and the</i></p>	
	8.EE.4	15	<p>Work with radicals and integer exponents.</p> <p>8.EE.4 Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities, e.g., use millimeters per year for seafloor spreading. Interpret scientific notation that has been</p>	
	8.EE.5	16	<p>Understand the connections between proportional relationships, lines, and linear equations.</p> <p>8.EE.5 Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. <i>For example,</i></p>	
	8.EE.6	17	<p>Understand the connections between proportional relationships, lines, and linear equations.</p> <p>8.EE.6 Use similar triangles to explain why the slope m is the same between any two distinct points on a non-vertical line in the coordinate plane; derive the equation $y = mx$ for a line</p>	

	8.EE.7	18	<p>Analyze and solve linear equations and pairs of simultaneous linear equations. 8.EE.7 Solve linear equations in one variable.</p> <p>a. Give examples of linear equations in one variable with one solution, infinitely many solutions, or no solutions. Show which of these possibilities is the case by successively transforming the given equation into simpler forms, until an equivalent equation of the form $x = a$, $a = a$, or $a = b$ results (where a and b are different numbers).</p>
			<p>b. Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms.</p>
	8.EE.8	19	<p>Analyze and solve linear equations and pairs of simultaneous linear equations. 8.EE.8 Analyze and solve pairs of simultaneous linear equations.</p> <p>a. Understand that solutions to a system of two linear equations in two variables correspond to points of intersection of their graphs, because points of intersection satisfy both equations simultaneously.</p>
			<p>b. Solve systems of two linear equations in two variables algebraically, and estimate solutions by graphing the equations. Solve simple cases by inspection. For example, $3x + 2y = 5$ and $3x + 2y = 6$ have no solution because $3x + 2y$ cannot simultaneously be 5 and 6.</p>
			<p>c. Solve real-world and mathematical problems leading to two linear equations in two variables. For example, given coordinates for two pairs of points, determine whether the line through the first pair of points intersects the line through the second pair.</p>
Functions	8.F.1	20	<p>Define, evaluate, and compare functions. 8.F.1 Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding</p>
	8.F.2	21	<p>Define, evaluate, and compare functions. 8.F.2 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). <i>For example, given a linear function represented by a table of values and a linear function represented by an algebraic expression, determine which function has the greater rate of change.</i></p>
	8.F.3	22	<p>Define, evaluate, and compare functions. 8.F.3 Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. <i>For example, the function $A = s^2$ giving the area of a square as a function of its side length is not linear because its graph contains the points $(1, 1)$, $(2, 4)$ and $(3, 9)$, which are not on a straight line.</i></p>

	8.F.4	23	<p>Use functions to model relationships between quantities.</p> <p>8.F.4 Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x, y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of</p>
	8.F.5	24	<p>Use functions to model relationships between quantities.</p> <p>8.F.5 Describe qualitatively the functional relationship between two quantities by analyzing a graph, e.g., where the function is increasing or decreasing, linear or nonlinear. Sketch a graph that exhibits the qualitative features of a function that has been described verbally.</p>
Geometry	8.G.1	25	<p>Understand congruence and similarity using physical models, transparencies, or geometry software.</p> <p>8.G.1 Verify experimentally the properties of rotations, reflections, and translations:</p> <p>a. Lines are taken to lines, and line segments to line segments of the same length.</p>
			b. Angles are taken to angles of the same measure.
			c. Parallel lines are taken to parallel lines.
	8.G.2	26	<p>Understand congruence and similarity using physical models, transparencies, or geometry software.</p> <p>8.G.2 Understand that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections, and translations; given two congruent figures, describe a sequence that exhibits the congruence between them.</p>
	8.G.3	27	<p>Understand congruence and similarity using physical models, transparencies, or geometry software.</p> <p>8.G.3 Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates.</p>
	8.G.4	28	<p>Understand congruence and similarity using physical models, transparencies, or geometry software.</p> <p>8.G.4 Understand that a two-dimensional figure is similar to another if the second can be obtained from the first by a sequence of rotations, reflections, translations, and dilations; given two similar two-dimensional figures, describe a sequence that exhibits the similarity</p>
8.G.5	29	<p>Understand congruence and similarity using physical models, transparencies, or geometry software.</p> <p>8.G.5 Use informal arguments to establish facts about the angle sum and exterior angle of triangles, about the angles created when parallel lines are cut by a transversal, and the angle-angle criterion for similarity of triangles. <i>For example, arrange three copies of the same triangle so that the sum of the three angles appears to form a line, and give an argument in</i></p>	
8.G.6	30	<p>Understand and apply the Pythagorean Theorem.</p> <p>8.G.6 Explain a proof of the Pythagorean Theorem and its converse.</p>	

	8.G.7	31	<p>Understand and apply the Pythagorean Theorem.</p> <p>8.G.7 Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.</p>
	8.G.8	32	<p>Understand and apply the Pythagorean Theorem.</p> <p>8.G.8 Apply the Pythagorean Theorem to find the distance between two points in a</p>
	8.G.9	33	<p>Solve real-world and mathematical problems involving volume of cylinders, cones, and spheres.</p> <p>8.G.9 Know the formulas for the volumes of cones, cylinders, and spheres and use them to</p>
Statistics and Probability	8.SP.1	34	<p>Investigate patterns of association in bivariate data.</p> <p>8.SP.1 Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association.</p>
	8.SP.2	35	<p>Investigate patterns of association in bivariate data.</p> <p>8.SP.2 Know that straight lines are widely used to model relationships between two quantitative variables. For scatter plots that suggest a linear association, informally fit a straight line, and informally assess the model fit by judging the closeness of the data points to</p>
	8.SP.3	36	<p>Investigate patterns of association in bivariate data.</p> <p>8.SP.3 Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept. <i>For example, in a linear model for a biology experiment, interpret a slope of 1.5 cm/hr as meaning that an additional hour of sunlight each day is associated with an additional 1.5 cm in mature plant height.</i></p>
	8.SP.4	37	<p>Investigate patterns of association in bivariate data.</p> <p>8.SP.4 Understand that patterns of association can also be seen in bivariate categorical data by displaying frequencies and relative frequencies in a two-way table. Construct and interpret a two-way table summarizing data on two categorical variables collected from the same subjects. Use relative frequencies calculated for rows or columns to describe possible association between the two variables. <i>For example, collect data from students in your class on whether or not they have a curfew on school nights and whether or not they have assigned chores at home. Is there evidence that those who have a curfew also tend to have</i></p>

Domain/ Conceptual Category	Standard	AES CODE	Original Standard	HIGH SCHOOL MATHEMATICS
Algebra	A.SSE.1	10	Interpret the structure of expressions. A.SSE.1 Interpret expressions that represent a quantity in terms of its context. ★ a. Interpret parts of an expression, such as terms, factors, and coefficients.	
		11	b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret $P(1+r)^n$ as the product of P and a factor not depending on P.	
	A.SSE.2	12	Interpret the structure of expressions. A.SSE.2 Use the structure of an expression to identify ways to rewrite it. <i>For example, see $x^4 - y^4$ as $(x^2)^2 - (y^2)^2$, thus recognizing it as a difference of squares that can be factored as $(x^2 - y^2)(x^2 + y^2)$.</i>	
	A.SSE.3	13	Write expressions in equivalent forms to solve problems. A.SSE.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. ★ a. Factor a quadratic expression to reveal the zeros of the function it defines.	
		14	b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.	
		15	c. Use the properties of exponents to transform expressions for exponential functions. For example the expression $1.15t$ can be rewritten as $(1.151/12)^{12t} \approx 1.012^{12t}$ to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.	
	A.APR.1	16	Perform arithmetic operations on polynomials. A.APR.1 Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.	
	A.CED.1	17	Create equations that describe numbers or relationships. A.CED.1 Create equations and inequalities in one variable and use them to solve problems. <i>Include equations arising from linear and quadratic functions, and simple rational and exponential functions.</i> ★	
	A.CED.2	18	Create equations that describe numbers or relationships. A.CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. ★	
	A.CED.3	19	Create equations that describe numbers or relationships. A.CED.3 Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. <i>For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.</i> ★	

A.CED.4	20	<p>Create equations that describe numbers or relationships.</p> <p>A.CED.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. <i>For example, rearrange Ohm's law $V = IR$ to highlight resistance R.</i> ★</p>
A.REI.1	21	<p>Understand solving equations as a process of reasoning and explain the reasoning.</p> <p>A.REI.1 Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.</p>
A.REI.3	22	<p>Solve equations and inequalities in one variable.</p> <p>A.REI.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.</p>
A.REI.4	23	<p>Solve equations and inequalities in one variable.</p> <p>A.REI.4 Solve quadratic equations in one variable.</p> <p>a. Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x - p)^2 = q$ that has the same solutions. Derive the quadratic formula from this form.</p>
	24	<p>b. Solve quadratic equations by inspection e.g., for $x^2 = 49$, taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers a and b.</p>
A.REI.5	25	<p>Solve systems of equations.</p> <p>A.REI.5 Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.</p>
A.REI.6	26	<p>Solve systems of equations.</p> <p>A.REI.6 Solve systems of linear equations exactly and approximately e.g., with graphs, focusing on pairs of linear equations in two variables.</p>
A.REI.7	27	<p>Solve systems of equations.</p> <p>A.REI.7 Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. <i>For example, find the points of intersection between the line $y = -3x$ and the circle $x^2 + y^2 = 3$.</i></p>
A.REI.10	28	<p>Represent and solve equations and inequalities graphically.</p> <p>A.REI.10 Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).</p>
A.REI.11	30	<p>Represent and solve equations and inequalities graphically.</p> <p>A.REI.11 Explain why the x-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.</p>

	A.REI.12	31	<p>Represent and solve equations and inequalities graphically.</p> <p>A.REI.12 Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.</p>
Functions	F.IF.1	32	<p>Understand the concept of a function, and use function notation.</p> <p>F.IF.1 Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then $f(x)$ denotes the output of f corresponding to the input x. The graph of f is the graph of the equation $y = f(x)$.</p>
	F.IF.2	33	<p>Understand the concept of a function, and use function notation.</p> <p>F.IF.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.</p>
	F.IF.3	34	<p>Understand the concept of a function, and use function notation.</p> <p>F.IF.3 Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. <i>For example, the Fibonacci sequence is defined recursively by $f(0) = f(1) = 1$, $f(n+1) = f(n) + f(n-1)$ for $n \geq 1$.</i></p>
	F.IF.4	35	<p>Interpret functions that arise in applications in terms of the context.</p> <p>F.IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. <i>Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.</i> ★</p>
	F.IF.5	36	<p>Interpret functions that arise in applications in terms of the context.</p> <p>F.IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. <i>For example, if the function $h(n)$ gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.</i> ★</p>
	F.IF.6	37	<p>Interpret functions that arise in applications in terms of the context.</p> <p>F.IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph. ★ (A2, M3)</p>

F.IF.7	38	Analyze functions using different representations. F.IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. ★ a. Graph linear and quadratic functions and show intercepts, maxima, and minima.
	39	b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.
	40	e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.
F.IF.8	41	Analyze functions using different representations. F.IF.8 Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.
	42	b. Use the properties of exponents to interpret expressions for exponential functions. For example, identify percent rate of change in functions such as $y = (1.02)^t$, $y = (0.97)^t$, $y = (1.01)^{12t}$, $y = (1.2)^{t/10}$, and classify them as representing exponential growth or decay.
F.IF.9	43	Analyze functions using different representations. F.IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). <i>For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.</i>
F.BF.1	44	Build a function that models a relationship between two quantities. F.BF.1 Write a function that describes a relationship between two quantities. ★ a. Determine an explicit expression, a recursive process, or steps for calculation from a context.
	45	b. Combine standard function types using arithmetic operations. For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.
F.BF.2	46	Build a function that models a relationship between two quantities. F.BF.2 Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms. ★

F.BF.3	47	<p>Build new functions from existing functions.</p> <p>F.BF.3 Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k f(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. <i>Include recognizing even and odd functions from their graphs and algebraic expressions for them.</i></p>
F.BF.4	48	<p>Build new functions from existing functions.</p> <p>F.BF.4 Find inverse functions.</p> <p>a. Solve an equation of the form $f(x) = x$ for a simple function f that has an inverse and write an expression for the inverse. <i>For example, $f(x) = 2x^3$ or $f(x) = (x+1)/(x-1)$ for $x \neq 1$.</i></p>
F.LE.1	49	<p>Construct and compare linear, quadratic, and exponential models, and solve problems.</p> <p>F.LE.1 Distinguish between situations that can be modeled with linear functions and with exponential functions. ★</p> <p>a. Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals.</p>
	50	b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.
	51	c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.
F.LE.2	52	<p>Construct and compare linear, quadratic, and exponential models, and solve problems.</p> <p>F.LE.2 Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table). ★</p>
F.LE.3	530	<p>Construct and compare linear, quadratic, and exponential models, and solve problems.</p> <p>F.LE.3 Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function. ★</p>
F.LE.4	531	<p>Construct and compare linear, quadratic, and exponential models, and solve problems.</p> <p>F.LE.4 For exponential models, express as a logarithm the solution to $ab^{ct} = d$ where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology. ★</p>
F.LE.5	54	<p>Interpret expressions for functions in terms of the situation they model.</p> <p>F.LE.5 Interpret the parameters in a linear or exponential function in terms of a context. ★</p>
F.TF.8	55	<p>Prove and apply trigonometric identities.</p> <p>F.TF.8 Prove the Pythagorean identity $\sin^2(\theta) + \cos^2(\theta) = 1$ and use it to find $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ given $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ and the quadrant of the angle.</p>

Geometry	G.CO.1	56	Experiment with transformations in the plane. G.CO.1 Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.
	G.CO.2	57	Experiment with transformations in the plane. G.CO.2 Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not, e.g., translation versus horizontal stretch.
	G.CO.3	58	Experiment with transformations in the plane. G.CO.3 Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.
	G.CO.4	59	Experiment with transformations in the plane. G.CO.4 Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.
	G.CO.5	60	Experiment with transformations in the plane. G.CO.5 Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using items such as graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.
	G.CO.6	61	Understand congruence in terms of rigid motions. G.CO.6 Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.
	G.CO.7	62	Understand congruence in terms of rigid motions. G.CO.7 Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.
	G.CO.8	63	Understand congruence in terms of rigid motions. G.CO.8 Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.
	G.CO.9	64	Prove geometric theorems. G.CO.9 Prove theorems about lines and angles. <i>Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.</i>
	G.CO.10	65	Prove geometric theorems. G.CO.10 Prove theorems about triangles. <i>Theorems include: measures of interior angles of a triangle sum to 180°; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.</i>

G.CO.11	66	<p>Prove geometric theorems.</p> <p>G.CO.11 Prove theorems about parallelograms. <i>Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.</i></p>
G.CO.12	67	<p>Make geometric constructions.</p> <p>G.CO.12 Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). <i>Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.</i></p>
G.CO.13	68	<p>Make geometric constructions.</p> <p>G.CO.13 Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.</p>
G.SRT.1	69	<p>Understand similarity in terms of similarity transformations.</p> <p>G.SRT.1 Verify experimentally the properties of dilations given by a center and a scale factor:</p> <p>a. A dilation takes a line not passing through the center of the dilation to a parallel line and leaves a line passing through the center unchanged.</p>
	70	<p>b. The dilation of a line segment is longer or shorter in the ratio given by the scale factor.</p>
G.SRT.2	71	<p>Understand similarity in terms of similarity transformations.</p> <p>G.SRT.2 Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.</p>
G.SRT.3	72	<p>Understand similarity in terms of similarity transformations.</p> <p>G.SRT.3 Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.</p>
G.SRT.4	73	<p>Prove theorems involving similarity.</p> <p>G.SRT.4 Prove theorems about triangles. <i>Theorems include: a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity.</i></p>
G.SRT.5	74	<p>Prove theorems involving similarity.</p> <p>G.SRT.5 Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.</p>
G.SRT.6	75	<p>Define trigonometric ratios, and solve problems involving right triangles.</p> <p>G.SRT.6 Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.</p>
G.SRT.7	76	<p>Define trigonometric ratios, and solve problems involving right triangles.</p> <p>G.SRT.7 Explain and use the relationship between the sine and cosine of complementary angles.</p>
G.SRT.8	77	<p>Define trigonometric ratios and solve problems involving right triangles.</p> <p>G.SRT.8 Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems. ★</p>

G.C.1	78	Understand and apply theorems about circles. G.C.1 Prove that all circles are similar.
G.C.2	79	Understand and apply theorems about circles. G.C.2 Identify and describe relationships among inscribed angles, radii, and chords. <i>Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.</i>
G.C.3	80	Understand and apply theorems about circles. G.C.3 Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.
G.C.5	81	Find arc lengths and areas of sectors of circles. G.C.5 Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector.
G.GPE.1	82	Translate between the geometric description and the equation for a conic section. G.GPE.1 Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.
G.GPE.4	83	Use coordinates to prove simple geometric theorems algebraically. G.GPE.4 Use coordinates to prove simple geometric theorems algebraically. <i>For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle; prove or disprove that the point $(1, \sqrt{3})$ lies on the circle centered at the origin and containing the point $(0, 2)$.</i>
G.GPE.5	84	Use coordinates to prove simple geometric theorems algebraically. G.GPE.5 Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point).
G.GPE.6	85	Use coordinates to prove simple geometric theorems algebraically. G.GPE.6 Find the point on a directed line segment between two given points that partitions the segment in a given ratio.
G.GPE.7	86	Use coordinates to prove simple geometric theorems algebraically. G.GPE.7 Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula. ★
G.GMD.1	87	Explain volume formulas, and use them to solve problems. G.GMD.1 Give an informal argument for the formulas for the circumference of a circle, area of a circle, and volume of a cylinder, pyramid, and cone. <i>Use dissection arguments, Cavalieri's principle, and informal limit arguments.</i>
G.GMD.3	88	Explain volume formulas, and use them to solve problems. G.GMD.3 Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems. ★
G.GMD.4	89	Visualize relationships between two-dimensional and three-dimensional objects. G.GMD.4 Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.

	G.MG.1	90	Apply geometric concepts in modeling situations. G.MG.1 Use geometric shapes, their measures, and their properties to describe objects, e.g., modeling a tree trunk or a human torso as a cylinder. ★
	G.MG.2	91	Apply geometric concepts in modeling situations. G.MG.2 Apply concepts of density based on area and volume in modeling situations, e.g., persons per square mile, BTUs per cubic foot. ★
	G.MG.3	92	Apply geometric concepts in modeling situations. G.MG.3 Apply geometric methods to solve design problems, e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios. ★
Number and Quantity	N.RN.1	93	Extend the properties of exponents to rational exponents. N.RN.1 Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. <i>For example, we define $5^{1/3}$ to be the cube root of 5 because we want $(5^{1/3})^3 = 5^{(1/3)3}$ to hold, so $(5^{1/3})^3$ must equal 5.</i>
	N.RN.2	94	Extend the properties of exponents to rational exponents. N.RN.2 Rewrite expressions involving radicals and rational exponents using the properties of exponents.
	N.RN.3	95	Use properties of rational and irrational numbers. N.RN.3 Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.
	N.Q.1	96	Reason quantitatively and use units to solve problems. N.Q.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. ★
	N.Q.2	97	Reason quantitatively and use units to solve problems. N.Q.2 Define appropriate quantities for the purpose of descriptive modeling. ★
	N.Q.3	98	Reason quantitatively and use units to solve problems. N.Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. ★
	N.CN.1	99	Perform arithmetic operations with complex numbers. N.CN.1 Know there is a complex number i such that $i^2 = -1$, and every complex number has the form $a + bi$ with a and b real.
	N.CN.2	100	Perform arithmetic operations with complex numbers. N.CN.2 Use the relation $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.
	N.CN.7	101	Use complex numbers in polynomial identities and equations. N.CN.7 Solve quadratic equations with real coefficients that have complex solutions.
Statistics and Probability	S.ID.1	102	Summarize, represent, and interpret data on a single count or measurement variable. S.ID.1 Represent data with plots on the real number line (dot plots, histograms, and box plots). ★

S.ID.2	103	Summarize, represent, and interpret data on a single count or measurement variable. S.ID.2 Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets. ★
S.ID.3	104	Summarize, represent, and interpret data on a single count or measurement variable. S.ID.3 Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers). ★
S.ID.5	105	Summarize, represent, and interpret data on two categorical and quantitative variables. S.ID.5 Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data. ★
S.ID.6	106	Summarize, represent, and interpret data on two categorical and quantitative variables. S.ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. ★ a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. <i>Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.</i>
	107	b. Informally assess the fit of a function by plotting and analyzing residuals.
	108	c. Fit a linear function for a scatter plot that suggests a linear association.
S.ID.7	109	Interpret linear models. S.ID.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data. ★
S.ID.8	110	Interpret linear models. S.ID.8 Compute (using technology) and interpret the correlation coefficient of a linear fit. ★
S.ID.9	111	Interpret linear models. S.ID.9 Distinguish between correlation and causation. ★
S.CP.1	112	Understand independence and conditional probability, and use them to interpret data. S.CP.1 Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events (“or,” “and,” “not”).*
S.CP.2	113	Understand independence and conditional probability, and use them to interpret data. S.CP.2 Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent. ★
S.CP.3	114	Understand independence and conditional probability, and use them to interpret data. S.CP.3 Understand the conditional probability of A given B as $P(A \text{ and } B)/P(B)$, and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B. ★

S.CP.4	115	<p>Understand independence and conditional probability, and use them to interpret data.</p> <p>S.CP.4 Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities. <i>For example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results.</i> ★</p>
S.CP.5	116	<p>Understand independence and conditional probability, and use them to interpret data.</p> <p>S.CP.5 Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. <i>For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.</i> ★</p>
S.CP.6	117	<p>Use the rules of probability to compute probabilities of compound events in a uniform probability model.</p> <p>S.CP.6 Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A, and interpret the answer in terms of the model. ★</p>
S.CP.7	118	<p>Use the rules of probability to compute probabilities of compound events in a uniform probability model.</p> <p>S.CP.7 Apply the Addition Rule, $P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$, and interpret the answer in terms of the model. ★</p>

Appendix E-ELA Standards Coding Sheet

Ohio Learning Standards Grade 3

CODE	STANDARD
Reading: Literature	
10	Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.
11	Recount stories, including fables, folktales, and myths from diverse cultures; determine the central message, lesson, or moral and explain how it is conveyed through key details in the text.
12	Describe characters in a story (e.g., their traits, motivations, or feelings) and explain how their actions contribute to the sequence of events
13	Determine the meaning of words and phrases as they are used in a text, distinguishing literal from nonliteral language.
14	Refer to parts of stories, dramas, and poems when writing or speaking about a text, using terms such as chapter, scene, and stanza; describe how each successive part builds on earlier sections.
15	Distinguish their own point of view from that of the narrator or those of the characters.
16	Explain how specific aspects of a text's illustrations contribute to what is conveyed by the words in a story (e.g., create mood, emphasize aspects of a character or setting)
17	Compare and contrast the themes, settings, and plots of stories written by the same author about the same or similar characters (e.g., in books from a series)
Reading: Informational Text	
18	Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.
19	Determine the main idea of a text; recount the key details and explain how they support the main idea.
20	Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect.
21	Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a <i>grade 3 topic or subject area</i> .
22	Use text features and search tools (e.g., key words, sidebars, hyperlinks) to locate information relevant to a given topic efficiently.
23	Distinguish their own point of view from that of the author of a text.
24	Use information gained from illustrations (e.g., maps, photographs) and the words in a text to demonstrate understanding of the text (e.g., where, when, why, and how key events occur).
25	Describe the logical connection between particular sentences and paragraphs in a text (e.g., comparison, cause/effect, first/second/third in a sequence).
26	Compare and contrast the most important points and key details presented in two texts on the same topic.
Writing	
	<p>Write opinion pieces on topics or texts, supporting a point of view with reasons.</p> <ul style="list-style-type: none"> • Introduce the topic or text they are writing about, state an opinion, and create an organizational structure that lists reasons. • Provide reasons that support the opinion.

27	<ul style="list-style-type: none"> • Use linking words and phrases (e.g., <i>because, therefore, since, for example</i>) to connect opinion and reasons. • Provide a concluding statement or section.
28	<p>Write informative/explanatory texts to examine a topic and convey ideas and information clearly.</p> <ul style="list-style-type: none"> • Introduce a topic and group related information together; include illustrations when useful to aiding comprehension. • Develop the topic with facts, definitions, and details. • Use linking words and phrases (e.g., <i>also, another, and, more, but</i>) to connect ideas within categories of information. • Provide a concluding statement or section.
29	<p>With guidance and support from adults, produce writing in which the development and organization are appropriate to task and purpose.</p>
30	<p>With guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, and editing.</p>
31	<p>Conduct short research projects that build knowledge about a topic.</p>
32	<p>Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories.</p>
Language	
33	<p>Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.</p> <ul style="list-style-type: none"> • Explain the function of nouns, pronouns, verbs, adjectives, and adverbs in general and their functions in particular sentences. • Form and use regular and irregular plural nouns. • Use abstract nouns (e.g., <i>childhood</i>). • Form and use regular and irregular verbs. • Form and use the simple (e.g., <i>I walked; I walk; I will walk</i>) verb tenses. • Ensure subject-verb and pronoun-antecedent agreement. Form and use comparative and superlative adjectives and adverbs, and choose between them depending on what is to be modified. • Use coordinating and subordinating conjunctions. • Produce simple, compound, and complex sentences.
34	<p>Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.</p> <ul style="list-style-type: none"> • Capitalize appropriate words in titles. • Use commas in addresses. • Use commas and quotation marks in dialogue. • Form and use possessives. • Use conventional spelling for high-frequency and other studied words and for adding suffixes to base words (e.g., <i>sitting, smiled, cries, happiness</i>). • Use spelling patterns and generalizations (e.g., <i>word families, position-based spellings, syllable patterns, ending rules, meaningful word parts</i>) in writing words.
	<p>Use knowledge of language and its conventions when writing, speaking, reading, or listening.</p> <ul style="list-style-type: none"> • Choose words and phrases for effect.

35	<ul style="list-style-type: none"> Recognize and observe differences between the conventions of spoken and written standard English.
36	<p>Determine or clarify the meaning of unknown and multiple-meaning word and phrases based on grade 3 reading and content, choosing flexibly from a range of strategies.</p> <ul style="list-style-type: none"> Use sentence-level context as a clue to the meaning of a word or phrase. Determine the meaning of the new word formed when a known affix is added to a known word (e.g., <i>agreeable/disagreeable, comfortable/uncomfortable, care/careless, heat/preheat</i>). Use a known root word as a clue to the meaning of an unknown word with the same root (e.g., <i>company, companion</i>). Use glossaries or beginning dictionaries, both print and digital, to determine or clarify the precise meaning of key words and phrases.
37	<p>Demonstrate understanding of figurative language, word relationships and nuances in word meanings.</p> <ul style="list-style-type: none"> Distinguish the literal and nonliteral meanings of words and phrases in context (e.g., <i>take steps</i>). Identify real-life connections between words and their use (e.g., describe people who are <i>friendly</i> or <i>helpful</i>). Distinguish shades of meaning among related words that describe states of mind or degrees of certainty (e.g., <i>knew, believed, suspected, heard, wondered</i>).
38	<p>Acquire and use accurately grade-appropriate conversational, general academic, and domain-specific words and phrases, including those that signal spatial and temporal relationships (e.g., <i>After dinner that night we went looking for them</i>).</p>

Ohio Learning Standards Grade 4

CODE	STANDARD
Reading: Literature	
10	Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.
11	Determine a theme of a story, drama, or poem from details in the text; summarize the text.
12	Describe in depth a character, setting, or event in a story or drama, drawing on specific details in the text (e.g., a character's thoughts, words, or actions).
13	Determine the meaning of words and phrases as they are used in a text, including those that allude to significant characters found in mythology (e.g., Herculean).
14	Explain major differences between poems, drama, and prose, and refer to the structural elements of poems (e.g., verse, rhythm, meter) and drama (e.g., casts of characters, settings, descriptions, dialogue, stage directions) when writing or speaking about a text.
15	Compare and contrast the point of view from which different stories are narrated, including the difference between first- and third-person narrations.
16	Make connections between the text of a story or drama and a visual or oral presentation of the text, identifying where each version reflects specific descriptions and directions in the text.
17	Compare and contrast the treatment of similar themes and topics (e.g., opposition of good and evil) and patterns of events (e.g., the quest) in stories, myths, and traditional literature from different cultures.
Reading: Informational Text	
18	Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.
19	Determine the main idea of a text and explain how it is supported by key details; summarize the text.
20	Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.
21	Determine the meaning of general academic and domain-specific words or phrases in a text relevant to a grade 4 topic or subject area.
22	Describe the overall structure (e.g., chronology, comparison, cause/effect, problem/solution) of events, ideas, concepts, or information in a text or part of a text.
23	Compare and contrast a firsthand and secondhand account of the same event or topic; describe the differences in focus and the information provided.
24	Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears.
25	Explain how an author uses reasons and evidence to support particular points in a text.
26	Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably.
Writing	
27	Write opinion pieces on topics or texts, supporting a point of view with reasons and information. <ul style="list-style-type: none"> • Introduce a topic or text clearly, state an opinion, and create an organizational structure in which related ideas are grouped to support the writer's purpose. • Provide reasons that are supported by facts and details. • Link opinion and reasons using words and phrases (e.g., for instance, in order to, in addition). • Provide a concluding statement or section related to the opinion presented.
28	Write informative/explanatory texts to examine a topic and convey ideas and information clearly. <ul style="list-style-type: none"> • Introduce a topic clearly and group related information in paragraphs and sections; include formatting (e.g., headings), illustrations, and multimedia when useful to aiding comprehension. • Develop the topic with facts, definitions, concrete details, quotations, or other information

	<p>and examples related to the topic.</p> <ul style="list-style-type: none"> • Link ideas within categories of information using words and phrases (e.g., another, for example, also, because). • Use precise language and domain-specific vocabulary to inform about or explain the topic. • Provide a concluding statement or section related to the information or explanation presented.
29	Produce clear and coherent writing in which the development and organization are appropriate to task, purpose, and audience.
30	With guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, and editing.
31	With some guidance and support from adults, use technology, including the Internet, to produce and publish writing as well as to interact and collaborate with others; demonstrate sufficient command of keyboarding skills to type a minimum of one page in a single sitting.
32	Conduct short research projects that build knowledge through investigation of different aspects of a topic.
33	Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources.
34	Draw evidence from literary or informational texts to support analysis, reflection, and research.
Language	
33	<p>Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.</p> <ul style="list-style-type: none"> • Use relative pronouns (who, whose, whom, which, that) and relative adverbs (where, when, why). • Form and use the progressive (e.g., I was walking; I am walking; I will be walking) verb tenses. • Use modal auxiliaries (e.g., can, may, must) to convey various conditions. • Order adjectives within sentences according to conventional patterns (e.g., a small red bag rather than a red small bag). • Form and use prepositional phrases. • Produce complete sentences, recognizing and correcting inappropriate fragments & run-ons. • Correctly use frequently confused words (e.g., to, too, two; there, their).
34	<p>Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.</p> <ul style="list-style-type: none"> • Use correct capitalization. • Use commas and quotation marks to mark direct speech and quotations from a text. • Use a comma before a coordinating conjunction in a compound sentence. • Spell grade-appropriate words correctly, consulting references as needed.
35	<p>Use knowledge of language and its conventions when writing, speaking, reading, or listening.</p> <ul style="list-style-type: none"> • Choose words and phrases to convey ideas precisely. • Choose punctuation for effect. • Differentiate between contexts that call for formal English (e.g., presenting ideas) and situations where informal discourse is appropriate (e.g., small-group discussion).
36	<p>Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grade 4 reading and content, choosing flexibly from a range of strategies.</p> <ul style="list-style-type: none"> • Use context (e.g., definitions, examples, or restatements in text) as a clue to the meaning of a word or phrase. • Use common, grade-appropriate Greek and Latin affixes and roots as clues to the meaning of a word (e.g., telegraph, photograph, autograph). • Consult reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation and determine or clarify the precise meaning of key words and phrases.
37	Demonstrate understanding of figurative language, word relationships, and nuances in word

	<p>meanings.</p> <ul style="list-style-type: none">• Explain the meaning of simple similes and metaphors (e.g., as pretty as a picture) in context.• Recognize and explain the meaning of common idioms, adages, and proverbs.• Demonstrate understanding of words by relating them to their opposites (antonyms) and to words with similar but not identical meanings (synonyms).
38	<p>Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases, including those that signal precise actions, emotions, or states of being (e.g., quizzed, whined, stammered) and that are basic to a particular topic (e.g., wildlife, conservation, and endangered when discussing animal preservation).</p>

Ohio Learning Standards Grade 5

CODE	STANDARD
Reading: Literature	
10	Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text.
11	Determine a theme of a story, drama, or poem from details in the text, including how characters in a story or drama respond to challenges or how the speaker in a poem reflects upon a topic; summarize the text.
12	Compare and contrast two or more characters, settings, or events in a story or drama, drawing on specific details in the text (e.g., how characters interact).
13	Determine the meaning of words and phrases as they are used in a text, including figurative language such as metaphors and similes.
14	Explain how a series of chapters, scenes, or stanzas fits together to provide the overall structure of a particular story, drama, or poem.
15	Describe how a narrator's or speaker's point of view influences how events are described.
16	Analyze how visual and multimedia elements contribute to the meaning, tone, or beauty of a text (e.g., graphic novel, multimedia presentation of fiction, folktale, myth, poem).
17	Compare and contrast stories in the same genre (e.g., mysteries and adventure stories) on their approaches to similar themes and topics.
Reading: Informational Text	
18	Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text.
19	Determine two or more main ideas of a text and explain how they are supported by key details; summarize the text.
20	Explain the relationships or interactions between two or more individuals, events, ideas, or concepts in a historical, scientific, or technical text based on specific information in the text.
21	Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 5 topic or subject area.
22	Compare and contrast the overall structure (e.g., chronology, comparison, cause/effect, problem/solution) of events, ideas, concepts, or information in two or more texts.
23	Analyze multiple accounts of the same event or topic, noting important similarities and differences in the point of view they represent.
24	Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently.
25	Explain how an author uses reasons and evidence to support particular points in a text, identifying which reasons and evidence support which point(s).
26	Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably.
Writing	
27	Write opinion pieces on topics or texts, supporting a point of view with reasons and information. <ul style="list-style-type: none"> • Introduce a topic or text clearly, state an opinion, and create an organizational structure in which ideas are logically grouped to support the writer's purpose. • Provide logically ordered reasons that are supported by facts and details. • Link opinion and reasons using words, phrases, and clauses (e.g., consequently, specifically). • Provide a concluding statement or section related to the opinion presented.
28	Write informative/explanatory texts to examine a topic and convey ideas and information clearly. Introduce a topic clearly, provide a general observation and focus, and group related information logically; include formatting (e.g., headings), illustrations, and multimedia when useful to aiding comprehension. <ul style="list-style-type: none"> • Develop the topic with facts, definitions, concrete details, quotations, or other information

	<p>and examples related to the topic.</p> <ul style="list-style-type: none"> • Link ideas within and across categories of information using words, phrases, and clauses (e.g., in contrast, especially). • Use precise language and domain-specific vocabulary to inform about or explain the topic. • Provide a concluding statement or section related to the information or explanation presented.
29	Produce clear and coherent writing in which the development and organization are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1-3 above.)
30	With guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.
31	With some guidance and support from adults, use technology, including the Internet, to produce and publish writing as well as to interact and collaborate with others; demonstrate sufficient command of keyboarding skills to type a minimum of two pages in a single sitting.
32	Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.
33	Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources.
34	Draw evidence from literary or informational texts to support analysis, reflection, and research.
Language	
33	<p>Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.</p> <ul style="list-style-type: none"> • Explain the function of conjunctions, prepositions, and interjections in general and their function in particular sentences. • Form and use the perfect (e.g., I had walked; I have walked; I will have walked) verb tenses. • Use verb tense to convey various times, sequences, states, and conditions. • Recognize and correct inappropriate shifts in verb tense. • Use correlative conjunctions (e.g., either/or, neither/nor).
34	<p>Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.</p> <ul style="list-style-type: none"> • Use punctuation to separate items in a series. • Use a comma to separate an introductory element from the rest of the sentence. • Use a comma to set off the words yes and no (e.g., Yes, thank you), to set off a tag question from the rest of the sentence (e.g., It's true, isn't it?), and to indicate direct address (e.g., Is that you, Steve?). • Use underlining, quotation marks, or italics to indicate titles of works. • Spell grade-appropriate words correctly, consulting references as needed.
35	<p>Use knowledge of language and its conventions when writing, speaking, reading, or listening.</p> <ul style="list-style-type: none"> • Expand, combine, and reduce sentences for meaning, reader/listener interest, and style. • Compare and contrast the varieties of English (e.g., dialects, registers) used in stories, dramas, or poems.
36	<p>Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grade 5 reading and content, choosing flexibly from a range of strategies.</p> <ul style="list-style-type: none"> • Use context (e.g., cause/effect relationships and comparisons in text) as a clue to the meaning of a word or phrase. • Use common, grade-appropriate Greek and Latin affixes and roots as clues to the meaning of a word (e.g., photograph, photosynthesis). • Consult reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation and determine or clarify the precise meaning of key words and phrases.

37	Demonstrate understanding of figurative language, word relationships, and nuances in word meanings. <ul style="list-style-type: none">• Interpret figurative language, including similes and metaphors, in context.• Recognize and explain the meaning of common idioms, adages, and proverbs.• Use the relationship between particular words (e.g., synonyms, antonyms, homographs) to better understand each of the words.
38	Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases, including those that signal contrast, addition, and other logical relationships (e.g., however, although, nevertheless, similarly, moreover, in addition).

Ohio Learning Standards Grade 6

CODE	STANDARD
Reading: Literature	
10	Cite textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.
11	Determine a theme or central idea of a text and how it is conveyed through particular details; provide a summary of the text distinct from personal opinions or judgments.
12	Describe how a particular story's or drama's plot unfolds in a series of episodes as well as how the characters respond or change as the plot moves toward a resolution.
13	Determine the meaning of words and phrases as they are used in a text, including figurative and connotative meanings; analyze the impact of a specific word choice on meaning and tone.
14	Analyze how a particular sentence, chapter, scene, or stanza fits into the overall structure of a text and contributes to the development of the theme, setting, or plot.
15	Explain how an author develops the point of view of the narrator or speaker in a text.
16	Compare and contrast the experience of reading a story, drama, or poem to listening to or viewing an audio, video, or live version of the text, including contrasting what they "see" and "hear" when reading the text to what they perceive when they listen or watch.
17	Compare and contrast texts in different forms or genres (e.g., stories and poems; historical novels and fantasy stories) in terms of their approaches to similar themes and topics.
Reading: Informational Text	
18	Cite textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.
19	Determine a central idea of a text and how it is conveyed through particular details; provide a summary of the text distinct from personal opinions or judgments.
20	Analyze in detail how a key individual, event, or idea is introduced, illustrated, and elaborated in a text (e.g., through examples or anecdotes).
21	Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings.
22	Analyze how a particular sentence, paragraph, chapter, or section fits into the overall structure of a text and contributes to the development of the ideas.
23	Determine an author's point of view or purpose in a text and explain how it is conveyed in the text.
24	Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.
25	Trace and evaluate the argument and specific claims in a text, distinguishing claims that are supported by reasons and evidence from claims that are not.
26	Compare and contrast one author's presentation of events with that of another (e.g., a memoir written by and a biography on the same person).
Writing	
27	<p>Write arguments to support claims with clear reasons and relevant evidence.</p> <ul style="list-style-type: none"> • Introduce claim(s) and organize the reasons and evidence clearly. • Support claim(s) with clear reasons and relevant evidence, using credible sources and demonstrating an understanding of the topic or text. • Use words, phrases, and clauses to clarify the relationships among claim(s) and reasons. • Establish and maintain a formal style. • Provide a concluding statement or section that follows from the argument presented.
28	<p>Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.</p> <ul style="list-style-type: none"> • Introduce a topic; organize ideas, concepts, and information, using strategies such as definition, classification, comparison/contrast, and cause/effect; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding

	<p>comprehension.</p> <ul style="list-style-type: none"> • Develop the topic with relevant facts, definitions, concrete details, quotations, or other information and examples. • Use appropriate transitions to clarify the relationships among ideas and concepts. • Use precise language and domain-specific vocabulary to inform about or explain the topic. • Establish and maintain a formal style. • Provide a concluding statement or section that follows from the information or explanation presented.
29	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
30	With some guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.
31	Use technology, including the Internet, to produce and publish writing as well as to interact and collaborate with others; demonstrate sufficient command of keyboarding skills to type a minimum of three pages in a single sitting.
32	Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate.
33	Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources.
34	Draw evidence from literary or informational texts to support analysis, reflection, and research.
Language	
33	<p>Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.</p> <ul style="list-style-type: none"> • Ensure that pronouns are in the proper case (subjective, objective, possessive). • Use intensive pronouns (e.g., myself, ourselves). • Recognize and correct inappropriate shifts in pronoun number and person. • Recognize and correct vague pronouns (i.e., ones with unclear or ambiguous antecedents). • Recognize variations from standard English in their own and others' writing and speaking, and identify and use strategies to improve expression in conventional language.
34	<p>Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.</p> <ul style="list-style-type: none"> • Use punctuation (commas, parentheses, dashes) to set off nonrestrictive/parenthetical elements.* • Spell correctly.
35	<p>Use knowledge of language and its conventions when writing, speaking, reading, or listening.</p> <ul style="list-style-type: none"> • Vary sentence patterns for meaning, reader/listener interest, and style. • Maintain consistency in style and tone.
36	<p>Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grade 6 reading and content, choosing flexibly from a range of strategies.</p> <ul style="list-style-type: none"> • Use context (e.g., the overall meaning of a sentence or paragraph; a word's position or function in a sentence) as a clue to the meaning of a word or phrase. • Use common, grade-appropriate Greek or Latin affixes and roots as clues to the meaning of a word (e.g., audience, auditory, audible). • Consult reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning or its part of speech. • Verify the preliminary determination of the meaning of a word or phrase (e.g., by checking the inferred meaning in context or in a dictionary).
37	Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.

	<ul style="list-style-type: none"> • Interpret figures of speech (e.g., personification) in context. • Use the relationship between particular words (e.g., cause/effect, part/whole, item/category) to better understand each of the words. • Distinguish among the connotations (associations) of words with similar denotations (definitions) (e.g., stingy, scrimping, economical, unwasteful, thrifty).
38	Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases; gather vocabulary knowledge when considering a word or phrase important to comprehension or expression.

Ohio Learning Standards Grade 7

CODE	STANDARD
Reading: Literature	
10	Cite several pieces of textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.
11	Determine a theme or central idea of a text and analyze its development over the course of the text; provide an objective summary of the text.
12	Analyze how particular elements of a story or drama interact (e.g., how setting shapes the characters or plot).
13	Determine the meaning of words and phrases as they are used in a text, including figurative and connotative meanings; analyze the impact of rhymes and other repetitions of sounds (e.g., alliteration) on a specific verse or stanza of a poem or section of a story or drama.
14	Analyze how a drama’s or poem’s form or structure (e.g., soliloquy, sonnet) contributes to its meaning.
15	Analyze how an author develops and contrasts the points of view of different characters or narrators in a text.
16	Compare and contrast a written story, drama, or poem to its audio, filmed, staged, or multimedia version, analyzing the effects of techniques unique to each medium (e.g., lighting, sound, color, or camera focus and angles in a film).
17	Compare and contrast a fictional portrayal of a time, place, or character and a historical account of the same period as a means of understanding how authors of fiction use or alter history
18	By the end of the year, read and comprehend literature, including stories, dramas, and poems, in the grades 6–8 text complexity band proficiently, with scaffolding as needed at the high end of the range.
Reading: Informational Text	
19	Cite several pieces of textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.
20	Determine two or more central ideas in a text and analyze their development over the course of the text; provide an objective summary of the text.
21	Analyze the interactions between individuals, events, and ideas in a text (e.g., how ideas influence individuals or events, or how individuals influence ideas or events).
22	Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze the impact of a specific word choice on meaning and tone.
23	Analyze the structure an author uses to organize a text, including how the major sections contribute to the whole and to the development of the ideas
24	Determine an author’s point of view or purpose in a text and analyze how the author distinguishes his or her position from that of others.
25	Compare and contrast a text to an audio, video, or multimedia version of the text, analyzing each medium’s portrayal of the subject (e.g., how the delivery of a speech affects the impact of the words).
26	Trace and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient to support the claims.
27	Analyze how two or more authors writing about the same topic shape their presentations of key information by emphasizing different evidence or advancing different interpretations of facts.
Reading: Literacy in History/Social Studies	
28	Cite specific textual evidence to support analysis of primary and secondary sources.
29	Determine the central ideas or information of a primary or secondary source; provide an accurate summary of the source distinct from prior knowledge or opinions.
30	Identify key steps in a text’s description of a process related to history/social studies (e.g., how a bill becomes law, how interest rates are raised or lowered).
31	Determine the meaning of words and phrases as they are used in a text, including vocabulary specific

	to domains related to history/social studies.
32	Describe how a text presents information (e.g., sequentially, comparatively, causally).
33	Identify aspects of a text that reveal an author's point of view or purpose (e.g., loaded language, inclusion or avoidance of particular facts).
34	Integrate visual information (e.g., in charts, graphs, photographs, videos, or maps) with other information in print and digital texts.
35	Distinguish among fact, opinion, and reasoned judgment in a text.
36	Analyze the relationship between a primary and secondary source on the same topic.
Reading: Literacy in Science and Technical Subjects	
37	Cite specific textual evidence to support analysis of science and technical texts.
38	Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.
39	Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
40	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6–8 texts and topics.
41	Analyze the structure an author uses to organize a text, including how the major sections contribute to the whole and to an understanding of the topic.
42	Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).
43	Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.
44	Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.
Writing	
45	<p>Write arguments to support claims with clear reasons and relevant evidence.</p> <ul style="list-style-type: none"> • Introduce claim(s), acknowledge alternate or opposing claims, and organize the reasons and evidence logically. • Support claim(s) with logical reasoning and relevant evidence, using accurate, credible sources and demonstrating an understanding of the topic or text. • Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), reasons, and evidence. • Establish and maintain a formal style. • Provide a concluding statement or section that follows from and supports the argument presented.
46	<p>Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.</p> <ul style="list-style-type: none"> • Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information, using strategies such as definition, classification, comparison/contrast, and cause/ effect; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension. • Develop the topic with relevant facts, definitions, concrete details, quotations, or other information and examples. • Use appropriate transitions to create cohesion and clarify the relationships among ideas and concepts. Use precise language and domain-specific vocabulary to inform about or explain the topic. • Establish and maintain a formal style. • Provide a concluding statement or section that follows from and supports the information or explanation presented.
47	<p>Write narratives to develop real or imagined experiences or events using effective technique, relevant descriptive details, and well-structured event sequences.</p> <ul style="list-style-type: none"> • Engage and orient the reader by establishing a context and point of view and introducing a

	<p>narrator and/or characters; organize an event sequence that unfolds naturally and logically.</p> <ul style="list-style-type: none"> • Use narrative techniques, such as dialogue, pacing, and description, to develop experiences, events, and/or characters. • Use a variety of transition words, phrases, and clauses to convey sequence and signal shifts from one time frame or setting to another. • Use precise words and phrases, relevant descriptive details, and sensory language to capture the action and convey experiences and events. • Provide a conclusion that follows from and reflects on the narrated experiences or events
48	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
49	With some guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on how well purpose and audience have been addressed.
50	Use technology, including the Internet, to produce and publish writing and link to and cite sources as well as to interact and collaborate with others, including linking to and citing sources.
51	Conduct short research projects to answer a question, drawing on several sources and generating additional related, focused questions for further research and investigation.
52	Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.
53	Draw evidence from literary or informational texts to support analysis, reflection, and research.
54	Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences
Writing: Literacy and History/Social Studies, Science, and Technical Subjects	
55	<p>Write arguments focused on discipline-specific content.</p> <ul style="list-style-type: none"> • Introduce claim(s) about a topic or issue, acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically. • Support claim(s) with logical reasoning and relevant, accurate data and evidence that demonstrate an understanding of the topic or text, using credible sources. • Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence. Establish and maintain a formal style. e. Provide a concluding statement or section that follows from and supports the argument presented.
56	<p>Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.</p> <ul style="list-style-type: none"> • Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information into broader categories as appropriate to achieving purpose; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension. • Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples. • Use appropriate and varied transitions to create cohesion and clarify the relationships among ideas and concepts. • Use precise language and domain-specific vocabulary to inform about or explain the topic. e. Establish and maintain a formal style and objective tone.
57	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
58	With some guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on how well purpose and

	audience have been addressed.
59	Use technology, including the Internet, to produce and publish writing and present the relationships between information and ideas clearly and efficiently.
60	Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
61	Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.
62	Draw evidence from informational texts to support analysis reflection, and research.
Language	
63	Demonstrate command of the conventions of standard English grammar and usage when writing or speaking. <ul style="list-style-type: none"> • Explain the function of phrases and clauses in general and their function in specific sentences. • Choose among simple, compound, complex, and compound-complex sentences to signal differing relationships among ideas. • Place phrases and clauses within a sentence, recognizing and correcting misplaced and dangling modifiers.
64	Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing. <ul style="list-style-type: none"> • Use a comma to separate coordinate adjectives (e.g., <i>It was a fascinating, enjoyable movie but not He wore an old[,] green shirt</i>). • Spell correctly.
65	Use knowledge of language and its conventions when writing, speaking, reading, or listening. <ul style="list-style-type: none"> • Choose language that expresses ideas precisely and concisely, recognizing and eliminating wordiness and redundancy. *
66	Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grade 7 reading and content, choosing flexibly from a range of strategies. <ul style="list-style-type: none"> • Use context (e.g., the overall meaning of a sentence or paragraph; a word's position or function in a sentence) as a clue to the meaning of a word or phrase. • Use common, grade-appropriate Greek or Latin affixes and roots as clues to the meaning of a word (e.g., <i>belligerent, bellicose, rebel</i>). • Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning or its part of speech. • Verify the preliminary determination of the meaning of a word or phrase (e.g., by checking the inferred meaning in context or in a dictionary).
67	Demonstrate understanding of figurative language, word relationships, and nuances in word meanings. <ul style="list-style-type: none"> • Interpret figures of speech (e.g., literary, biblical, and mythological allusions) in context. • Use the relationship between particular words (e.g., synonym/antonym, analogy) to better understand each of the words. • Distinguish among the connotations (associations) of words with similar denotations (definitions) (e.g., <i>refined, respectful, polite, diplomatic, condescending</i>).
68	Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases; gather vocabulary knowledge when considering a word or phrase important to comprehension or expression.

Ohio Learning Standards Grade 8

CODE	STANDARD
Reading: Literature	
10	Cite the textual evidence that most strongly supports an analysis of what the text says explicitly as well as inferences drawn from the text.
11	Determine a theme or central idea of a text and analyze its development over the course of the text, including its relationship to the characters, setting, and plot; provide an objective summary of the text.
12	Analyze how particular lines of dialogue or incidents in a story or drama propel the action, reveal aspects of a character, or provoke a decision.
13	Determine the meaning of words and phrases as they are used in a text, including figurative and connotative meanings; analyze the impact of specific word choices on meaning and tone, including analogies or allusions to other texts.
14	Compare and contrast the structure of two or more texts and analyze how the differing structure of each text contributes to its meaning and style.
15	Analyze how differences in the points of view of the characters and the audience or reader (e.g., created through the use of dramatic irony) create such effects as suspense or humor.
16	Analyze the extent to which a filmed or live production of a story or drama stays faithful to or departs from the text or script, evaluating the choices made by the director or actors.
17	Analyze how a modern work of fiction draws on themes, patterns of events, or character types from myths, traditional stories, or religious works such as the Bible, including describing how the material is rendered new.
18	
Reading: Informational Text	
19	Cite the textual evidence that most strongly supports an analysis of what the text says explicitly as well as inferences drawn from the text.
20	Determine a central idea of a text and analyze its development over the course of the text, including its relationship to supporting ideas; provide an objective summary of the text.
21	Analyze how a text makes connections among and distinctions between individuals, ideas, or events (e.g., through comparisons, analogies, or categories).
22	Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze the impact of specific word choices on meaning and tone, including analogies or allusions to other texts.
23	Analyze in detail the structure of a specific paragraph in a text, including the role of particular sentences in developing and refining a key concept.
24	Determine an author's point of view or purpose in a text and analyze how the author acknowledges and responds to conflicting evidence or viewpoints.
25	Evaluate the advantages and disadvantages of using different mediums (e.g., print or digital text, video, multimedia) to present a particular topic or idea.
26	Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient; recognize when irrelevant evidence is introduced.
27	Analyze a case in which two or more texts provide conflicting information on the same topic and identify where the texts disagree on matters of fact or interpretation.
28	
Reading: Literacy in History/Social Studies	
29	Cite specific textual evidence to support analysis of primary and secondary sources.
30	Determine the central ideas or information of a primary or secondary source; provide an accurate summary of the source distinct from prior knowledge or opinions.
31	Identify key steps in a text's description of a process related to history/social studies (e.g., how a bill becomes law, how interest rates are raised or lowered).

32	Determine the meaning of words and phrases as they are used in a text, including vocabulary specific to domains related to history/social studies.
33	Describe how a text presents information (e.g., sequentially, comparatively, causally).
34	Identify aspects of a text that reveal an author's point of view or purpose (e.g., loaded language, inclusion or avoidance of particular facts).
35	Integrate visual information (e.g., in charts, graphs, photographs, videos, or maps) with other information in print and digital texts.
36	Distinguish among fact, opinion, and reasoned judgment in a text.
37	Analyze the relationship between a primary and secondary source on the same topic.
Reading: Literacy in Science and Technical Subjects	
38	Cite specific textual evidence to support analysis of science and technical texts.
39	Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.
40	Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
41	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6–8 texts and topics.
42	Analyze the structure an author uses to organize a text, including how the major sections contribute to the whole and to an understanding of the topic.
43	Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).
44	Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.
45	Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.
Writing	
46	Write arguments to support claims with clear reasons and relevant evidence. <ul style="list-style-type: none"> • Introduce claim(s), acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically. • Support claim(s) with logical reasoning and relevant evidence, using accurate, credible sources and demonstrating an understanding of the topic or text. • Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence. • Establish and maintain a formal style. e. Provide a concluding statement or section that follows from and supports the argument presented.
47	Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. <ul style="list-style-type: none"> • Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information into broader categories; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension. • Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples. • Use appropriate and varied transitions to create cohesion and clarify the relationships among ideas and concepts. • Use precise language and domain-specific vocabulary to inform about or explain the topic. • Establish and maintain a formal style. • Provide a concluding statement or section that follows from and supports the information or explanation presented.
48	Write narratives to develop real or imagined experiences or events using effective technique, relevant descriptive details, and well-structured event sequences. <ul style="list-style-type: none"> • Engage and orient the reader by establishing a context and point of view and introducing a narrator and/or characters; organize an event sequence that unfolds naturally and logically.

	<ul style="list-style-type: none"> • Use narrative techniques, such as dialogue, pacing, description, and reflection, to develop experiences, events, and/or characters. • Use a variety of transition words, phrases, and clauses to convey sequence, signal shifts from one time frame or setting to another, and show the relationships among experiences and events. • Use precise words and phrases, relevant descriptive details, and sensory language to capture the action and convey experiences and events. • Provide a conclusion that follows from and reflects on the narrated experiences or events.
49	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
50	With some guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on how well purpose and audience have been addressed.
51	Use technology, including the Internet, to produce and publish writing and present the relationships between information and ideas efficiently as well as to interact and collaborate with others.
52	Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.
53	Draw evidence from literary or informational texts to support analysis, reflection, and research. <ul style="list-style-type: none"> •
54	Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline- specific tasks, purposes, and audiences.
Writing: Literacy and History/Social Studies, Science, and Technical Subjects	
55	Write arguments focused on discipline-specific content. <ul style="list-style-type: none"> • Introduce claim(s) about a topic or issue, acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically. • Support claim(s) with logical reasoning and relevant, accurate data and evidence that demonstrate an understanding of the topic or text, using credible sources. • Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence. Establish and maintain a formal style. e. Provide a concluding statement or section that follows from and supports the argument presented.
56	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
57	With some guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on how well purpose and audience have been addressed.
58	Use technology, including the Internet, to produce and publish writing and present the relationships between information and ideas clearly and efficiently.
59	Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
60	Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.
61	Draw evidence from informational texts to support analysis reflection, and research.
Language	
62	Demonstrate command of the conventions of standard English grammar and usage when writing or speaking. <ul style="list-style-type: none"> • Explain the function of verbals (gerunds, participles, infinitives) in general and their function

	<p>in particular sentences.</p> <ul style="list-style-type: none"> • Form and use verbs in the active and passive voice. • Form and use verbs in the indicative, imperative, interrogative, conditional, and subjunctive mood. • Recognize and correct inappropriate shifts in verb voice and mood.
63	<p>Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.</p> <ul style="list-style-type: none"> • Use punctuation (comma, ellipsis, dash) to indicate a pause or break. • Use an ellipsis to indicate an omission. • Spell correctly.
64	<p>Use knowledge of language and its conventions when writing, speaking, reading, or listening.</p> <ul style="list-style-type: none"> • Use verbs in the active and passive voice and in the conditional and subjunctive mood to achieve particular effects (e.g., emphasizing the actor or the action; expressing uncertainty or describing a state contrary to fact)
65	<p>Determine or clarify the meaning of unknown and multiple-meaning words or phrases based on grade 8 reading and content, choosing flexibly from a range of strategies.</p> <ul style="list-style-type: none"> • Use context (e.g., the overall meaning of a sentence or paragraph; a word's position or function in a sentence) as a clue to the meaning of a word or phrase. • Use common, grade-appropriate Greek or Latin affixes and roots as clues to the meaning of a word (e.g., precede, recede, secede). • Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning or its part of speech. • Verify the preliminary determination of the meaning of a word or phrase (e.g., by checking the inferred meaning in context or in a dictionary).
66	<p>Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.</p> <ul style="list-style-type: none"> • Interpret figures of speech (e.g. verbal irony, puns) in context. • Use the relationship between particular words to better understand each of the words. • Distinguish among the connotations (associations) of words with similar denotations (definitions) (e.g., bullheaded, willful, firm, persistent, resolute).
67	<p>Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases; gather vocabulary knowledge when considering a word or phrase important to comprehension or expression.</p>

Ohio Learning Standards Grades 9-10

CODE	STANDARD
Reading: Literature	
10	Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.
11	Determine a theme or central idea of a text and analyze in detail its development over the course of the text, including how it emerges and is shaped and refined by specific details; provide an objective summary of the text.
12	Analyze how complex characters (e.g., those with multiple or conflicting motivations) develop over the course of a text, interact with other characters, and advance the plot or develop the theme.
13	Determine the meaning of words and phrases as they are used in the text, including figurative and connotative meanings; analyze the cumulative impact of specific word choices on meaning and tone (e.g., how the language evokes a sense of time and place; how it sets a formal or informal tone).
14	Analyze how an author's choices concerning how to structure a text, order events within it (e.g., parallel plots), and manipulate time (e.g., pacing, flashbacks) create such effects as mystery, tension, or surprise.
15	Analyze a particular point of view or cultural experience reflected in a work of literature from outside the United States, drawing on a wide reading of world literature.
16	Analyze the representation of a subject or a key scene in two different artistic mediums, including what is emphasized or absent in each treatment (e.g., Auden's "Musée des Beaux Arts" and Breughel's Landscape with the Fall of Icarus).
17	Analyze how an author draws on and transforms source material in a specific work (e.g., how Shakespeare treats a theme or topic from Ovid or the Bible or how a later author draws on a play by Shakespeare).
Reading: Informational Text	
18	Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.
19	Determine a central idea of a text and analyze its development over the course of the text, including how it emerges and is shaped and refined by specific details; provide an objective summary of the text.
20	Analyze how the author unfolds an analysis or series of ideas or events, including the order in which the points are made, how they are introduced and developed, and the connections that are drawn between them.
21	Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze the cumulative impact of specific word choices on meaning and tone (e.g., how the language of a court opinion differs from that of a newspaper).
22	Analyze in detail how an author's ideas or claims are developed and refined by particular sentences, paragraphs, or larger portions of a text (e.g., a section or chapter).
23	Determine an author's point of view or purpose in a text and analyze how an author uses rhetoric to advance that point of view or purpose.
24	Analyze various accounts of a subject told in different mediums (e.g., a person's life story in both print and multimedia), determining which details are emphasized in each account.
25	Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is valid and the evidence is relevant and sufficient; identify false statements and fallacious reasoning.
26	Analyze seminal U.S. documents of historical and literary significance (e.g., Washington's Farewell Address, the Gettysburg Address, Roosevelt's Four Freedoms speech, King's "Letter from Birmingham Jail"), including how they address related themes and concepts.
Reading: Literacy in History/Social Studies	
27	Cite specific textual evidence to support analysis of primary and secondary sources, attending to such features as the date and origin of the information.

28	Determine the central ideas or information of a primary or secondary source; provide an accurate summary of how key events or ideas develop over the course of the text
29	Analyze in detail a series of events described in a text; determine whether earlier events caused later ones or simply preceded them.
30	Determine the meaning of words and phrases as they are used in a text, including vocabulary describing political, social, or economic aspects of history/social studies
31	Analyze how a text uses structure to emphasize key points or advance an explanation or analysis.
32	Compare the point of view of two or more authors for how they treat the same or similar topics, including which details they include and emphasize in their respective accounts.
33	Integrate quantitative or technical analysis (e.g., charts, research data) with qualitative analysis in print or digital text.
34	Assess the extent to which the reasoning and evidence in a text support the author's claims.
35	Compare and contrast treatments of the same topic in several primary and secondary sources.
Reading: Literacy in Science and Technical Subjects	
36	Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
37	Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
38	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
39	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9–10 texts and topics.
40	Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).
41	Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.
42	Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
43	Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.
44	Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.
Writing	
45	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence. <ul style="list-style-type: none"> • Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among claim(s), counterclaims, reasons, and evidence. • Develop claim(s) and counterclaims fairly, supplying evidence for each while pointing out the strengths and limitations of both in a manner that anticipates the audience's knowledge level and concerns. • Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims. • Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. • Provide a concluding statement or section that follows from and supports the argument presented.
46	Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

	<ul style="list-style-type: none"> • Introduce a topic; organize complex ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. • Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. • Use appropriate and varied transitions to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts. • Use precise language and domain-specific vocabulary to manage the complexity of the topic. • Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. • Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).
47	<p>Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.</p> <ul style="list-style-type: none"> • Engage and orient the reader by setting out a problem, situation, or observation, establishing one or multiple point(s) of view, and introducing a narrator and/or characters; create a smooth progression of experiences or events. • Use narrative techniques, such as dialogue, pacing, description, reflection, and multiple plot lines, to develop experiences, events, and/or characters. • Use a variety of techniques to sequence events so that they build on one another to create a coherent whole. • Use precise words and phrases, telling details, and sensory language to convey a vivid picture of the experiences, events, setting, and/or characters. • Provide a conclusion that follows from and reflects on what is experienced, observed, or resolved over the course of the narrative.
48	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience
49	Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
50	Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.
51	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
52	Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.
53	Draw evidence from literary or informational texts to support analysis, reflection, and research.
54	Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.
Writing: Literacy in History/Social Studies, Science and Technical Subjects	
55	<p>Write arguments focused on discipline-specific content.</p> <ul style="list-style-type: none"> • Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence. • Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and

	<p>concerns.</p> <ul style="list-style-type: none"> • Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims. • Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. • Provide a concluding statement or section that follows from or supports the argument presented.
56	<p>Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.</p> <ul style="list-style-type: none"> • Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. • Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. • Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts. • Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers. • Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. • Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic)
57	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
58	Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
59	Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.
60	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
61	Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.
62	Draw evidence from informational texts to support analysis, reflection, and research.
Language	
63	<p>Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.</p> <ul style="list-style-type: none"> • Use parallel structure. • Use various types of phrases (noun, verb, adjectival, adverbial, participial, prepositional, absolute) and clauses (independent, dependent; noun, relative, adverbial) to convey specific meanings and add variety and interest to writing or presentations.

64	<p>Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.</p> <ul style="list-style-type: none"> • Use a semicolon (and perhaps a conjunctive adverb) to link two or more closely related independent clauses. • Use a colon to introduce a list or quotation. • Spell correctly.
65	<p>Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend more fully when reading or listening.</p> <ul style="list-style-type: none"> • Write and edit work so that it conforms to the guidelines in a style manual (e.g., <i>MLA Handbook</i>, <i>Turabian's Manual for Writers</i>) appropriate for the discipline and writing type.
66	<p>Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 9–10 reading and content, choosing flexibly from a range of strategies.</p> <ul style="list-style-type: none"> • Use context (e.g., the overall meaning of a sentence, paragraph, or text; a word's position or function in a sentence) as a clue to the meaning of a word or phrase. • Identify and correctly use patterns of word changes that indicate different meanings or parts of speech (e.g., analyze, analysis, analytical; advocate, advocacy). • Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning, its part of speech, or its etymology. • Verify the preliminary determination of the meaning of a word or phrase (e.g., by checking the inferred meaning in context or in a dictionary).
67	<p>Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.</p> <ul style="list-style-type: none"> • Interpret figures of speech (e.g., euphemism, oxymoron) in context and analyze their role in the text. • Analyze nuances in the meaning of words with similar denotations.
68	<p>Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.</p>

Appendix F-Science Standards Coding Sheet

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BACK TO K-8 INDEX

Grade 5

INTRODUCTION TO CONTENT STATEMENTS

GRADE BAND THEME: INTERCONNECTIONS WITHIN SYSTEMS

This theme focuses on helping students recognize the components of various systems and then investigate dynamic and sustainable relationships within systems using scientific inquiry.

SCIENCE INQUIRY AND APPLICATION

During the years of grades 5-8, all students must use the following scientific processes, with appropriate **laboratory safety techniques**, to construct their knowledge and understanding in all science content areas:

- Identify questions that can be answered through scientific investigations;
- Design and conduct a **scientific investigation**;
- Use appropriate mathematics, tools and techniques to gather data and information;
- Analyze and interpret data;
- Develop descriptions, models, explanations and predictions;
- Think critically and logically to connect evidence and explanations;
- Recognize and analyze alternative explanations and predictions; and
- Communicate scientific procedures and explanations.

STRANDS

Strand Connections: Cycles on Earth, such as those occurring in ecosystems, in the solar system, and in the movement of light and sound result in describable patterns. Speed is a measurement of movement. Change in speed is related to force and mass*. The transfer of energy drives changes in systems, including ecosystems and physical systems.

EARTH AND SPACE SCIENCE (ESS)

Topic: Cycles and Patterns in the Solar System

This topic focuses on the characteristics, cycles and patterns in the solar system and within the universe.

10. The solar system includes the sun and all celestial bodies that orbit the sun. Each planet in the solar system has unique characteristics.

11. The sun is one of many stars that exist in the universe.

12. Most of the cycles and patterns of motion between the Earth and sun are predictable.

PHYSICAL SCIENCE (PS)

Topic: Light, Sound and Motion

This topic focuses on the forces that affect motion. This includes the relationship between the change in speed of an object, the amount of force applied and the mass* of the object. Light and sound are explored as forms of energy that move in predictable ways, depending on the matter through which they move.

13. The amount of change in movement of an object is based on the mass* of the object and the amount of force exerted.

14. Light and sound are forms of energy that behave in predictable ways.

LIFE SCIENCE (LS)

Topic: Interactions within Ecosystems

This topic focuses on foundational knowledge of the structures and functions of ecosystems.

15. Organisms perform a variety of roles in an ecosystem.

16. All of the processes that take place within organisms require energy.

CONDENSED CONTENT STATEMENTS

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BACK TO K-8 INDEX

Grade 8

INTRODUCTION TO CONTENT STATEMENTS

GRADE BAND THEME: ORDER AND ORGANIZATION

This theme focuses on helping students use scientific inquiry to discover patterns, trends, structures and relationships that may be described by simple principles. These principles are related to the properties or interactions within and between systems.

SCIENCE INQUIRY AND APPLICATION

During the years of grades 5-8, all students must use the following scientific processes, with appropriate **laboratory safety techniques**, to construct their knowledge and understanding in all science content areas:

- Identify questions that can be answered through scientific investigations;
- Design and conduct a **scientific investigation**;
- Use appropriate mathematics, tools and techniques to gather data and information;
- Analyze and interpret data;
- Develop descriptions, models, explanations and predictions;
- Think critically and logically to connect evidence and explanations;
- Recognize and analyze alternative explanations and predictions; and
- Communicate scientific procedures and explanations.

STRANDS

Strand Connections: Systems can be described and understood by analysis of the interaction of their components. Energy, forces and motion combine to change the physical features of the Earth. The changes of the physical Earth and the species that have lived on Earth are found in the rock record. For species to continue, reproduction must be successful.

EARTH AND SPACE SCIENCE (ESS)

Topic: Physical Earth

This topic focuses on the physical features of Earth and how they formed. This includes the interior of Earth, the rock record, plate tectonics and landforms.

- 10.** The composition and properties of Earth's interior are identified by the behavior of seismic waves.
- 11.** Earth's crust consists of major and minor tectonic plates that move relative to each other.
- 12.** A combination of constructive and destructive geologic processes formed Earth's surface.
- 13.** Evidence of the dynamic changes of Earth's surface through time is found in the geologic record.

PHYSICAL SCIENCE (PS)

Topic: Forces and Motion

This topic focuses on forces and motion within, on and around the Earth and within the universe.

- 14.** Forces between objects act when the objects are in direct contact or when they are not touching.
- 15.** Forces have magnitude and direction.
- 16.** There are different types of potential energy.

LIFE SCIENCE (LS)

Topic: Species and Reproduction

This topic focuses on continuation of the species.

- 17.** Diversity of species occurs through gradual processes over many generations. Fossil records provide evidence that changes have occurred in number and types of species.
- 18.** Reproduction is necessary for the continuation of every species.
- 19.** The characteristics of an organism are a result of inherited traits received from parent(s).

CONDENSED CONTENT STATEMENTS

BACK TO INDEX

Biology

SYLLABUS AND MODEL CURRICULUM

COURSE DESCRIPTION

Biology is a high school level course, which satisfies the **Ohio Core** science graduation requirements of **Ohio Revised Code Section 3313.603**. This section of Ohio law requires a three-unit course with inquiry-based laboratory experience that engages students in asking valid scientific questions and gathering and analyzing information.

This course investigates the composition, diversity, complexity and interconnectedness of life on Earth. Fundamental concepts of heredity and evolution provide a framework through inquiry-based instruction to explore the living world, the physical environment and the interactions within and between them.

Students engage in **investigations** to understand and explain the behavior of living things in a variety of scenarios that incorporate scientific reasoning, analysis, communication skills and real-world applications.

SCIENCE INQUIRY AND APPLICATION

During the years of grades 9 through 12, all students must use the following scientific processes with appropriate **laboratory safety techniques** to construct their knowledge and understanding in all science content areas:

- Identify questions and concepts that guide scientific investigations;
- Design and conduct **scientific investigations**;
- Use technology and mathematics to improve investigations and communications;
- Formulate and revise explanations and models using logic and evidence (critical thinking);
- Recognize and analyze explanations and models; and
- Communicate and support a scientific argument.

COURSE CONTENT

The following information may be taught in any order; there is no ODE-recommended sequence.

HEREDITY

- 10.* Cellular genetics
- 11.* Structure and function of DNA in cells
- 12.* Genetic mechanisms and inheritance
- 13.* Mutations
- 14.* Modern genetics

EVOLUTION

- 15.* Mechanisms
 - Natural selection
 - Mutation
 - Genetic drift
 - Gene flow (immigration, emigration)
 - Sexual selection
 - History of life on Earth
- 16.* Diversity of Life
 - Speciation and biological classification based on molecular evidence
 - Variation of organisms within a species due to population genetics and gene frequency

DIVERSITY AND INTERDEPENDENCE OF LIFE

- 17.* Classification systems are frameworks created by scientists for describing the vast diversity of organisms indicating the degree of relatedness between organisms.

18.

- Ecosystems
- Homeostasis
- Carrying capacity
- Equilibrium and disequilibrium

CELLS

19. Cell structure and function

- Structure, function and interrelatedness of cell organelles
- Eukaryotic cells and prokaryotic cells

20. Cellular processes

- Characteristics of life regulated by cellular processes o Photosynthesis, chemosynthesis, cellular respiration o Cell division and differentiation

Appendix G-Science Cognitive Demand Classification

Ohio's Cognitive Demands for Science

As with all other frameworks and cognitive demand systems, Ohio's revised system has overlap between the categories. Recalling Accurate Science is a part of the other three cognitive demands included in Ohio's framework because science knowledge is required for students to demonstrate scientific literacy.

These definitional paragraphs are used to describe the cognitive demand and are the prerequisite conditions that must be met before secondary conditions are considered.

Cognitive Demand	Description
Designing Technological/ Engineering Solutions Using Science Concepts (T)	Requires students to solve science-based engineering or technological problems through application of scientific inquiry. Within given scientific constraints, propose or critique solutions, analyze and interpret technological and engineering problems, use science principles to anticipate effects of technological or engineering design, find solutions using science and engineering or technology, consider consequences and alternatives and/or integrate and synthesize scientific information.
Demonstrating Science Knowledge (D)	Requires students to use scientific inquiry and develop the ability to think and act in ways associated with inquiry, including asking questions, planning and conducting investigations, using appropriate tools and techniques to gather and organize data, thinking critically and logically about relationships between evidence and explanations, constructing and analyzing alternative explanations, and communicating scientific arguments. (Slightly altered from National Science Education Standards) Note: Procedural knowledge (knowing how) is included in Recalling/Identifying Accurate Science.
Interpreting and Communicating Science Concepts (C)	Requires students to use subject-specific conceptual knowledge to interpret and explain events, phenomena, concepts and experiences using grade-appropriate scientific terminology, technological knowledge and mathematical knowledge. Communicate with clarity, focus and organization using rich, investigative scenarios, real-world data and valid scientific information.
Recalling Accurate Science (R)	Requires students to provide accurate statements about scientifically valid facts, concepts and relationships. Recall only requires students to provide a rote response, declarative knowledge or perform routine mathematical task. This cognitive demand refers to students' knowledge of science fact, information, concepts, tools, procedures and basic principles.