A Review of the Oklahoma January 2016 English Language Arts and Mathematics Academic Standards

March 18, 2016
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Introduction

This report provides a review of Oklahoma’s January 2016 Academic Standards for English language arts (ELA) and mathematics. Achieve has enjoyed a long-standing relationship with Oklahoma. Through the state’s participation in the American Diploma Project Network, Achieve supported Oklahoma’s efforts to raise high school graduation requirements and develop the 2007 Priority Academic Student Skills (PASS) standards, which were, at that time, among the best in the United States.

In this review, Achieve compared the January 2016 final version of Oklahoma’s newly developed Academic Standards to the Common Core State Standards (CCSS). Achieve used the CCSS as the base of comparison because they are the K-12 expectations in English and mathematics in over 40 states. In addition, an important element of House Bill 3399, signed into law by Governor Mary Fallin in June 2014, requires that the new standards prepare students for college, careers, and citizenship and directs the Oklahoma State Board of Education to compare the proposed English language arts (ELA) and mathematics standards with the previous standards that were adopted by the Board of Education, which is the CCSS. Achieve’s review includes a comprehensive side-by-side chart to facilitate an easier comparison.

We have evaluated the standards using criteria and procedures that Achieve has developed, refined, and used to evaluate academic standards for more than 25 states over the past 15 years. Achieve has used similar methods for comparing standards in 15 countries. These six criteria are rigor, focus, coherence, specificity, clarity/accessibility, and measurability.

As described in detail in this report, in both content areas the standards fail to serve students, teachers or parents well. They are more akin to early state standards in that they cover a lot of content, but with very little depth; a phenomena sometimes referred to as “a mile wide and an inch deep” in standards language. The ELA standards will likely cause confusion for Oklahoma’s teachers because they aren’t sufficiently clear, specific, and/or consistent enough to guide their teaching. In addition, the standards will fail to adequately prepare Oklahoma students for postsecondary success because they don’t insist that they read texts of sufficient complexity, nor consistently or adequately call on them to make arguments drawn on evidence in the texts. In addition, they don’t require kids to read texts from a rich variety literary genre and informational texts in a range of academic disciplines. Consequently, they will not help students develop the broad and deep knowledge base, nor the increasingly sophisticated skills, necessary for postsecondary success. In mathematics, there are several critical concepts missing at every level so that students will have gaps in their math knowledge. Moreover, the standards do not provide an adequate foundation in the early grades to ensure Oklahoma students are prepared to study advanced math in high school. In addition there are inconsistencies, interruptions, and dead ends in conceptual progressions both within and across the grade levels, making it impossible for both students and teachers to make the necessary connections between concepts. In short, as summarized below and in the attached report and accompanying side by sides, the proposed standards lack the attributes of high quality K-12 standards.

With respect to rigor, the Oklahoma standards in ELA do not expect students to read texts of appropriate grade-level complexity. The standards do not clearly and consistently expect students to draw evidence from text. They merge literary and informational reading, so the result is a set of broad standards that fail to emphasize the skills needed to comprehend and analyze specific literary genres or content-rich informational text. In mathematics, the Oklahoma standards have a much stronger emphasis on doing than on understanding – they insist students learn the procedural steps in solving
math problems, but do not ensure they develop a strong conceptual understanding of the mathematics, which is necessarily to build the solid foundation for mastering more advanced mathematics in subsequent grades. The analysis illustrates there are numerous high school mathematics standards that are included in the CCSS but do not appear in the Oklahoma standards. This may disadvantage Oklahoma graduates in college and careers as they compete with their counterparts from other states.

Oklahoma’s standards reflect a commitment to a few of the key priorities in college- and career-ready research, including some strong requirements (e.g., around research, academic vocabulary, independent reading, multimodal literacies). However, there are many more examples where critical content is missing—in both ELA and mathematics-raising concerns about focus.

There are also a number of concerns with regards to coherence. Oklahoma’s ELA standards divide reading process from critical reading but the division is puzzling. In addition, many ELA standards repeat grade to grade or shift ever so slightly that overall they lack meaningful progression, and therefore do not strengthen students reading skills each year. Similarly, there are several concerns about the development of specific mathematics topics in the Oklahoma standards; in some places, ideas simply do not progress from one grade to the next, and as a result, many students will experience significant gaps in their understanding of the math.

The specificity of the Oklahoma standards is inconsistent across content areas and grades. With respect to the ELA standards, many standards are overly broad and leave too much to interpretation, increasing the likelihood that students will be held accountable to different levels of performance. Educators could deliver a low-level, non-college- and career-ready version of curriculum and still be in alignment.

With respect to clarity/accessibility, there is some good news: the format and presentation of the Oklahoma standards is attractive, easy to navigate, and accessible to the general public. The standards are written largely in a user-friendly, informal style of language so that all users, even those who do not consider themselves experts in literacy or mathematics, can understand them. However there are a number of instances where the standards are inaccurate, ambiguous, or garbled.

Since the expectations and objectives of the Oklahoma standards in mathematics are generally very procedural, it follows that they are written using language that generally lends itself to being measurable, observable, or verifiable. However, the broad nature of many of the ELA standards poses real challenges to determining how well students meet the standards.

Implementing these standards will require Oklahoma to develop supplemental materials to clarify confusing standards and communicate expectations. Oklahoma educators and instructional leaders will need guidance and a strategy for instructional materials and assessments, as well as access to professional learning opportunities. It’s important to note that efforts in recent years to curate, develop, review and/or select instructional materials and assessments will have been a waste of time and money as these standards will require new materials.

Achieve has a long history of reviewing state standards and is familiar with the current standards in most states; given our history in helping states, including Oklahoma, develop quality standards it is discouraging to see Oklahoma moving backwards instead of forward. The standards fall short on nearly all of Achieve’s criteria for quality standards because they are too broad or inappropriately focused to effectively guide instruction that is appropriately rigorous across the grade levels. Worst of all, these
standards will disadvantage Oklahoma students compared to their peers in other states; students in Oklahoma will be less prepared to successfully enter college and careers.

We hope the constructive feedback provided in this report will support Oklahoma’s policymakers, educators and instructional leaders and parents provide students in Oklahoma the best chance of being prepared for college and careers.
Review of Oklahoma’s English Language Arts Academic Standards Using Achieve’s Criteria for Evaluating College- and Career-Ready Standards

The purpose of Achieve’s standards review is to assist states in developing high-quality college- and career-ready standards in English language arts (ELA) and literacy that prepare students for success in credit-bearing college courses and quality, high-growth jobs. When evaluating standards, Achieve has historically used a set of six criteria: rigor, focus, coherence, specificity, clarity/accessibility, and measurability.

Rigor

Rigor is the quintessential hallmark of exemplary standards. It is the measure of how closely a set of standards represents the content and cognitive demand necessary for students to succeed in credit-bearing college courses without remediation and in quality, entry-level high-growth jobs. To reflect the research that identifies what students need to be well prepared for college and careers, standards need to focus on (a) access to text complexity and academic vocabulary, (b) drawing evidence from texts to support claims and conclusions, and (c) content-rich nonfiction.

The following are the results of analyzing Oklahoma’s standards against these measures:

While the state does define grade-level complexity in terms of Lexile ranges in supplemental materials, the Oklahoma standards lack specificity with regard to a staircase of complexity levels of texts within the standards. Moreover, the ranges as defined by Oklahoma (in the supplemental materials) will not prepare students for the demands of college- and career-level reading by graduation.

The research in ACT’s 2006 report Reading Between the Lines: What the ACT Reveals about College Readiness in Reading showed that “the clearest differentiator in reading between students who are college-ready and students who are not is the ability to comprehend complex texts.” This is a crucial feature of college- and career-ready standards, and any standards that do not explicitly target this need lack a critical element.

The Common Core State Standards (CCSS) describe a variety of quantitative levels and qualitative factors that define text complexity and include Appendix A: Research Supporting Key Elements of the Standards in which text complexity is defined by grade band. In addition, the CCSS offer Appendix B that includes text complexity exemplars for all grades and most genres. In addition, the standards themselves include specific requirements regarding the kinds of grade-level appropriate texts that students should read and have access to, including plays by Shakespeare and an American dramatist as well as seminal U.S. documents of historical and literary significance (e.g., The Declaration of Independence, the Bill of Rights). The CCSS don’t just specify specific texts as examples, they also include suggestions for the range and quality of texts by suggesting an array of text types for K–5 and 6–12 and specifying that these

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come from a broad range of cultures, genres, and periods. These lists such as the following one help to ensure that ELA teachers expand their reading lists beyond the traditional repertoire of well-loved novels: www.corestandards.org/ELA-Literacy/standard-10-range-quality-complexity/range-of-text-types-for-612/

The Oklahoma standards, on the other hand, do not include individual objectives in which the expectation is for reading texts of appropriate grade-level complexity (similar to the CCSS statements, RL #10 and RI #10 at each grade level). Instead, the expectation that students will read increasingly complex texts is offered in the overarching Standard 2: Reading and Writing Process strand description which states: “Students will read and comprehend increasingly complex literary and informational texts.” If students are held accountable to the expectations within the standards statements themselves (not necessarily to the expectations described within the supplemental text to the standards), as is typically the case in standards-based assessment systems, text complexity will not necessarily be an expectation for student performance and thus, not a focus of classroom instruction and learning.

Oklahoma does include references to grade-level texts in some standards statements. For example, in grades 1 through 4 for fluency: “Students will orally read grade-level text at an appropriate rate, smoothly and accurately, with expression that connotes comprehension.” (1.2.F.2, 2.2.F.2, 3.2.F.2, 4.2.F.2)

Some of the Oklahoma reading expectations also specify that students will read and interpret grade-level texts. For example: “Students will evaluate how the point of view and perspective affect grade-level literary and/or informational text.” (6.3.R.2, 7.3.R.2)

But other reading standards refer to “texts” without specifying that these are grade-level texts: “Students will evaluate literary devices to support interpretations of literary texts.” (5.3.R.4, 6.3.R.4, 7.3.R.4, 8.3.R.4)

By embedding the expectation for “grade-level” texts within some standards but not consistently within all, the state creates some confusion. (When not specified, is the expectation not necessarily for grade-level texts?) The CCSS approach of including a separate statement dedicated to appropriate text complexity ensures that teachers and students are held accountable to working with texts at an appropriate level of complexity to prepare students for college and careers.

The Oklahoma standards do offer additional guidance to educators and students regarding selecting works of appropriate complexity levels in two supplemental sections entitled “Text Complexity Bands” (page 90) and “College- and Career-Readiness Reading Range” (page 91). As the table on the next page shows, however, the ranges set by Oklahoma are woefully low—many of them around or even below the old Lexile ranges that were not tied college- and career-readiness expectations. The Lexile ranges as defined by Oklahoma will not ensure that all students become college- and career-ready readers. As the
Achieve Standards Review (March 2016)

The table shows, the Oklahoma ranges are much lower than the levels defined by the CCSS that are anchored to research on the demands of college- and career-level reading.²

<table>
<thead>
<tr>
<th>Grade</th>
<th>Oklahoma Lexile Ranges</th>
<th>Old Lexile Ranges NOT Tied to College- and Career-Ready Expectations</th>
<th>CCSS Lexile Ranges Tied to College- and Career-Ready Expectations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Up to 300</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>2</td>
<td>140–500</td>
<td>450–725</td>
<td>420–820</td>
</tr>
<tr>
<td>3</td>
<td>330–700</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>4</td>
<td>445–810</td>
<td>645–845</td>
<td>740–1010</td>
</tr>
<tr>
<td>5</td>
<td>565–910</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>6</td>
<td>665–1000</td>
<td>860–1010</td>
<td>925–1185</td>
</tr>
<tr>
<td>7</td>
<td>735–1065</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>8</td>
<td>805–1100</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>9</td>
<td>855–1165</td>
<td>960–1115</td>
<td>1050–1335</td>
</tr>
<tr>
<td>10</td>
<td>905–1195</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>11 and 12</td>
<td>940–1210</td>
<td>1070–1220</td>
<td>1185–1385</td>
</tr>
</tbody>
</table>

Oklahoma does not include any further supports, i.e., the standards include no reading list; no parenthetical examples of texts; no standards that specify certain texts, such as reading foundational American literary works or Shakespeare plays. In particular, the Oklahoma standards do not include seminal U.S. documents—texts that in particular will help to ensure that students are ready to participate in public discourse and civic life.

**The Oklahoma standards dedicate a strand to vocabulary that includes critical content that relates to the acquisition of academic vocabulary.**

Closely related to text complexity—and inextricably connected to reading comprehension by nearly a century of research—is the need for a focus on building students’ academic vocabulary, words that appear in texts in a variety of content areas. The Oklahoma standards dedicate a strand to vocabulary,

www.corestandards.org/assets/E0813_Appendix_A_New_Research_on_Text_Complexity.pdf
signaling its importance. They address the connotation and denotation of words, along with roots and affixes, and determining the meaning of words in context. The standards also include building knowledge of academic vocabulary—and the application of this vocabulary knowledge by using the words when writing and speaking.

The Oklahoma standards focus on vocabulary acquisition and effective approaches for that acquisition (context, morphology, use of resources, making connections between known words, and so on). It is worth noting that the standards do this to the exclusion of considering words as they are used in varied ways, such as to offer rhythm or rhyme in poetry, to appropriately address readers and listeners with the use of formal language, and so on. With its inclusion of standards such as those embedded within the reading and language strands, the CCSS do a more comprehensive job of reflecting that the goal with vocabulary acquisition is not only to acquire a wide and deep body of known words, but also to be able to analyze words thoughtfully and use words purposefully. For example:

CCSS.RL.1.4 Identify words and phrases in stories or poems that suggest feelings or appeal to the senses.

CCSS.RL.2.4 Determine how words and phrases (e.g., regular beats, alliteration, rhymes, repeated lines) supply rhythm and meaning in a story, poem, or song.


The Oklahoma standards provide some grounding in drawing evidence from texts, but its inclusion is haphazard—included in some reading and writing standards and not in others.

Surveys of employers and college faculty cite the ability to extract details from texts and draw accurate conclusions in writing using evidence as key to success in college and the workplace. As the ability to find and use evidence to support claims is a hallmark of strong readers and writers, college- and career-ready standards call on students to answer text-dependent questions that demonstrate their ability to closely read a text. This measure places a premium on students not only explicitly finding what is stated, but also making valid claims that square with the evidence when writing to sources.

Identifying relevant textual evidence while reading is included in specific Oklahoma reading standards, but it is not always included in the same standards across the grade levels. In a word, inclusion of drawing textual evidence from texts is haphazard in the Oklahoma standards. For example, textual evidence (or using text to support answers) is typically included in standards dedicated to the structure of texts, comparison of texts, and writing informative and argumentative texts. As one would expect, standards in the research strand also require students to integrate evidence. On the other hand,

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standards dedicated to determining an author’s purpose and point of view do not mention textual evidence. Moreover, textual evidence appears only sometimes in standards dedicated to literary elements or devices. By grade 8, there is an additional standard that asks students to evaluate textual evidence to determine whether a claim is substantiated or unsubstantiated, and by grade 10, students are asked to distinguish among different kinds of textual evidence. These standards ask students to make inferences about textual evidence rather than make inferences supported by textual evidence.

Contrasting this approach to the CCSS approach shows the impact of this haphazard approach. In the CCSS, both the literary text reading and the informational text reading strands open with the expectation that students will identify and reference textual evidence, standard RL #1 and RI #1 across grade levels. This through-line approach ensures that readers of the standards immediately recognize the importance of text-dependent work and textual evidence.

*The Oklahoma standards merge literary and informational reading and, as a result, do not place adequate emphasis on reading specific literary genres or content-rich informational text in ELA classes.*

Most of the required reading in college and workforce training programs is informational in structure and challenging in content. Part of the motivation to supporting the interdisciplinary approach to literacy is the extensive research establishing the need for college- and career-ready students to be proficient in reading and learning from complex informational text independently in a variety of content areas. Fulfilling this mandate requires that ELA teachers also place greater attention on a specific category of informational text—literary nonfiction—than has been traditional in many classrooms. The elementary years are key for students to grow their knowledge about the world. Research shows that the connection between informational text, content knowledge, and reading comprehension is crucial but that the dominance of narrative and fictional text in the elementary curriculum has lessened the growth of knowledge necessary to build students’ reading comprehension skills.⁴

Unlike the CCSS that include one set of standards for literature and another for informational texts, Oklahoma’s Standard 2 (“Reading and Writing Process”) and Standard 3 (“Critical Reading and Writing”) merge literary and informational reading. Oklahoma includes a discussion of genre in the supplemental materials, but the state does not include specific standards or parenthetical references within standards such as those included in the CCSS that pertain to reading poetry, drama, narratives, fables, folk tales, texts from other cultures, arguments and other informational texts, etc. In many cases this leads Oklahoma to adopt generic wording rather than genre-specific standards. This results in several shortcomings. First, it might be difficult for teachers to identify an appropriate balance between teaching literature versus informational texts or arguments. Second, combining literary and informational text expectations into a single set of standards often results in standards being so broad that teachers could deliver a low-level, non-college- and career-readiness version of curriculum and still be in alignment. Third, because the state has taken out the majority of the language included in CCSS’

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specific references to and parenthetical examples of poetry, drama, American literature, literature from other cultures, and so on, this content may not be part of what is taught or measured. In contrast to Oklahoma’s standards, within the standards themselves, as mentioned earlier, the CCSS include specific requirements regarding the kinds of grade-level appropriate texts that students should read and have access to, including plays by Shakespeare and an American dramatist as well as seminal U.S. documents of historical and literary significance and foundational works of American literature. Being able to read content-rich complex texts across a range of text types is a strong predictor of college- and career-readiness and prepares students for a wide variety of reading challenges. Reading seminal U.S. documents in particular will help to ensure that students are ready to participate fully in public discourse and civic life.

There is further confusion caused by how Oklahoma has written its standards. There are times that the standards are clearly focused on one genre of text or another, even though they should be applied to both literary and informational texts. In other cases, they are written with genre-specific language, but they are meant to be applied to both informational and literary text.

In the following example, Oklahoma specifies that this expectation is with literary texts only (underlining added by reviewer for emphasis), suggesting that authors of informational texts would not use figurative language (often used in literary nonfiction, such as a memoir or a political speech), hyperbole (often used in arguments), or tone (important across all text genres).

6.3.R.4 Students will evaluate literary devices to support interpretations of literary texts:

- Simile
- Metaphor
- Personification
- Onomatopoeia
- Hyperbole
- Imagery
- Symbolism
- Tone

In the next example, part of the standard suggests informational text only (not literary); the main idea would rarely be stated so that students could “locate” it in a literary text. If students were to write a summary for a novel, they might summarize by plot, setting, or character. Will they have met the standard? On the other hand, another part of the standard (“logical sequence of events”) suggests literary rather than informational text. If students write a summary for an informational text, there may not be a “logical sequence of events”; the text may be organized as compare/contrast, problem/solution, etc. The same is true when students are summarizing an argument with claims and supporting reasons and evidence, not chronological events. Again, will students have met the standard?

5.2.R.1 Students will create an objective summary, including main idea and supporting details, while maintaining meaning and a logical sequence of events.
Similarly, the standard on text structure is written in such a way as to apply only to informational texts, neglecting the importance that structure plays in fictional texts, in which the author might play with alternating points of view, flashback or foreshadow, a story within a story structure, and so on.

5.3.R.6 Students will distinguish the structures of texts (e.g., description, compare/contrast, sequential, problem/solution, cause/effect) and content by making inferences about texts and use textual evidence to support understanding.

The Oklahoma standards include clear requirements around conducting research.

Research requires the ability to frame, analyze, and solve problems while building on the ideas and contributions of others. As future college students or employees, students will be asked to hone these essential skills with increasing sophistication. Requiring several short research projects during students’ K–12 careers enables students to repeat the research process many times in a year so they are able to develop the expertise needed to conduct research independently. A progression of shorter research projects also encourages students to develop expertise in one area by confronting and analyzing different aspects of the same topic.

Oklahoma dedicates a separate standard to research (Standard 6: Research), indicating its importance to the field. The standards ask students to develop questions, find information about a specific topic, evaluate sources for relevancy, integrate findings, and cite sources appropriately. These are important elements in an effective research process and product. The Oklahoma standards do mention writing research papers (and other types of writing) over extended and shorter timeframes, thus making the point that a progression of shorter research projects is a critical expectation.

Oklahoma does not include standards that define literacy across different content areas in this set of standards, though the state has indicated to Achieve that they have addressed literacy within other content areas, such as social studies.

The Oklahoma ELA standards do not address the need for all content areas to address the issue of literacy skills in instruction. This is crucial because disciplines such as science and history depend on reading and writing too; strong literacy skills are essential to success across content areas, not only in ELA classes. The CCSS include an entirely separate set of disciplinary specific standards—“Literacy in History/Social Studies, Science, and Technical Subjects”—for grades 6–12. Reading and writing standards are addressed differently in the various content areas; they respond to the unique needs of the discipline and the texts associated with them. For students to become truly competent readers, writers, and thinkers and be fully prepared for the rigor of college and careers, standards should include clear expectations for reading (and writing) that extend beyond the ELA classroom. Importantly, the state has indicated that they have embedded literacy expectations into content-area standards, such as science and social studies. Referencing this within the ELA standards themselves would reassure ELA teachers that the development of content-area literacy is not the sole responsibility of these teachers and would highlight the importance of literacy development in other content areas.
Focus

When Achieve considers the focus of a set of standards, reviewers ask themselves the question of whether the state has made appropriate choices about what is most important for students to learn. Do the state’s standards appropriately prioritize the concepts and skills students need to be college- and career-ready by the end of grade 12? Are the priorities consistent with the CCSS, which are used as a benchmark for college- and career-readiness standards? Are the standards manageable—or do they include so much content as to be unwieldy?

Oklahoma’s standards reflect a commitment to some of the key priorities in the college- and career-ready research. However, critical content is missing.

Oklahoma should be recognized for a strong focus on the writing process (from foundational writing in the early elementary years to process writing at the secondary level); the research process; acquisition of academic vocabulary; and the development of multimodal literacies. All of these elements are important for college and career readiness.

However, the state has neglected to focus on other key performances and content important for high-quality, college- and career-preparatory instruction. Missed opportunities on focusing on grade-appropriate complex texts, drawing evidence from texts, and content-area literacy have been discussed earlier in this report. Some other examples that are at a finer grain size, but are still important performances and content, include:

- Adapting speech as appropriate to varied contexts and tasks, such as using informal or formal English (for examples, see CCSS SL #6 across grade levels);
- Attending to style and tone in writing (for example, see CCSS.L.5.3 Expand, combine, and reduce sentences for meaning, reader/listener interest, and style.);
- Coming to group discussions prepared and continuing conversations through multiple exchanges (see CCSS SL #1 across grade levels);
- Analyzing language not just for meaning but also for rhetorical impact and style (such as in this early elementary example, CCSS.RL.1.4 Identify words and phrases in stories or poems that suggest feelings or appeal to the senses.);
- Focusing closely on the connections between a series of events and ideas and the relationships between sentences and paragraphs within a text in order to build knowledge (for examples, see CCSS RI #3 and #4 across grade levels); and
- Tracing the reasons and evidence an author gives so students are able to break down arguments and understand the structure of claims, warrants, and evidence (for examples, see CCSS RI #8 across grade levels).

The Oklahoma standards highlight some important skills that provide good foundations for students headed for college and good careers. These skills are not as fully developed in the CCSS.

Following are Oklahoma standards that are not developed or not as fully developed in the CCSS:
• **Prekindergarten Expectations:** The inclusion of prekindergarten expectations by Oklahoma highlights the importance of early childhood education. The CCSS include standards from kindergarten through grade 12 and do not include prekindergarten expectations.

• **Foundational Writing:** While the CCSS focus on foundational reading, foundational writing is less well developed. Oklahoma more explicitly describes elements of early writing foundations—producing complete sentences, correctly forming letters in print and in cursive, and appropriately spacing between words and sentences.

• **Reading Independently:** While the CCSS point to the importance of independent reading by embedding that skill in the context of text-complexity expectations, Oklahoma includes a standalone standard that explicitly calls for sustained independent reading. Independent reading is another important aspect of learning to read. Students develop stamina, efficacy, and persistence through reading on their own a volume of texts that engage them. Independent reading also is when students rapidly expand their vocabularies and knowledge bases through contextualized exposure to lots of words and ideas, and when students can learn the sheer pleasure of becoming lost in the printed world of ideas.

**Coherence**

The way in which a state’s college- and career-ready standards are categorized and broken out into supporting strands should reflect a coherent structure of the discipline. The structure of the standards ought to reveal significant relationships among the strands and how the study of one complements the study of another. In addition, the progression of standards should be meaningful and appropriate across the grades.

The following are the results of analyzing Oklahoma’s standards against this criterion:

*The Oklahoma standards include areas that have been traditionally underrepresented in the ELA curriculum.*

The Oklahoma standards present a broad vision of ELA that include important knowledge and skills, not only in such traditional areas of language, writing, and literature, but also in the areas of reading and writing with informational texts and digital media and speaking and listening. These areas are critical for preparing students for postsecondary success and have been traditionally underrepresented in the ELA curriculum.

*The strands within Oklahoma’s standards connect to one another to create an integrated model of ELA.*

The Oklahoma standards arrange the expected ELA content and performance into eight overarching standards, each of which addresses both reading and writing (and listening and speaking, as relevant):
Standard 1: Speaking and Listening
Standard 2: Reading Foundations/Reading and Writing Process
Standard 3: Critical Reading and Writing
Standard 4: Vocabulary
Standard 5: Language
Standard 6: Research
Standard 7: Multimodal Literacies
Standard 8: Independent Reading and Writing

The different strands are meant to function as interdependent units that form a coherent whole when translated into instruction. It is helpful in a set of standards to reveal significant relationships among the strands, suggesting how the study of one complements the study of another. While the Oklahoma structure sometimes leads to awkward repetition or separation of skills (such as the emphasis in grammar on identification rather than use), the structure of Oklahoma’s standards does a nice job of showing the strong connections between reading and writing in Standards 2–8. (It could be somewhat confusing to standards’ users that reading and writing serve as subheads to the speaking and listening standards, however.) Standards are challenging in that they present separate statements but are often describing activities that are much more closely interrelated than they appear when presented as a list of isolated standards. Oklahoma’s standards visually display some of those connections, particularly between the receptive and productive processes of listening and speaking and reading and writing.

The division of Oklahoma’s reading standards into process standards and critical standards is confusing.

Oklahoma divides reading process from critical reading. This could suggest that multiple readings are needed for deep comprehension of texts (first read for what the text says; then read again for how the text says what it means). Standard 2: Reading Foundations/Reading and Writing Process and Standard 3: Critical Reading and Writing run consecutively, which is helpful. There are times, however, when it is unclear what the decision rules are for putting content in one set of standards or the other. For instance, finding the main idea and analyzing details to evaluate patterns of genres are included in reading process standards though these actions certainly require critical thinking skills. Likewise, under Standard 3: Critical Reading and Writing are objectives that state the expectation that students will ask and answer questions about texts. These objectives could logically fit under Standard 2: Reading and Writing Process.

Many Oklahoma standards objectives are repeated grade to grade so overall the standards lack meaningful progression.

Progression is always a fundamental challenge in ELA standards. Students use many of the same reading and writing skills and strategies across all grade levels (such as identifying main idea and supporting details, identifying theme, analyzing point of view or text structure, writing to inform and explain, etc.),
but educators expect increasing sophistication and flexibility in the use and application of these skills, including reading increasingly challenging texts.

There is not a lot of research available to describe the ideal sequence or progression of how students should be taught and gain individual skills in ELA/literacy. There is, however, substantial research about the importance of reading texts and tasks growing in rigor as students advance through school in order to meet the increasing reading demands students will face in college and on the job.\textsuperscript{5}

Moreover, the 2015 Frequently Asked Questions on the new Oklahoma standards emphasize that the standards should demonstrate vertical alignment from one grade level to the next to ensure appropriate placement.\textsuperscript{6} The progression of standards should be meaningful and appropriate across the grades, yet they are not in this final draft. Often the demands in grades 4 and 5, grades 6 and 7, grades 8 and 9, and grades 10–12 are precisely the same.

Sometimes the progression is difficult to assess because of the verbiage. For example:

Grades 6–7: 6.3.R.1 and 7.3.R.1 Students will compare and contrast stated or implied purposes of authors writing on the same topic in grade-level literary and/or informational texts.

Grades 8–9: 8.3.R.1 and 9.3.R.1 Students will analyze works written on the same topic and compare the methods the authors use to achieve similar or different purposes and include support using textual evidence.

In grades 6–7 could students just say that the purpose for a literary text was to entertain while the purpose for an informational text was to inform, but in grades 8–9 are students expected to analyze within the text how authors achieve their purposes? This is a big jump in cognitive demand.

Other times, language shifts but the significance of the progression is not entirely clear. For example:

5.2.R.1-7.2.R.1 (Grades 5 through 7) Students will create an objective summary, including main idea and supporting details, while maintaining meaning and a logical sequence of events.
8.2.R.1 Students will summarize and paraphrase ideas, while maintaining meaning and a logical sequence of events, within and between texts.
9.2.R.1 Students will summarize, paraphrase, and generalize ideas, while maintaining meaning and a logical sequence of events, within and between texts.


\textsuperscript{6} http://ok.gov/sde/sites/ok.gov.sde/files/6-30-15%20ELAOAS%20FAQs.pdf
10.2.R.1-12.2.R.1 (Grades 10 through 12) Students will summarize, paraphrase, and synthesize ideas, while maintaining meaning and a logical sequence of events, within and between texts.

In these examples, students move from summarizing, to summarizing and paraphrasing, to also generalizing, to synthesizing—but always with a “logical sequence of events” (which suggests a specific type of text, as many texts neither include a chronological sequence nor describe a series of events).

Sometimes the progression shifts so slightly, the differences are hard to explain and understand (differences from previous standard are underlined):

2.2.R.2 Students will begin to compare and contrast details (e.g., plots or events, settings, and characters) to discriminate genres.
3.2.R.2 Students will compare and contrast details (e.g., plots or events, settings, and characters) to discriminate genres.
4.2.R.2 Students will compare and contrast details in literary and nonfiction/informational texts to discriminate various genres.
5.2.R.2 Students will compare and contrast details in literary and nonfiction/informational texts to distinguish genres.
6.2.R.2 Students will analyze details in literary and nonfiction/informational texts to distinguish genres.
7.2.R.2 Students will analyze details in literary and nonfiction/informational texts to distinguish genres.
8.2.R.2 Students will analyze details in literary and nonfiction/informational texts to evaluate patterns of genres.
9.2.R.2 Students will analyze details in literary and nonfiction/informational texts to evaluate patterns of genres.
10.2.R.2 Students will analyze details in literary and nonfiction/informational texts to connect how genre supports the author’s purpose.
11.2.R.2 Students will evaluate details in literary and non-fiction/informational texts to connect how genre supports the author’s purpose.
12.2.R.2 Students will evaluate details in literary and non-fiction/informational texts to connect how genre supports the author’s purpose.

Sometimes no progression is shown, such as in this example:

5.2.W.1-12.2.W.1 (Grades 5 through 12) Students will apply components of a recursive writing process for multiple purposes to create a focused, organized, and coherent piece of writing.

As stated, expectations need to show increasing rigor and sophistication across grade levels so that, whatever they are reading, students show a steadily growing ability to discern more from and make fuller use of text. This includes making an increasing number of connections among ideas and between
texts; considering a wider range of textual evidence; and becoming more sensitive to inconsistencies, ambiguities, and poor reasoning in texts.

**Specificity**

Quality standards are precise and provide sufficient detail to convey the level of performance expected without being overly prescriptive. Those that are overly broad leave too much open to interpretation, while those that are too atomistic encourage a checklist approach to teaching. Both approaches undermine students’ overall understanding of the discipline, whereas standards that maintain a relatively consistent level of precision (“grain size”) are easier to understand and use.

The following are the results of analyzing Oklahoma’s standards against this criterion:

*In many cases, the Oklahoma expectations are broader and less precise than the CCSS.*

Oklahoma includes many standard objectives that are overly broad or vague, leaving too much open to interpretation and increasing the likelihood that students will be held accountable to different levels of performance or that teachers and assessment developers will lack adequate direction. This is an important issue because a primary goal of academic standards is equity. By defining expectations clearly, the state hopes to standardize learning opportunities across schools and districts so that all students reach high levels of content knowledge and performance. Here is an example where Oklahoma is overly simplified compared to a CCSS standard and loses important concepts:

<table>
<thead>
<tr>
<th>CCSS</th>
<th>Simplified OK Standard</th>
<th>Reflection</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCSS.RI.8.8 Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient and identifying when irrelevant evidence is introduced.</td>
<td>8.3.R.5 Students will evaluate textual evidence to determine whether a claim is substantiated or unsubstantiated.</td>
<td>The CCSS wording asks students to assess the reasoning (is it sound?) and evidence (is it relevant?) and identify when irrelevant evidence is introduced. The CCSS statement suggests that students will encounter strong models of arguments. The OK expectation suggests that students could look at a text and simply determine that “yes” the author has supported a claim.</td>
</tr>
</tbody>
</table>

Below is a small sample of Oklahoma standard objectives that are too broad and lack rigor, and as a result, could lead to different expectations for students. Examples from the CCSS that are most closely connected to the Oklahoma statements are included for comparison.

<table>
<thead>
<tr>
<th>Oklahoma Standards</th>
<th>CCSS</th>
</tr>
</thead>
</table>
| 9.3.R.3 Students will analyze how authors use key literary elements to contribute to meaning and interpret how themes are connected across texts:  
  - Setting  
  - Plot  
  - Characters (e.g., protagonist, antagonist) | CCSS.RL.9-10.3 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. |
<table>
<thead>
<tr>
<th><strong>Character development</strong></th>
<th><strong>Theme...</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>10.3.R.3</strong> Students will analyze how authors use key literary elements to contribute to meaning and interpret how themes are connected across texts:</td>
<td><strong>CCSS.RL.9-10.2</strong> 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.</td>
</tr>
<tr>
<td>• Character development</td>
<td></td>
</tr>
<tr>
<td>• Theme</td>
<td></td>
</tr>
<tr>
<td>• Conflict (i.e., internal and external)</td>
<td></td>
</tr>
<tr>
<td>• Archetypes</td>
<td></td>
</tr>
</tbody>
</table>

| **9.3.R.6, 10.3.R.6** Students will comparatively analyze the structures of texts (e.g., compare/contrast, problem/solution, cause/effect, claims/counterclaims/evidence) and content by inferring connections among multiple texts and providing textual evidence to support their inferences | **CCSS.RI.9-10.3** 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. |

| **9.3.R.3** Students will analyze how authors use key literary elements to contribute to meaning and interpret how themes are connected across texts: | **CCSS.RL.9-10.9** 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). |
| • ... | |
| • Archetypes | |

| **10.3.R.3** Students will analyze how authors use key literary elements to contribute to meaning and interpret how themes are connected across texts: | **CCSS.RL.9-10.4** 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). |
| • Character development | |
| • Theme | |
| • Conflict (i.e., internal and external) | |
| • Archetypes | |

| **9.3.R.4** Students will evaluate literary devices to support interpretations of texts, including comparisons across texts: | **CCSS.RL.9-10.4** |
| • Simile | |
| • Metaphor | |
| • ... | |
| • Tone | |

| **10.3.R.4** Students will evaluate literary devices to support interpretations of texts, including comparisons across texts: | |
| • Figurative language... | |
| • Tone... | |

| **9.4.R.4, 10.4.R.4** Students will analyze the relationships among words with multiple meanings and recognize the connotation and denotation of words. | |

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11.3.R.1, 12.3.R.1 Students will analyze the extent to which historical, cultural, and/or global perspectives affect authors’ stylistic and organizational choices in grade-level literary and informational genres.

CCSS.RL.11-12.9 Analyze seventeenth-, eighteenth-, and nineteenth-century foundational U.S. documents of historical and literary significance (including The Declaration of Independence, the Preamble to the Constitution, the Bill of Rights, and Lincoln’s Second Inaugural Address) for their themes, purposes, and rhetorical features.

CCSS.RL.11-12.9 Demonstrate knowledge of eighteenth-, nineteenth- and early-twentieth-century foundational works of American literature, including how two or more texts from the same period treat similar themes or topics.

10.3.W.1 Students will write narratives embedded in other modes as appropriate.

CCSS.W.9-10.3 Write narratives to develop real or imagined experiences or events using effective techniques, well-chosen details, and well-structured event sequences.

   a. 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.

   b. Use narrative techniques, such as dialogue, pacing, description, reflection, and multiple plot lines, to develop experiences, events, and/or characters.

   c. Use a variety of techniques to sequence events so that they build on one another to create a coherent whole.

   d. Use precise words and phrases, telling details, and sensory language to convey a vivid picture of the experiences, events, setting, and/or characters.

   e. Provide a conclusion that follows from and reflects on what is experienced, observed, or resolved over the course of the narrative.

Clarity/Accessibility

To be effective, standards must be largely written in clear, jargon-free language, thereby communicating expectations in prose that can gain widespread acceptance not only by postsecondary faculty but also by educators, parents, school administrators, school boards, legislators, and others who have a stake in schooling.

The following are the results of analyzing Oklahoma’s standards against this criterion:

**Offering the Oklahoma standards in two formats—grade by grade and through a vertical grade progression—would be helpful to teachers as they plan instruction.**

Offering two formats for the standards, i.e., grade by grade and a vertical progression, would be helpful to teachers. In its current form, teachers see at a glance what their students should have learned in the
previous grade and what they are preparing students for in subsequent grades. It would be helpful to also present the Oklahoma standards for each grade level. Importantly, that would allow teachers to have in one place all of the demands they need to teach the grade to which they are assigned.

The standards include a user-friendly and consistent numbering system to allow users of the document to connect each statement with a unique number, for the purposes of quick referencing and showing linkages between grade levels.

**Measurability**

A critical component of any college- and career-ready set of standards—and one called for by the Oklahoma legislation—is the ability to measure or assess students’ progress toward meeting the standards.

The following are the results of analyzing Oklahoma’s standards against this criterion:

*The Oklahoma standards focus on results rather than processes, however the broad, general statements that Oklahoma includes pose real measurability challenges.*

In general, standards should focus on the results, rather than the processes of teaching and learning. The Oklahoma standards do just that: they present student outcomes that focus on results rather than the processes of teaching and learning. The standard objectives also make use of performance verbs that call for students to demonstrate knowledge and skills, rather than those that refer to learning activities (such as *examine* and *explore*) or cognitive processes (such as *know* or *appreciate*).

Also important is that standards avoid a focus on internal teaching/learning processes (such as activating schema to make neural connections between prior knowledge and new knowledge). The Oklahoma standards avoid focusing on internal strategies students might use in service of comprehension and instead focus on actions that students can perform to demonstrate comprehension.

As discussed previously, however, many of the broad statements that Oklahoma includes pose measurability challenges because such generally stated, encompassing expectations make it challenging to understand exactly and specifically what students should know and be able to do. When statements are open to such varied interpretation, users will come to their own interpretations—which can result in a mismatch between teaching, learning, and assessment. To ensure alignment between standards, instruction, and assessment, precision is essential.

The purpose of Achieve’s standards review is to assist states in developing high-quality college- and career-ready standards in mathematics that prepare students for success in credit-bearing college courses and quality, high-growth jobs. When evaluating standards, Achieve has historically used a set of six criteria: rigor, focus, coherence, specificity, clarity/accessibility, and measurability. This report provides a review of the January 2016 final version of the OAS.\(^7\)

Key Findings

Using a side-by-side perspective, looking at comparable grain sizes of the two sets of standards, it is clear that the OAS are significantly different from the CCSS. Our review indicates:

1. **Overall, the OAS fall far short of the expectation to prepare all students for college and careers, particularly at the high school level.**

The Vision and Guiding Principles in the OAS introduction establish an objective of high expectations to support college and career readiness for all students—the standards are intended for all, not some. This is an ambitious goal that should be met and sustained in the standards. Unfortunately, the OAS falls short of the goal by neglecting the rigorous, coherent, and focused expectations needed to graduate students college and career ready.

The Oklahoma mathematics standards and objectives begin in prekindergarten and end with Algebra II, with the intention that all students will be exposed to all standards. However, students who aspire to study or work in mathematics-related fields will need the opportunity to be exposed to standards beyond the level of rigor established in the OAS. For example, most advanced mathematics builds on a foundational understanding of functions, which describe relationships between quantities and phenomena. However the average rate of change of nonlinear functions is missing from the OAS. Without this concept, Oklahoma students will struggle to develop a full understanding of functions in high school.

2. **The OAS need more emphasis on the development of concepts.**

The greatest goal of high-quality standards is to define clearly what students need to know and be able to do. The OAS focus strongly on the latter and weakly on the former. Across the grades, there needs to be more support for educators and students to provide the foundational understandings necessary to ensure that students can think about, in addition to doing, the mathematics. The OAS should include objectives that use verbs, such as “understand,” “interpret,” “distinguish between,” and “explain,” related to the procedures that students are expected to know how to do.

3. **The OAS contain several unclear progressions across the grade levels and courses.**

There are coherence issues in several of the conceptual progressions when those progressions are considered across multiple grades. Progressions illustrate ways that mathematical ideas build and

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connect. Some progressions that need attention in the OAS include concepts of currency, multiplication, volume, angles, and central measures. (These and other examples are outlined in detail in the Coherence section of this report.)

When progressions become confused, so do students. When students are unable to make connections between concepts, learning is reduced to a set of discrete skills that have little to do with each other. From a student’s perspective, this translates into the assumption that, with every lesson, chapter, or unit, they are learning a new concept, which makes it unlikely that they will be able to internalize, generalize, or apply their learning to new situations.

4. The objectives in the OAS too often lack clarity.

There are times when the OAS lack mathematical precision or make mathematical mistakes. Many examples of these are described in the Clarity/Accessibility section of this report. Detailed descriptions of the issues related to each standard may be found in the tables accompanying this review.

5. While there are areas of content overlap, there are significant differences between the OAS and the CCSS.

The Oklahoma standards are a set of learning goals that are unique to Oklahoma. This is partly due to the many inconsistencies between the CCSS and OAS for grade-level alignment. As such, it will be difficult for educators to adapt existing textbooks, assessments, or online resources, which are the result of efforts in recent years to curate, develop, select, and procure instructional materials and assessments aligned to the state’s previous standards.

Introduction

The Oklahoma document provides standards and objectives for PK–7, Pre-Algebra, Algebra I, Geometry, and Algebra II, with Algebra I as the prerequisite for both Geometry and Algebra II. Since prekindergarten standards are not included in the CCSS, for the purposes of this review only the Oklahoma standards for K–12 are used. The standards and objectives are organized around four content strands: number and operations, algebraic reasoning and algebra, geometry and measurement, and data and probability. The strands roughly correspond with the K–8 domains and the high school conceptual categories of the CCSS. The table below shows how the two sets of standards are organized similarly.

<table>
<thead>
<tr>
<th>CCSS K–8 Domains</th>
<th>CCSS High School Conceptual Categories</th>
<th>OAS K–12 Strands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Counting and Cardinality</td>
<td>Number and Quantity</td>
<td>Number and Operations</td>
</tr>
<tr>
<td>Number and Operations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ratios and Proportional</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The document also includes seven process standards that are laid out in the introduction to the standards (pages 6–7) and listed at the top of each set of grade level and course standards. These “are defined as the Mathematical Actions and Processes and are comprised of the skills and abilities students should develop and be engaged in developing throughout their PK–12 mathematics education.” The process standards are the following:

- Develop a Deep and Flexible Conceptual Understanding
- Develop Accurate and Appropriate Procedural Fluency
- Develop Strategies for Problem Solving
- Develop Mathematical Reasoning
- Develop a Productive Mathematical Disposition
- Develop the Ability to Make Conjectures, Model, and Generalize
- Develop the Ability to Communicate Mathematically

These “actions and processes” are similar and partially aligned to the CCSS Standards for Mathematical Practice and are intended for all grade levels. More details about this alignment are provided in the Focus section of this report.

Established in the introduction to the OAS for mathematics are four guiding principles:

- Guiding Principle 1: Excellence in mathematics education requires equity-high expectations and strong support for all students.

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• Guiding Principle 2: Mathematical ideas should be explored in ways that stimulate curiosity, create enjoyment of mathematics, and develop depth of understanding.
• Guiding Principle 3: An effective mathematics program focuses on problem solving.
• Guiding Principle 4: Technology is essential in teaching and learning mathematics.

These principles form the basis for the OAS vision that “all students in Oklahoma will become mathematically proficient and literate through a strong mathematics program that emphasizes and engages them in problem solving, communicating, reasoning and proof, making connections, and using representations.” These are noble goals and indicate a desire for excellence in mathematics education.

Accompanying this report is a side-by-side chart that provides the full K–12 alignment analysis and commentary. The side-by-side chart uses the CCSS as the organizing structure in the left column. While the OAS provide both standards and objectives, it is the objectives that are intended to serve the same purpose as the CCSS. As such, this analysis aims to match CCSS to OAS objectives. Each Oklahoma objective is used in the side-by-side chart at least once in the column directly to the right of the CCSS. When multiple OAS objectives are needed for a full alignment to a particular CCSS, the cells are merged to indicate their grouping. Color-coding and underlining helps users of this analysis navigate the report quickly and efficiently:

• **Alignment gaps**, indicated by an empty cell in either the CCSS or the OAS columns, are highlighted in bright yellow for an easy visual reference. In high school, gaps with CCSS that are designated with (+), for students expecting to continue to advanced mathematics, are highlighted in a lighter yellow.
• When an OAS objective, or group of objectives, **partially, but not wholly, meets** the expectations of a CCSS, the cell with the OAS objective is highlighted in grey. In addition the word(s) that particularly relate to the alignment in either the CCSS or the OAS are underlined.
• Within the text of either or both of the CCSS and the OAS, the **specific word or phrase indicating a partial gap** can be identified in red.
• Commentary on the partial or weak alignments is found in the third column and is also in red to connect to that particular part of the text.
• If there are **words or phrases that are unclear or incorrect** in an OAS objective, they can be identified in blue.
• Commentary on clarity issues can be found in the third column of the side-by-side chart and is in blue to connect to that particular part of the text. (Note: In some cases there are clarity issues with an entire objective, and blue is not used in the objective itself.)
• In some cases an OAS objective **from earlier or later grades** provides the best alignment with a particular CCSS. In those cases, the cells are highlighted in shades of green to indicate OAS that are addressed earlier than in the CCSS or in shades of pink for those OAS that are addressed later than in the CCSS.
• **Varying shades of green** (for OAS that are addressed earlier than in the CCSS) and **pink** (for OAS that are addressed later than in the CCSS) indicate the number of years. The palest color of shading indicates one year of difference, the second level of shading indicates two years of difference, and the darkest indicates more than two years of difference.
Rigor

Rigor refers to the intellectual demand of the standards. It is the measure of how closely a set of standards represents the content and cognitive demand necessary for students to succeed in credit-bearing college courses without remediation and in entry-level, quality, and high-growth jobs. Rigorous standards should reflect, with appropriate balance, conceptual understanding, procedural skill and fluency, and applications. For Achieve’s purposes, the CCSS represent the appropriate threshold of rigor.

Overall, the OAS address all three of the aspects of rigor, although not with the same balance evident in the CCSS. While the balance between the three aspects of rigor remains fairly consistent across the grade spans in the CCSS, this is not the case for the OAS. As such, while the CCSS “define what students should understand and be able to do in the study of mathematics,”9 the OAS indicate a much stronger emphasis on doing than on understanding. With that emphasis, Achieve found that the OAS are heavy to procedural and light on conceptual standards. Achieve found the OAS to be very similar to the CCSS in their emphasis on application of mathematics. In fact nearly all of the application standards in the CCSS have counterparts in the OAS.

Sometimes standards address multiple components of rigor. For example, consider this grade 3 CCSS, which has no OAS counterpart:

3.NF.2 Understand a fraction as a number on the number line; represent fractions on a number line diagram.

The first part of the standard addresses the conceptual understanding of fraction as a number that can be represented as a position on the number line. The second part is more procedural in the expectation that students will locate fractions on a number line. In this case, the primary purpose of the standard comes first, which is often the case in a compound standard. Another indication that this standard is primarily conceptual is that it comes early in the student’s building of their understanding of fractions. For this reason the primary purpose of 3.NF.2 is considered to be conceptual understanding. If this same type of standard were placed a year or two later in the fractions progression, it might be considered primarily procedural.

A large portion of the OAS is primarily procedural in nature. In many cases a conceptual understanding CCSS that requires explaining a concept is changed to applying the procedure related to the concept. In other cases CCSS that require explaining, describing, understanding, recognizing, or knowing have no OAS match.

The table below shows CCSS, by grade level, that are primarily conceptual and that have no match in the OAS:

<table>
<thead>
<tr>
<th>Examples of Conceptual Standards in the CCSS without a Match in the OAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>K.CC.4b Understand that the last number name said tells the number of objects counted. The number of objects is the same regardless of their arrangement or the order in which they were counted.</td>
</tr>
<tr>
<td>K.CC.4c Understand that each successive number name refers to a quantity that is one larger.</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>K.G.3</th>
<th>Identify shapes as two-dimensional (lying in a plane, “flat”) or three-dimensional (“solid”).</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.OA.5</td>
<td>Relate counting to addition and subtraction (e.g., by counting on 2 to add 2).</td>
</tr>
<tr>
<td>2.NBT.9</td>
<td>Explain why addition and subtraction strategies work, using place value and the properties of operations.</td>
</tr>
<tr>
<td>3.NF.2</td>
<td>Understand a fraction as a number on the number line; represent fractions on a number line diagram.</td>
</tr>
<tr>
<td>4.OA.1</td>
<td>Interpret a multiplication equation as a comparison, e.g., interpret 35 = 5 x 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.</td>
</tr>
<tr>
<td>4.NBT.1</td>
<td>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. For example, recognize that 700 ÷ 70 = 10 by applying concepts of place value and division.</td>
</tr>
<tr>
<td>4.NF.1</td>
<td>Explain why a fraction a/b is equivalent to a fraction (n × a)/(n × 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 equivalent fractions.</td>
</tr>
<tr>
<td>4.NF.3a</td>
<td>Understand addition and subtraction of fractions as joining and separating parts referring to the same whole.</td>
</tr>
<tr>
<td>4.NF.3</td>
<td>Understand a fraction a/b with a &gt; 1 as a sum of fractions 1/b.</td>
</tr>
<tr>
<td>4.NF.4a</td>
<td>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 × (1/4), recording the conclusion by the equation 5/4 = 5 × (1/4).</td>
</tr>
<tr>
<td>4.NF.4b</td>
<td>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 × (2/5) as 6 × (1/5), recognizing this product as 6/5. (In general, n × (a/b) = (n × a)/b.)</td>
</tr>
<tr>
<td>4.MD.7</td>
<td>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 angle measure.</td>
</tr>
<tr>
<td>5.NBT.2</td>
<td>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.</td>
</tr>
<tr>
<td>5.NF.3</td>
<td>Interpret a fraction as division of the numerator by the denominator (a/b = a ÷ 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. 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?</td>
</tr>
</tbody>
</table>
5.NF.4a 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 \(a \times q \div b\). 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, \((a/b) \times (c/d) = ac/bd\).)

5.NF.5 Interpret multiplication as scaling (resizing), by:

a. Comparing 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.

b. Explaining 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 \(a/b = (nxa)/(nxb)\) to the effect of multiplying \(a/b\) by 1

5.G.3 Understand that attributes belonging to a category of two-dimensional figures also belong to all subcategories of that category. For example, all rectangles have four right angles and squares are rectangles, so all squares have four right angles.

6.NS.7b Write, interpret, and explain statements of order for rational numbers in real-world contexts. For example, write \(−3\) degrees C > \(−7\) degrees C to express the fact that \(−3\) degrees C is warmer than \(−7\) degrees C.

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. 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.

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.

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 with a single number.

7.NS.2a 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.

7.NS.2b 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 describing real-world contexts.

7.EE.2 Understand that rewriting an expression in different forms in a problem context can shed light on the problem and how the quantities in it are related. For example, \(a + 0.05a = 1.05a\) means that “increase by 5%” is the same as “multiply by 1.05.”

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 through the origin and the equation \(y = mx + b\) for a line intercepting the vertical axis at \(b\).

8.EE.8a 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.

8.F.2 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). 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.

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. 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 chores?

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. For example, we define $5^{1/3}$ to be the cube root of 5 because we want $(5^{1/3})^3 = 5^{1(1/3)}$ to hold, so $(5^{1/3})^3$ must equal 5.

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 Define appropriate quantities for the purpose of descriptive modeling.

N.Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

A.SSE.1 Interpret expressions that represent a quantity in terms of its context.

A.SSE.1a Interpret parts of an expression, such as terms, factors, and coefficients.

A.SSE.1b 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.APR.4 Prove polynomial identities and use them to describe numerical relationships. For example, the polynomial identity $(x^2 + y^2)^2 = (x^2 - y^2)^2 + (2xy)^2$ can be used to generate Pythagorean triples.

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. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.

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.

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.

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).

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.

F.IF.8b 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. (cluster C: 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). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

**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.

**F.LE.5** Interpret the parameters in a linear or exponential function in terms of a context.

**F.TF.1** Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.

**F.TF.2** Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.

**G.CO.4** Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.

**G.CO.10** Prove theorems about triangles. 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.

**G.SRT.4** Prove theorems about triangles. 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.

**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.

**G.C.1** Prove that all circles are similar.

**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.GMD.1** Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. *Use dissection arguments, Cavalieri’s principle, and informal limit arguments*.

**S.IC.1** Understand statistics as a process for making inferences about population parameters based on a random sample from that population.

**S.IC.3** Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.

**S.IC.4** Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.

**S.IC.5** Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.

**S.ID.6b** Informally assess the fit of a function by plotting and analyzing residuals.

**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.IC.3** Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.
**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.5** Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. *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.*

It is clear that conceptual understanding standards are missing in the OAS in all K–8 grade levels and all high school conceptual categories. However it is clear from the table above that the problem is more pronounced in some grade levels/conceptual categories than others, where the emphasis throughout is primarily procedural.

Additionally, an OAS objective will sometimes align to part of a particular CCSS, matching the procedural component while de-emphasizing the conceptual aspect. The following table shows examples of OAS that are partial matches with the CCSS but with gaps in conceptual understanding:
<table>
<thead>
<tr>
<th>CCSS</th>
<th>OAS</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
<td>6.A.3.1 Represent real-world or mathematical situations using expressions, equations and inequalities involving variables and rational numbers.</td>
<td>This OAS matches the procedural part of this CCSS but misses out on the conceptual foundation of understanding the meaning and purpose of a variable.</td>
</tr>
<tr>
<td>6.RP.3d Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities.</td>
<td>6.GM.3.2 Solve problems in various real-world and mathematical contexts that require the conversion of weights, capacities, geometric measurements, and time within the same measurement systems using appropriate units.</td>
<td>The OAS does not specify that “problems involving conversion” are limited to converting measurement units. Here the CCSS expects students to extend ratio reasoning to make conversions. That is not the expectation in OAS.</td>
</tr>
<tr>
<td>7.NS.2 Apply and extend previous understandings of multiplication and division and of fractions to multiply and divide rational numbers.</td>
<td>7.N.2.3 Solve real-world and mathematical problems involving addition, subtraction, multiplication and division of rational numbers; use efficient and generalizable procedures including but not limited to standard algorithms.</td>
<td>The OAS doesn’t specify working from previous understandings. Too often, understandings of multiplication and division are separated from procedures in this work.</td>
</tr>
<tr>
<td>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 expansion repeats eventually, and convert a decimal expansion which repeats eventually into a rational number.</td>
<td>7.N.1.1 Know that every rational number can be written as the ratio of two integers or as a terminating or repeating decimal.</td>
<td>This grade 7 OAS indicates knowing about repeating decimals but doesn’t expect students to show anything.</td>
</tr>
<tr>
<td>A.SSE.4</td>
<td>Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems. <em>For example, calculate mortgage payments.</em></td>
<td>A2.A.1.7</td>
</tr>
<tr>
<td>---------</td>
<td>-------------------------------------------------------------------------------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>A.APR.1</td>
<td>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.</td>
<td>A1.A.3.2</td>
</tr>
<tr>
<td></td>
<td>A2.A.2.2 Add, subtract, multiply, divide, and simplify polynomial and rational expressions.</td>
<td>A1.A.3.6</td>
</tr>
<tr>
<td>A1.A.3.5</td>
<td>Recognize that arithmetic sequences are linear using equations, tables, graphs, and verbal descriptions. Use the pattern, find the next term.</td>
<td>A1.A.3.2</td>
</tr>
<tr>
<td>F.IF.3</td>
<td>Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by $f(0) = f(1) = 1, f(n+1) = f(n) + f(n-1)$ for $n \neq 1$.</td>
<td>G.CO.8</td>
</tr>
<tr>
<td></td>
<td>G2D.1.8 Construct logical arguments to prove triangle congruence (SSS, SAS, ASA, AAS and HL) and triangle similarity (AA, SSS, SAS).</td>
<td>G.CO.8</td>
</tr>
<tr>
<td></td>
<td>G.CO.8</td>
<td>Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.</td>
</tr>
</tbody>
</table>

While there is a dramatic difference in the expectations of conceptual objectives in the OAS in comparison to the CCSS, there are OAS topics that are not found in the CCSS. For example the OAS

Achieve Standards Review (March 2016)
expect grade 1 students to be able to “subitize” up to 20 objects and place a greater emphasis on estimation. The following sample list shows a strong leaning to procedures and often pushes for increased work with patterns and money. The full set of differences, along with commentary, may be found in the alignment charts accompanying this report.

### Examples of Standards in the OAS That Have No Match in the CCSS

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>K.N.1.4</td>
<td>Recognize without counting (subitize) the quantity of a small group of objects in organized and random arrangements up to 10.</td>
</tr>
<tr>
<td>K.N.3.1</td>
<td>Distribute equally a set of objects into at least two smaller equal sets.</td>
</tr>
<tr>
<td>K.A.1.2</td>
<td>Recognize, duplicate, complete, and extend repeating, shrinking and growing patterns involving shape, color, size, objects, sounds, movement, and other contexts.</td>
</tr>
<tr>
<td>K.D.1.2</td>
<td>Use categorical data to create real-object and picture graphs.</td>
</tr>
<tr>
<td>K.N.4.1</td>
<td>Identify pennies, nickels, dimes, and quarters by name.</td>
</tr>
<tr>
<td>K.GM.3.1</td>
<td>Develop an awareness of simple time concepts using words such as yesterday, today, tomorrow, morning, afternoon, and night within his/her daily life</td>
</tr>
<tr>
<td>1.A.1.1</td>
<td>Identify, create, complete, and extend repeating, growing, and shrinking patterns with quantity, numbers, or shapes in a variety of real-world and mathematical contexts.</td>
</tr>
<tr>
<td>1.N.1.1</td>
<td>Recognize numbers to 20 without counting (subitize) the quantity of structured arrangements.</td>
</tr>
<tr>
<td>1.N.4.1</td>
<td>Identifying pennies, nickels, dimes, and quarters by name and value.</td>
</tr>
<tr>
<td>1.N.4.2</td>
<td>Write a number with the cent symbol to describe the value of a coin.</td>
</tr>
<tr>
<td>1.N.4.3</td>
<td>Determine the value of a collection of pennies, nickels, or dimes up to one dollar counting by ones, fives, or tens.</td>
</tr>
<tr>
<td>2.N.2.3</td>
<td>Estimate sums and differences up to 100.</td>
</tr>
<tr>
<td>2.A.1.2</td>
<td>Represent and describe repeating patterns involving shapes in a variety of contexts.</td>
</tr>
<tr>
<td>2.A.1.1</td>
<td>Represent, create, describe, complete, and extend growing and shrinking patterns with quantity and numbers in a variety of real-world and mathematical contexts.</td>
</tr>
<tr>
<td>2.GM.2.3</td>
<td>Explore how varying shapes and styles of containers can have the same capacity.</td>
</tr>
<tr>
<td>2.D.1.1</td>
<td>Explain that the length of a bar in a bar graph or the number of objects in a picture graph represents the number of data points for a given category.</td>
</tr>
<tr>
<td>3.A.1.2</td>
<td>Describe the rule (single operation) for a pattern from an input/output table or function machine involving addition, subtraction, or multiplication.</td>
</tr>
<tr>
<td>3.N.3.1</td>
<td>Read and write fractions with words and symbols.</td>
</tr>
<tr>
<td>3.N.4.2</td>
<td>Select the fewest number of coins for a given amount of money up to one dollar.</td>
</tr>
<tr>
<td>Standard</td>
<td>Description</td>
</tr>
<tr>
<td>----------</td>
<td>-------------</td>
</tr>
<tr>
<td>3.N.4.1</td>
<td>Use addition to determine the value of a collection of coins up to one dollar using the cent symbol and a collection of bills up to twenty dollars.</td>
</tr>
<tr>
<td>3.GM.2.6</td>
<td>Use an analog thermometer to determine temperature to the nearest degree in Fahrenheit and Celsius.</td>
</tr>
<tr>
<td>4.N.1.7</td>
<td>Determine the unknown addend or factor in equivalent and non-equivalent expressions. (e.g., ( 5 + 6 = 4 + \Box ), ( 3 \times 8 &lt; 3 \times \Box ))</td>
</tr>
<tr>
<td>4.D.1.2</td>
<td>Use tables, bar graphs, timelines, and Venn diagrams to display data sets. The data may include benchmark fractions or decimals (( \frac{1}{4}, \frac{1}{3}, \frac{1}{2}, \frac{2}{3}, \frac{3}{4}, 0.25, 0.50, 0.75 )).</td>
</tr>
<tr>
<td>4.D.1.3</td>
<td>Solve one- and two-step problems using data in whole number, decimal, or fraction form in a frequency table and line plot.</td>
</tr>
<tr>
<td>5.GM.3.2</td>
<td>Choose an appropriate instrument and measure the length of an object to the nearest whole centimeter or ( \frac{1}{16} )-inch.</td>
</tr>
<tr>
<td>5.GM.2.3</td>
<td>Find the perimeter of polygons and create arguments for reasonable values for the perimeter of shapes that include curves.</td>
</tr>
<tr>
<td>6.N.1.5</td>
<td>Factor whole numbers and express prime and composite numbers as a product of prime factors with exponents.</td>
</tr>
<tr>
<td>7.A.2.4</td>
<td>Use proportional reasoning to assess the reasonableness of solutions.</td>
</tr>
<tr>
<td>PA.A.2.4</td>
<td>Predict the effect on the graph of a linear function when the slope or y-intercept changes. Use appropriate tools to examine these effects.</td>
</tr>
<tr>
<td>PA.D.1.1</td>
<td>Describe the impact that inserting or deleting a data point has on the mean and the median of a data set. Know how to create data displays using a spreadsheet and use a calculator to examine this impact.</td>
</tr>
<tr>
<td>PA.D.1.2</td>
<td>Explain how outliers affect measures of central tendency.</td>
</tr>
<tr>
<td>G.RL.1.2</td>
<td>Analyze and draw conclusions based on a set of conditions using inductive and deductive reasoning. Recognize the logical relationships between a conditional statement and its inverse, converse, and contrapositive.</td>
</tr>
<tr>
<td>G.RL.1.3</td>
<td>Assess the validity of a logical argument and give counterexamples to disprove a statement.</td>
</tr>
<tr>
<td>G.3D.1.2</td>
<td>Use ratios derived from similar three-dimensional figures to make conjectures, generalize, and to solve for unknown values such as angles, side lengths, perimeter or circumference of a face, area of a face, and volume.</td>
</tr>
<tr>
<td>A2.D.1.3</td>
<td>Based upon a real-world context, recognize whether a discrete or continuous graphical representation is appropriate and then create the graph.</td>
</tr>
</tbody>
</table>

In addition to the standards referenced above, the high school OAS include solving real-world quadratic problems, more emphasis on absolute value equations and inequalities, and clear expectation of solving 3X3 systems. The OAS also have increased specificity in requiring writing roots in “simplest radical form,” rationalizing the denominator when necessary, performing synthetic division, and using set and
interval notation. The OAS also include work with matrices and complex numbers beyond what the CCSS expect for all students. These objectives, as indicated in the accompanying alignment charts, overlap with some of the (+) standards in the CCSS. While there is no objection to including some of the higher-level mathematics concepts in the OAS, this should not happen at the expense of an emphasis on conceptual foundations. It is more important to provide deep understanding of the most critical concepts than to increase the number of concepts addressed in the three OAS high school courses. Some of those higher mathematics concepts could be used in an optional fourth-year high school course.

There are some standards in the high school OAS that exceed the expectations of their CCSS counterparts. For example in the area of complex numbers, the CCSS expect recognizing that \( i^2 = -1 \) and addition, subtraction, and multiplication of complex numbers, while the OAS require finding the value of all powers of \( i \) and includes division of complex numbers. These and other examples of OAS high school standards that exceed the requirements of their CCSS counterparts can be found in the table below. These standards should be identified so that educators can make good decisions about how much emphasis they need to make on these topics.

| Examples of the OAS Exceeding the Requirements of CCSS Standards for All Students |
|---------------------------------|---------------------------------|---------------------------------|
| **CCSS**                        | **OAS**                         | **Comments**                    |
| **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. | **A2.N.1.1** Find the value of \( i^n \) for any whole number \( n \). | This OAS objective goes beyond (but subsumes) this CCSS in that it asks for all powers of \( i \), rather than just \( i^2 \). This is left to teacher discretion in the CCSS in standard N.CN.2. |
| **N.CN.2** Use the relation \( i^2 = -1 \) and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers. | **A2.N.1.2** Simplify, add, subtract, multiply, and divide complex numbers. | Division of complex numbers is not addressed in this CCSS but is addressed in N.CN.3, a (+) standard. |
| **A.APR.3** Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial. | **A2.A.1.4** Solve polynomial equations with real roots using various methods and tools that may include factoring, polynomial division, **synthetic division**, graphing calculators or other appropriate technology. | This OAS includes synthetic division and could go beyond polynomials with suitable factorizations. Using the zeros to construct the graph is not in the OAS. |
| **F.BF.4** Find inverse functions. | **A2.F.2.3** Find and graph the inverse of a function, if it exists, in real-world and mathematical situations. **Know that the domain of a function \( f \) is the range of the inverse function \( f^{-1} \), and the range of the function \( f \) is the domain of the inverse function \( f^{-1} \).** | This Algebra II OAS goes beyond the scope of the CCSS by requiring graphing and knowledge of the domain and range of inverse functions. |
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).

PA.D.1.2 Explain how outliers affect measures of central tendency.

Outliers are addressed in the OAS Gr 8, PA.D.1.2, but this CCSS goes beyond that to interpreting differences in data sets.

S.ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.

S.ID.6c Fit a linear function for a scatter plot that suggests a linear association.

A1.D.1.2 Collect data and use scatterplots to analyze patterns and describe linear relationships between two variables. Using graphing technology, determine regression lines and correlation coefficients; use regression lines to make predictions and correlation coefficients to assess the reliability of those predictions.

A2.D.1.2 Collect data and use scatterplots to analyze patterns and describe linear, exponential or quadratic relationships between two variables. Using graphing technology, determine regression lines and correlation coefficients; use regression equations to make predictions and correlation coefficients to assess the reliability of those predictions.

This Algebra II OAS goes beyond the requirement of the CCSS.

An article seems to be missing here: ("... determine ["a" or" the"] regression equation... ")

Of the 55 (+) CCSS (designated as for students who are interested in careers or studies involving higher mathematics), the OAS include 10. This relatively small number shows an emphasis on high school standards that are appropriate and important for all students. However, in supporting educators with implementing the standards in the classroom, it may be helpful to identify these 10 standards as content that could be deemphasized if time runs short or students are struggling with more critical content.

<table>
<thead>
<tr>
<th>Examples of the CCSS (+) Standards with Full or Partial Alignment to the OAS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CCSS (+)</strong></td>
</tr>
<tr>
<td>N.CN.3 (+) Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.</td>
</tr>
<tr>
<td>N.VM.6 (+) Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network.</td>
</tr>
<tr>
<td><strong>N.VM.7</strong> (+) Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled.</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td><strong>N.VM.8.</strong> (+) Add, subtract, and multiply matrices of appropriate dimensions.</td>
</tr>
<tr>
<td><strong>F.IF.7d</strong> (+) Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.</td>
</tr>
<tr>
<td><strong>F.BF.1c</strong> (+) Compose functions. For example, if T(y) is the temperature in the atmosphere as a function of height, and h(t) is the height of a weather balloon as a function of time, then T(h(t)) is the temperature at the location of the weather balloon as a function of time.</td>
</tr>
<tr>
<td><strong>F.BF.4b</strong> (+) Verify by composition that one function is the inverse of another.</td>
</tr>
<tr>
<td><strong>F.BF.5</strong> (+) Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.</td>
</tr>
<tr>
<td><strong>F.TF.3</strong> (+) Use special triangles to determine geometrically the values of sine, cosine, tangent for π/3, π/4 and π/6, and use the unit circle to express the values of sine, cosine, and tangent for π−x, π+x, and 2π−x in terms of their values for x, where x is any real number.</td>
</tr>
<tr>
<td><strong>S.MD.7</strong> (+) Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).</td>
</tr>
</tbody>
</table>
OAS Mathematical Actions and Processes (The CCSS Standards for Mathematical Practice)

The OAS have a set of seven “action and process” standards and are “comprised of the skills and abilities students should develop and be engaged in throughout their PK–12 mathematics education.” Based on the titles, it might appear as though these would coincide with the eight CCSS Standards for Mathematical Practice. Yet there are several significant ways that these sets of process standards differ. Unlike the CCSS Standards for Mathematical Practice, the OAS does not specifically expect the following:

- Students extend the sense of numbers to quantities and their relationships in problem situations, including decontextualizing and then re-contextualizing a problem situation and considering the quantities as they relate to units.
- Students learn to shift and practice shifting their perspective and seeing complicated situations as composed of several simpler parts and look for general methods and shortcuts based on insights in repeated reasoning.
- Students have a clear understanding and application of an appropriate degree of precision to problems.
- Students apply their mathematical knowledge in real and practical situations that are not presented with scaffolds and that require making and testing assumptions and approximations, as well as creating mathematical models to represent and test their hypotheses, analyze the mathematical relationships, draw conclusions, and reflect on the results in the context of the situation. (Note: More information about modeling with mathematics can be found later in this section.)

Analysis of the connections to the CCSS Standards for Mathematical Practice for the seven OAS process standards is below, followed by the practices that have no match in the OAS.

OAS Process Standards: Develop a Deep and Flexible Conceptual Understanding; Develop Accurate and Appropriate Procedural Fluency

These two OAS actions and process standards represent two components of rigor in the CCSS: conceptual understanding and procedural fluency. When considering the expectations of these two actions and processes together, there is a “strong sense of numbers;” a deep understanding of concepts, operations, and relationships between those numbers; and both mathematical and real-world applications. Similar practices are also addressed in the CCSS through MP.2: “Reason abstractly and quantitatively.” However, MP.2 places the emphasis on “quantities and their relationships in problem situations” rather than “a strong sense of numbers;” it expects student to create a coherent representation of a problem while considering the relationships between those quantities and operations. It also expects consideration of the units involved and the ability to decontextualize when manipulating the symbols and then to re-contextualize when considering the reasonableness of the solution.

In addition, there is a connection between Develop Accurate and Appropriate Procedural Fluency and MP.6: “Attend to precision.” The OAS actions and processes standards address a sophisticated understanding and efficiency with computational procedures, based on a strong sense of numbers. Attending to precision in the CCSS also requires computational and procedural accuracy in its definition but goes beyond procedural accuracy by adding precise use of language and symbols, units of measure,
and scales and labels for axes. The CCSS also address an understanding of the degree of precision appropriate for the context in problem solutions.

OAS Process Standard: Develop Strategies for Problem Solving
This OAS process standard relates most closely to MP.1: “Make sense of problems and persevere in solving them.” Both sets of standards require analysis of complex tasks that are related to real-world or mathematical applications, with an emphasis on entry points for a solution, flexibility in selecting strategies for solving, reasoning about the solution, and using multiple representations. In the CCSS, MP.1 goes beyond this in that it also expects students to monitor their progress and change course if necessary, to consider analogous problems in their plan, to explain correspondences between representations for a problem, to search for regularity or trends, and to strategically use technology to assist them.

OAS Process Standard: Develop Mathematical Reasoning; Develop the Ability to Communicate Mathematically
When taken together these two OAS processes relate most strongly with MP.3: “Construct viable arguments and critique the reasoning of others.” The OAS actions and processes require that students use reasoning strategies to think through problems, develop and present reasoned arguments, make connections to other contexts, learn and use mathematical definitions, and translate and critique the ideas and reasoning of others. The CCSS counterpart shares those same requirements but also expects students to recognize and use previously stated assumptions, results, and counterexamples to construct arguments. Under the CCSS, students are expected to make conjectures and build a logical progression of statements to explore the truth of those conjectures. In addition, in the CCSS, MP.3 specifically addresses reasoning with data, comparing the effectiveness of arguments, taking the context of a problem into account, justifying conclusions and communicating them to others, and responding to the arguments of others. These additional expectations meet the requirements for advanced mathematical studies and careers and support the kind of critical thinking and communication skills that all citizens need to navigate the world.

The OAS action and process standard Develop Mathematical Reasoning also has a connection to MP.1 in the CCSS, “Make sense of problems and persevere in solving them,” in its requirement to explore a variety of problem solving strategies.

OAS Process Standard: Develop a Productive Mathematical Disposition
The primary requirement in this OAS process is to hold the belief that mathematics is “sensible, useful, and worthwhile.” There is no direct match in the CCSS for this. A “mathematical disposition,” while very important to the successful study of mathematics, is neither an action nor a process. This mathematical disposition also includes the intention that students will persevere in their problem solving, similar to MP.1.

OAS Process Standard: Develop the Ability to Make Conjectures, Model, and Generalize
Because the term “model” is used in the title for this OAS action and process standards, the closest connection to the CCSS might be assumed to be MP.4. However, this is not evident in the descriptor. The descriptor actually relates best to MP.7, “Look for and make use of structure,” and MP.8, “Look for and express regularity in repeated reasoning,” in that it expects that students draw conclusions based on patterns and repeated structures. However, MP.7 in the CCSS goes beyond these OAS action and process standards by requiring that students shift their perspective and see complicated things as being
composed of several simpler parts, and MP.8 expects that students are able to look for general methods and shortcuts based on regularity in repeated reasoning and that they maintain oversight of the process while attending to details. While generalization is part of the title for this OAS action and process standards and might appear to strengthen the connection to MP.8 in the CCSS, it is not clearly addressed, described, or defined in the descriptor.

The following CCSS Standards for Mathematical Practice are not addressed by the OAS Actions and Processes:

**CCSS Standard for Mathematical Practice: MP.4: Model with mathematics**

MP.4 is not addressed in the OAS actions and processes. In fact, the term as it is used in the OAS process standard Develop the Ability to Make Conjectures, Model, and Generalize is not in agreement with the description of mathematical modeling in the CCSS. In MP.4, students are expected to apply the mathematics they know to real-world situations and contexts. That is, students should model with mathematics. They must make assumptions and identify important quantities in a problem situation; determine and analyze relationships between the quantities; make approximations to simplify a complicated situation; and create an equation, a graph, a diagram, a table, a flowchart, a formula, and/or a function to visualize the situation. They must analyze the relationships mathematically and draw conclusions and then interpret and reflect on the reasonableness of their results.

**CCSS Standard for Mathematical Practice: MP.5: Use appropriate tools strategically**

While there are multiple references to the use of tools in the Oklahoma content standards and objectives, there is no specific reference to the strategic use of tools in the OAS action and process standards.

While the CCSS practices are just that—practices—the OAS counterparts are classified as Actions and Processes. It is unclear, however, which are actions and which might be processes. It is also unclear how the terms “action” and “process” are being defined and used. There is a significant body of mathematics education research that use these terms. However, it appears the terms are used in a different way in the OAS. Given that the phrase “actions and processes” is used in every standard, it is important to provide educators clear definitions for the terms.

**Coherence**

*Coherence refers to how well a set of standards conveys a unified vision of the discipline, establishing connections among the major areas of study and showing a meaningful progression of content across the grades, grade spans, and courses.*

The CCSS are intentionally designed to connect concepts within and across grade levels. It is clear that the OAS were designed with the same intent. However, there are several concerns about the development of specific topics in the OAS. Sometimes there is lack of coherence in the OAS, where the ideas simply do not progress from one grade to the next. For example, consider the following two standards in which there is essentially no difference between grades 1 and 2:

1. **GM.1.1** Identify trapezoids and hexagons by pointing to the shape when given the name.

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2.GM.1.1 Recognize trapezoids and hexagons.

This happens multiple times in the OAS. For example, there is little difference between grade 6 and grade 7 objectives below:

6.A.3.1 Represent real-world or mathematical situations using expressions, equations and inequalities involving variables and rational numbers.

7.A.3.3 Represent real-world or mathematical situations using equations and inequalities involving variables and rational numbers.

An interesting example is found between grades 4 and 5, where there is perhaps an unintended reverse progression for working with fractions and decimals in which the grade 4 objective seems to exceed grade 5:

4.N.2.5 Represent tenths and hundredths with concrete models, making connections between fractions and decimals.

5.N.2.1 Represent decimal fractions (e.g., 1/10, 1/100) using a variety of models (e.g., 10 by 10 grids, rational number wheel, base-ten blocks, meter stick) and make connections between fractions and decimals.

Another possible unintended reverse progression exists between grade 8 and Algebra I, where representing is removed:

PA.A.2.1 Represent linear functions with tables, verbal descriptions, symbols, and graphs; translate from one representation to another.

A1.F.3.1 Identify and generate equivalent representations of linear equations, graphs, tables, and real-world situations.

The lack of coherence also is evident when prerequisite topics are inverted. Consider this progression where students in a typical traditional mathematics sequence of courses are expected to work with inverse functions the year before they would be introduced:

G.RT.1.3 Use the definition of the trigonometric functions to determine the sine, cosine, and tangent ratio of an acute angle in a right triangle. Apply the inverse trigonometric functions as ratios to find the measure of an acute angle in right triangles.

A2.F.2.3 Find and graph the inverse of a function, if it exists, in real-world and mathematical situations. Know that the domain of a function \( f \) is the range of the inverse function \( f^{-1} \), and the range of the function \( f \) is the domain of the inverse function \( f^{-1} \).

Sometimes issues of coherence are found across multiple years. For example, the OAS seem to make very little progress in the progression for the volume of prisms, particularly from grades 5 through 8:

4.GM.2.3 Using a variety of tools and strategies, develop the concept that the volume of rectangular prisms with whole-number edge lengths can be found by counting the total number of same-sized unit cubes that fill a shape without gaps or overlaps. Use appropriate measurements such as \( \text{cm}^3 \).

5.GM.2.1 Recognize that the volume of rectangular prisms can be determined by the number of cubes (\( n \)) and by the product of the dimensions of the prism \( (a \times b \times c = n) \). Know that rectangular prisms of different dimensions \( (p, q, \text{ and } r) \) can have the same volume if \( a \times b \times c = p \times q \times r = n \).
7.GM.1.2 Using a variety of tools and strategies, develop the concept that the volume of rectangular prisms with rational-valued edge lengths can be found by counting the total number of same-sized unit cubes that fill a shape without gaps or overlaps. Use appropriate measurements such as cm\(^3\).

PA.GM.2.3 Develop and use the formulas \(V = lwh\) and \(V = Bh\) to determine the volume of rectangular prisms. Justify why base area \((B)\) and height \((h)\) are multiplied to find the volume of a rectangular prism. Use appropriate measurements such as cm\(^3\).

Angles
Issues of coherence also are apparent across several years in the progression for angles. Comparing angle measurements appears in the OAS two years before student learn what it means to measure an angle:

2.GM.1.4 Recognize right angles and classify angles as smaller or larger than a right angle.
3.GM.1.3 Classify angles as acute, right, obtuse, and straight.
4.GM.1.1 Identify points, lines, line segments, rays, angles, endpoints, and parallel and perpendicular lines in various contexts.
4.GM.2.1 Measure angles in geometric figures and real-world objects with a protractor or angle ruler.
5.GM.3.1 Measure and compare angles according to size.

According to the OAS glossary, a right angle is “informally an angle whose measure is 90 degrees.” As such, students will need to use language in 2nd grade that they are not expected to understand until 4th grade. Recognizing that angles and angle measures are commonly misunderstood, the CCSS define an angle as a shape in grade 4 and expect students to understand that measuring an angle is measuring an attribute of that shape. The OAS make a mathematical error in 4.GM.2 when the standard refers to the angle itself as a measurable attribute:

4.GM.2 Understand angle, length, and area as measurable attributes of real world and mathematical objects. Use various tools to measure angles, length, area, and volume.

To clarify this issue: an angle is a figure that has a measurable attribute. That attribute is the fraction of the circular arc between the points where the two rays intersect a circle with its center at the endpoint of a ray. This is the point of 4.MD.5a in the CCSS.

Central Tendency
Consider also the progression for central tendency in the OAS. Students continue to see much of the same over a span of four years:

5.D.1.1 Find the measures of central tendency (mean, median, or mode) and range of a set of data. Understand that the mean is a “leveling out” or central balance point of the data.
6.D.1.1 Calculate the mean, median, and mode for a set of real-world data.
6.D.1.2 Explain and justify which measure of central tendency (mean, median, or mode) would provide the most descriptive information for a given set of data.
7.D.1.1 Design simple experiments, collect data and calculate measures of central tendency (mean, median, and mode) and spread (range). Use these quantities to draw conclusions about the data collected and make predictions.
**PA.D.1.1** Describe the impact that inserting or deleting a data point has on the mean and the median of a data set. Know how to create data displays using a spreadsheet and use a calculator to examine this impact.

There seems to be no progress from 5.D.1.1 to 6.D.1.1, while 6.D.1.2 is unclear in its intention, as the “most descriptive information for a given set of data” would be that which best addresses the question that needs to be answered by the data.

**Development of Multiplication**

One of the more substantial differences in progressions is related to the development of multiplication. The CCSS build multiplication from groups of objects in grades 2 and 3 (2.OA.C and 3.OA.1) to multiplication as comparison in grade 4 (4.OA.1) to multiplication as scaling in grade 5 (5.NF.5). The intention is that the work on proportionality, and thus linearity, builds from this foundation. Students who lack powerful ways of thinking about multiplication will encounter problems:

> “In Grades 6 and 7, rate, proportional relationships and linearity build upon this scalar extension of multiplication. Students who engage these concepts with the unextended version of multiplication \((a \text{ groups of } b \text{ things})\) will have prior knowledge that does not support the required mathematical coherences.”

There simply is no similar structure for developing comparison and scaling in the OAS:

**2.N.2.6** Use concrete models and structured arrangements, such as repeated addition, arrays and ten frames to develop understanding of multiplication.

**3.N.2.1** Represent multiplication facts by using a variety of approaches, such as repeated addition, equal-sized groups, arrays, area models, equal jumps on a number line and skip counting.

**Currency**

One of the key differences between the OAS and the CCSS for grades K through 5 is a dramatically increased number of expectations related to using currency. The OAS includes a progression addressing the use of currency that begins in kindergarten and continues through grade 4. However, there are several issues with this progression, including slow progress across the grades and inconsistencies when aligned to the grade-by-grade progression for arithmetic. For an example of a lack of consistency with the arithmetic progression within a grade level, consider the limitation on the grade 1 OAS expectation for numbers: basic addition and related subtraction facts up to 10 (1.N.2.3). And yet in 1.N.4.3 students are to determine the value of a collection of coins (pennies, nickels, or dimes) up to one dollar. This OAS standard is not clear whether combinations of different coins or of the same coins are expected. Even though the OAS for grade 1 includes a requirement to count by 1s, 2s, 5s, and 10s to 100 (1.N.1.4), the expectations of these two standards are different. In counting by 1s, 2s, 5s, and 10s, 1st grade students would not be expected to switch from 1s to 5s and then to 10s in the midst of their counting. For example, if a collection of coins included 7 pennies, 4 dimes, and 3 nickels, how would the student “count” by 1s, 5s, and 10s to get 62 cents? This standard, 1.N.4.3, essentially requires addition to 100, which is not required until grade 2 in the OAS. (Students are expected to add two-digit numbers in OAS 2.N.2.4 and 2.N.2.5). When comparing the OAS with the CCSS, the analysis demonstrates that addition

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to 100 is required in grade 1 (1.NBT.4), but there are no requirements to add with currency until grade 2 (2.MD.8). The only other CCSS that specifically requires working with currency is a grade 4 measurement standard requiring solving problems that involve money or time, distance, liquid volumes, and masses of objects (4.MD.2).

The OAS require representation (read and write) and comparison of decimals in grade 4, but the OAS do not include any decimal operations other than those related to the previously mentioned currency standards. The intention of 4.N.3.1 is not completely clear, but the implication is that either whole dollars up to $20 would be used or an undefined collection of coins. Does “whole dollars” imply one dollar bills? If so, it is trivial to require students to count by 1s to 20, which falls behind the expectation in grade 1 (OAS 1.N.1.1). If it is expected that other denominations of bills are used, such five and one dollar bills, it remains the same requirement as the expectation in grade 1: counting by 1s, 5s, and 10s (1.N.1.4).

When little or no progress is made from grade to grade, opportunities for students to make connections between new information and what they already know are lost, and the coherent flow of learning across the grades is interrupted. Examining the progression of currency requirements across the grade levels reinforces concerns about coherence. For example, nearly identical standards exist in grades 1 and 2:

1. N.4.3 Determine the value of a collection of pennies, nickels, or dimes up to one dollar counting by ones, fives, or tens.
2. N.4.1 Determine the value of a collection(s) of coins up to one dollar using the cent symbol.
2. N.4.2 Use a combination of coins to represent a given amount of money up to one dollar.

The only clear differences between the two grade level expectations are the use of the cent symbol and the possible addition of quarters to the list of coins in grade 2. (It is unlikely that half-dollars would be used here since there are so few in circulation.)

And a similar lack of progression occurs between grades 3 and 4:

3. N.4.1 Use addition to determine the value of a collection of coins up to one dollar using the cent symbol and a collection of bills up to twenty dollars.
3. N.4.2 Select the fewest number of coins for a given amount of money up to one dollar.
4. N.3.1 Given a total cost (whole dollars up to $20 or coins) and amount paid (whole dollars up to $20 or coins), find the change required in a variety of ways. Limited to whole dollars up to $20 or sets of coins.

The OAS in grade 3 repeat the expectations from grades 1 and 2 that students determine the value of a collection of coins up to one dollar and the introduction of dollar bills. It is not clear how students would perform the addition required in 3.N.4.1. It appears that a collection of coins to one dollar and bills to twenty dollars must be combined. Since the OAS do not expect students to use decimals until grade 4, it is not clear how this will be carried out. Decimals are also introduced in the CCSS in grade 4.

OAS 4.N.3.1 sets limitations for dollars, but the limitations are unclear for coins.
Focus

High-quality standards establish priorities about the concepts and skills that should be acquired by students. A sharpened focus helps ensure that the knowledge and skills students are expected to learn is important and manageable in any given grade or course.

The side-by-side chart that accompanies this report shows each OAS objective next to the corresponding CCSS to which it aligns. It should be consulted while reading what follows, as this section of the report relies heavily on that chart.

Achieve used the organizing structure of the CCSS as a framework for this section of the report. The most critical topics for each CCSS grade level are clearly described in the introductions for each grade and adhered to in the standards that follow. The relationship between the most critical content for a grade level and the supporting content is clear in the CCSS. There is no similar structure in the OAS and, as such, there is no indication as to which standards should have the highest priority. The accompanying side-by-side chart identifies gaps in the alignment between the two sets of standards. Those gaps show areas of concern related to the focus of the Oklahoma standards. For example, in kindergarten the CCSS instructs that “more learning time in Kindergarten should be devoted to number than to other topics.”

The alignment with the OAS for kindergarten identifies some critical number concepts that are missing in the OAS but that the CCSS include. Among the missing concepts are three that address conceptual foundations for counting (K.CC.4b, K.CC.4c, and K.CC.5); one that addresses fluency with addition and subtraction within 5 (K.OA.5); and one that addresses composition and decomposition of numbers to 20 (K.NBT.1). These are all critical concepts for kindergarten. There are also some critical concepts in kindergarten in the CCSS that are not addressed until later grades in the OAS. For example, the CCSS kindergarten requirement to add and subtract numbers within 10 is not required in the OAS until grade 1.

In addition there are several OAS for kindergarten that address concepts not expected in the CCSS. Those include topics such as subitizing, patterns, equal distribution of objects in a set, display of categorical data, identification of coins, and using language related to time. Without a clear message in the OAS of what is important, these topics may take the focus away from the most critical concepts for the grade level.

There are many examples of critical topics for each grade level that are missing in the OAS. Listed in the table below are a few examples for grades 1 through 5. Following the table is more information about the focus of middle and high school standards. For the full list with commentary, look for the yellow highlighted cells in the accompanying side-by-side chart.
### Examples of Differences in Focus between the CCSS and OAS in Grades 1–5

<table>
<thead>
<tr>
<th>Grade</th>
<th>CCSS Topics Missing in the OAS</th>
<th>OAS Topics Not Addressed in the CCSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Relate counting to add/subtract (1.OA.5)</td>
<td>Patterns (1.A.1.1)</td>
</tr>
<tr>
<td></td>
<td>Determine unknown quantity in add/subtract equation (1.OA.8)</td>
<td>Subitizing (1.N.1.1)</td>
</tr>
<tr>
<td></td>
<td>Add within 100 (1.NBT.4)</td>
<td>Currency (1.N.4.1, 1.N.4.2, 1.N.4.3)</td>
</tr>
<tr>
<td>2</td>
<td>Parity (even or odd) (2.OA.3)</td>
<td>Estimate sums and differences (2.N.2.3)</td>
</tr>
<tr>
<td></td>
<td>Understand and explain +/- strategies (2.NBT.9)</td>
<td>Patterns (2.A.1.1, 2.A.1.2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Exploring capacity (2.GM.2.3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Explain a bar or picture graph (2.D.1.1)</td>
</tr>
<tr>
<td>3</td>
<td>Understand fractions as numbers (3.NF.2)</td>
<td>Input/output table (3.A.1.2)</td>
</tr>
<tr>
<td></td>
<td>Express whole numbers as fractions (3.NF.3c)</td>
<td>Currency (3.N.4.1, 3.N.4.2)</td>
</tr>
<tr>
<td></td>
<td>Understand area as tiling (3.MD.7c)</td>
<td>Temperature (3.GM.2.6)</td>
</tr>
<tr>
<td></td>
<td>Partitioning shapes into equal areas (3.G.2)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Interpretation of multiplication in contexts (4.OA.1)</td>
<td>Unknown addend/factor (4.N.1.7)</td>
</tr>
<tr>
<td></td>
<td>Word problems with multiplication and division (4.OA.2)</td>
<td>Displays data using tables, bar graphs, timelines, and Venn diagrams (4.D.1.2)</td>
</tr>
<tr>
<td></td>
<td>Recognition of place value relationships (4.NBT.1)</td>
<td>Problems using data from a frequency table and line plot and involving fractions or decimals</td>
</tr>
<tr>
<td></td>
<td>Understanding/explaining fraction concepts (4.NF.1, 4.NF.3, 4.NF.4a, 4.NF.4b)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Understanding addition and subtraction of fractions (4.NF.3a)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Multiply fraction by whole number (4.NF.4, 4.NF.4c)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Understanding and problems involving angle measures (4.MD.7)</td>
<td></td>
</tr>
</tbody>
</table>
In OAS for middle school there also are critical concepts missing. For example, grade 6 is the first year in the CCSS where statistical thinking is developed. The analysis reveals that CCSS introducing statistics, 6.SP.1, 6.SP.2, and 6.SP.3, have no OAS counterparts. These three CCSS represent the foundational understanding required for success in work with statistics in later years. The full list of CCSS topics that are missing from the OAS follow:

**Grade 6**
- Comparison of rational numbers (6.NS.7b)
- Understanding absolute value (6.NS.7d)
- Writing and identifying the parts of an expression (6.EE.2a, 6.EE.2b)
- Identify equivalent expressions (6.EE.4)
- Development of statistical thinking (6.SP.1, 6.SP.2, 6.SP.3)

**Grade 7**
- Opposites (negative numbers) in contextual situations (7.NS.1a)
- Multiplication and division of integers (7.NS.2a, 7.NS.2b)
- Rewriting expressions for a purpose (7.EE.2)
- Draw shapes from descriptions (7.G.2)
- Describe cross sections of prisms and pyramids (7.G.3)
- Compare data sets based on measures of center or spread (7.SP.3, 7.SP.4)
- Probability from observation of frequencies (7.SP.7b)

**Grade 8**
- Explain slope using similar triangles and derive the equation of a line in slope intercept form (8.EE.6)
• Understand the solution for a system of two linear equations (8.EE.8a)
• Compare two functions represented in different ways (8.F.2)
• Use two-way frequency tables (8.SP.4)

The CCSS for high school has some standards identified with a (+). That symbol in the coding scheme indicates that the standard is required for students who have an interest in fields of work or study that will require higher mathematics. Those standards without the (+) symbol are necessary for all students. In the high school OAS the list of missing non-(+) concepts includes the following:

Non-(+) concepts missing in OAS Algebra
• Explain how rational exponents can be related to integer exponents and radicals (N.RN.1)
• Using and defining units and quantities (N.Q.1, N.Q.2, N.Q.3)
• Interpretation of expressions based on their structure (A.SSE.1, A.SSE.1a, A.SSE.1b)
• The remainder theorem and polynomial identities (A.APR.2, A.APR.4)
• Constraints on equations and inequalities (A.CED.3)
• Constructing an algebraic proof of a solution (A.REI.1)
• Complete the square to derive the quadratic formula (A.REI.4a)
• Prove that the process for solving a system of equations is valid (A.REI.5)
• Understand the graph of an inequality (A.REI.10)
• Explain how the graphs of functions can be used to solve equations like f(x) = g(x) (A.REI.11)

Functions
• Average rate of change for nonlinear functions (F.IF.6)
• Key features of a graph (F.IF.7)
• Interpret exponential functions (F.IF.8b)
• Compare two functions represented differently (F.IF.9)
• Determine a function from a context (F.BF.1a)
• Compare and interpret linear, quadratic, and exponential growth (F.LE.3, F.LE.5)
• Explain the unit circle and radian measure (F.TF.1, F.TF.2)
• Model periodic phenomena with trigonometric functions (F.TF.5)
• Prove the Pythagorean identity as it relates to trigonometric functions (F.TF.8)

Geometry
• Use transformations in the plane to define congruence and similarity (G.CO.2, G.CO.4, C.CO.7)
• Prove theorems about triangles (G.CO.10, G.SRT.3, G.SRT.4)
• Constructions (G.CO.12, G.CO.13)
• Define trigonometric ratios using similar triangles (G.SRT.6, G.SRT.7)
• Proofs and constructions involving circles (G.C.1, G.C.3)
• Understand radian measure and derive area of a sector (G.C.5)
• Derive the equation of a parabola (G.GPE.2)
• Defend formulas for circumference and area of a circle (G.GMD.1)
• Cross sections of 3-D figures and figures of rotation (G.GMD.4)
- Geometric models (G.MG.1)
- Density and design (G.MG.2, G.MG.3)

**Statistics and Probability**

- Two-way frequency tables (S.ID.5, S.CP.5)
- Informal fit of a function by residuals (S.ID.6b)
- Interpret the key characteristics for linear model from data (S.ID.7)
- Population parameters, sampling, and randomization (S.IC.3, S.IC.4, S.IC.5)
- Conditional probability (S.CP.3, S.CP.5, S.CP.6)
- Addition Rule for probability (S.CP.7)

There also are examples of partial alignments between the OAS and the CCSS, where a sometimes-subtle difference can cause some part of the CCSS requirement not to be met. The following table provides one example of a critical concept for each of the grades kindergarten through grade 8 that is partially met in the OAS. Information about partial alignments for high school standards follows the table. For the full list and commentary, see the cells highlighted in grey on the accompanying side-by-side chart.

### Examples of Partial Alignment of Critical Concepts between the OAS and CCSS in Each Grade K–8

<table>
<thead>
<tr>
<th>CCSS</th>
<th>OAS</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>K.CC.3 Write numbers from 0 to 20. Represent a number of objects with a written numeral 0-20 (with 0 representing a count of no objects).</td>
<td>K.N.1.6 Read, write, discuss, and represent whole numbers from 0 to at least 10. Representations may include numerals, pictures, real objects and picture graphs, spoken words, and manipulatives.</td>
<td>While &quot;to at least 10&quot; might be interpreted to mean that the requirement could go as high as 20, this is not completely clear.</td>
</tr>
<tr>
<td>1.OA.2 Solve word problems that call for addition of three whole numbers whose sum is less than or equal to 20, e.g., by using objects, drawings, and equations with a symbol for the unknown number to represent the problem.</td>
<td>1.N.2.1 Represent and solve real-world and mathematical problems using addition and subtraction up to ten.</td>
<td>This OAS objective requires solving add/subtract problems only to 10, which is a kindergarten requirement in the CCSS. There is also no specific OAS requirement to use three numbers in the problems.</td>
</tr>
<tr>
<td>2.NBT.3 Read and write numbers to 1000 using base-ten numerals, number names, and expanded form.</td>
<td>2.N.1.1 Read, write, discuss, and represent whole numbers up to 1,000. Representations may include numerals, words, pictures, tally marks, number lines and</td>
<td>The OAS objective includes other representations than the CCSS. Expanded form is not required in the OAS.</td>
</tr>
<tr>
<td>Objective</td>
<td>Description</td>
<td>Notes</td>
</tr>
<tr>
<td>-----------</td>
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</tr>
<tr>
<td>3.NF.3d</td>
<td>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 &gt;, =, or &lt;, and justify the conclusions, e.g., by using a visual fraction model.</td>
<td>The OAS objective does not specify that comparisons should be made with both like numerators and with like denominators. Additionally there is no call to use the comparison symbols when comparing fractions before OAS grade 6.</td>
</tr>
<tr>
<td>3.N.3.4</td>
<td>Use models and number lines to order and compare fractions that are related to the same whole.</td>
<td></td>
</tr>
<tr>
<td>4.NBT.6</td>
<td>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 equations, rectangular arrays, and/or area models.</td>
<td>This OAS objective limitation (3-digit by 1-digit) does not match that of the CCSS (4-digit by 1-digit). It also does not require an explanation of the calculations by the various means listed in the CCSS counterpart.</td>
</tr>
<tr>
<td>4.N.1.6</td>
<td>Use strategies and algorithms based on knowledge of place value, equality and properties of operations to divide 3-digit dividend by 1-digit whole number divisors. (e.g., mental strategies, standard algorithms, partial quotients, repeated subtraction, the commutative, associative, and distributive properties).</td>
<td></td>
</tr>
<tr>
<td>5.MD.5a</td>
<td>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.</td>
<td>The OAS objective expects an understanding of how volume is found but stops short of actually asking that students find the volume. The OAS does not require finding volume until grade 8 (PA.GM.2.3)</td>
</tr>
<tr>
<td>5.GM.2.1</td>
<td>Recognize that the volume of rectangular prisms can be determined by the number of cubes ( (n) ) and by the product of the dimensions of the prism ( (a \times b \times c = n) ). Know that rectangular prisms of different dimensions ( (p, q, \text{ and } r) ) can have the same volume if ( a \times b \times c = p \times q \times r = n ).</td>
<td></td>
</tr>
<tr>
<td>6.EE.6</td>
<td>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.</td>
<td>This OAS matches the procedural part of this CCSS but misses out on the conceptual foundation of understanding the meaning and purpose of a variable.</td>
</tr>
<tr>
<td>6.A.3.1</td>
<td>Represent real-world or mathematical situations using expressions, equations and inequalities involving variables and rational numbers.</td>
<td></td>
</tr>
<tr>
<td>7.NS.2d</td>
<td>Convert a rational number to a</td>
<td></td>
</tr>
<tr>
<td>7.N.1.1</td>
<td>Know that every rational</td>
<td>The OAS doesn’t specify</td>
</tr>
<tr>
<td>Decimal using long division; know that the decimal form of a rational number terminates in 0s or eventually repeats.</td>
<td>Number can be written as the ratio of two integers or as a terminating or repeating decimal.</td>
<td>Actually doing the conversion. Is it expected?</td>
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</tr>
<tr>
<td><strong>7.NS.2c</strong> Apply properties of operations as strategies to multiply and divide rational numbers.</td>
<td><strong>7.N.2.2</strong> Illustrate multiplication and division of integers using a variety of representations.</td>
<td>This OAS addresses integers but not application of the properties of operations with all rational numbers.</td>
</tr>
<tr>
<td><strong>8.F.3</strong> 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. 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.</td>
<td><strong>PA.A.1.3</strong> Identify a function as linear if it can be expressed in the form $y = mx + b$ or if its graph is a straight line.</td>
<td>This OAS does not include functions that are non-linear.</td>
</tr>
<tr>
<td><strong>A1.F.2.1</strong> Distinguish between linear and nonlinear (including exponential) functions arising from real-world and mathematical situations that are represented in tables, graphs, and equations. Understand that linear functions grow by equal intervals and that exponential functions grow by equal factors over equal intervals.</td>
<td>This Algebra I OAS comes one year later but does not expect students to provide examples of nonlinear functions.</td>
<td></td>
</tr>
</tbody>
</table>

The analysis reveals that the high school OAS have many partial alignments in Algebra, Functions, Geometry, and Data, including partial alignments to several CCSS requiring conceptual understanding. Examples include performances such as “use the structure of an expression...,” “derive the formula for the sum of a finite geometric series...,” “Understand that polynomials form a system analogous to the integers...,” “interpret key features of graphs and tables...,” and, more generally, “explain... .” In other partial high school alignments there are differences, for example, in the types of functions that are addressed, in different representations that are expected, and some with only part of a compound CCSS addressed in the OAS counterpart. Examples of these can be found in the high school section of the side-by-side analysis chart.

The accompanying side-by-side chart clearly illustrates examples of partial or full gaps in alignment between the OAS and the CCSS. In addition to grade-level gaps, or partial gaps, there are cases where CCSS requirement appears, either fully or partially, in an earlier or later OAS grade. These examples can be found in the accompanying chart shaded green or pink, respectively. The last row in the table above includes an example for CCSS grade 8 that is partially met in OAS Pre-Algebra but needs the OAS Algebra I objective to further the alignment. It should be noted here that even when considering both OAS levels, the CCSS is still partially matched.

When critical concepts, which are intended to be the focus of a particular grade, are aligned to OAS in other grades, this indicates a change in focus when compared to the CCSS. In some cases a single CCSS...
requires OAS objectives from several grades for a full alignment. For example, 6.EE.2c is partially aligned at grade level with 6.A.1.3. In addition, there are several other OAS objectives that assist in full alignment: three OAS from grade 7, one from grade 8, and one from Algebra I. There are far too many of these sorts of grade-level and out-of-grade-level partial matches to provide the entire list in this report. However, the table below provides a few examples for kindergarten through grade 3. In these examples the matches are addressed only at a lower (green) or higher (pink) grade level. For the full list and commentary, see the accompanying side-by-side analysis chart.

<table>
<thead>
<tr>
<th>CCSS</th>
<th>OAS</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>K.OA.1</strong> Represent addition and subtraction with objects, fingers, mental images, drawings, sounds (e.g., claps), acting out situations, verbal explanations, expressions, or equations.</td>
<td><strong>1.N.2.1</strong> Represent and solve real-world and mathematical problems using addition and subtraction up to ten.</td>
<td>This grade 1 OAS goes beyond in requiring problem solving.</td>
</tr>
<tr>
<td><strong>K.OA.2</strong> Solve addition and subtraction word problems, and add and subtract within 10, e.g., by using objects or drawings to represent the problem.</td>
<td><strong>1.N.2.1</strong> Represent and solve real-world and mathematical problems using addition and subtraction up to ten.</td>
<td>This OAS objective from grade 2 addresses representation of equations with objects and number lines. This implies some operation would be present. However, there is no expectation in OAS objective kindergarten for addition or subtraction.</td>
</tr>
<tr>
<td><strong>2.MD.9</strong> Generate measurement data by measuring lengths of several objects to the nearest whole unit, or by making repeated measurements of the same object. Show the measurements by making a line plot, where the horizontal scale is marked off in whole-number scale.</td>
<td><strong>3.D.1.1</strong> Summarize and construct a data set with multiple categories using a frequency table, line plot, pictograph, and/or bar graph with scaled intervals.</td>
<td>The grade 3 OAS objective does not specifically require collecting data based on measurement. Representing data in a line plot is expected one year later in the OAS than in the CCSS.</td>
</tr>
<tr>
<td>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.</td>
<td>4.A.2.1 Use number sense, properties of multiplication and the relationship between multiplication and division to solve problems and find values for the unknowns represented by letters and symbols that make number sentences true.</td>
<td>These OAS objectives match the CCSS expectation to solve word problems using equations that involve all four operations. These fall one year later in the OAS but do not limit the problems to those requiring no more than two steps.</td>
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<tr>
<td>4.A.2.2 Solve for unknowns in problems by solving open sentences (equations) and other problems involving addition, subtraction, multiplication, or division with whole numbers. Use real-world situations to represent number sentences and vice versa.</td>
<td>4.N.1.5 Solve multi-step real-world and mathematical problems requiring the use of addition, subtraction, and multiplication of multi-digit whole numbers. Use various strategies, including the relationship between operations, the use of appropriate technology, and the context of the problem to assess the reasonableness of results.</td>
<td>4.A.2.2 Solve for unknowns in problems by solving open sentences (equations) and other problems involving addition, subtraction, multiplication, or division with whole numbers. Use real-world situations to represent number sentences and vice versa.</td>
</tr>
<tr>
<td>3.NBT.3 Multiply one-digit whole numbers by multiples of 10 in the range 10–90 (e.g., 9 x 80, 5 x 60) using strategies based on place value and properties of operations.</td>
<td>4.N.1.2 Use an understanding of place value to multiply or divide a number by 10, 100 and 1,000.</td>
<td>This is a partial match in that the CCSS requires multiplication of a one-digit number by ANY multiple of 10 up to 90 (not restricted to 100 and 1,000).</td>
</tr>
<tr>
<td>3.NF.3a Understand two fractions as equivalent (equal) if they are the same size, or the same point on a number line.</td>
<td>4.N.2.1 Represent and rename equivalent fractions using fraction models (e.g. parts of a set, area models, fraction strips, number lines).</td>
<td>The OAS grade 4 objective requires representing and renaming but does not require understanding or reasoning about the equivalence, based on the fractions' size or position on the number line. It is not clear why “represent and rename” is used here rather than...</td>
</tr>
<tr>
<td>CCSS Objective</td>
<td>OAS Objective</td>
<td>Match Details</td>
</tr>
<tr>
<td>----------------</td>
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<td>---------------</td>
</tr>
<tr>
<td>3.NF.3b 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.</td>
<td>4.N.2.1 Represent and rename equivalent fractions using fraction models (e.g. parts of a set, area models, fraction strips, number lines).</td>
<td>This CCSS requirement appears one year later in the OAS. The CCSS has made a conceptual shift in grade 3 to understanding of fractions as quantities. There is no requirement in the OAS objective to explain why two fractions are equivalent.</td>
</tr>
<tr>
<td>5.N.2.4 Recognize and generate equivalent decimals, fractions, mixed numbers, and fractions less than one in various contexts.</td>
<td></td>
<td>This OAS objective addresses this concept two years later than the CCSS counterpart.</td>
</tr>
<tr>
<td>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.</td>
<td>1.GM.2.5 Use standard and nonstandard tools to identify volume/capacity. Compare and sort containers that hold more, less, or the same amount.</td>
<td>Liquid volume is addressed in the OAS in this grade 1 objective. Measures of weight are not addressed in OAS.</td>
</tr>
<tr>
<td>4.GM.2.5 Solve problems that deal with measurements of length, when to use liquid volumes, when to use mass, temperatures above zero and money using addition, subtraction, multiplication, or division as appropriate (customary and metric).</td>
<td></td>
<td>This grade 4 objective addresses solving problems related to mass and volume.</td>
</tr>
<tr>
<td>6.GM.3.1 Estimate weights, capacities and geometric measurements using objectives in customary and metric measurement systems with appropriate units.</td>
<td></td>
<td>Estimation of measurements using appropriate units is addressed in this grade 6 objective. There is no other match for this objective in the CCSS.</td>
</tr>
<tr>
<td>3.MD.7d 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.</td>
<td>4.GM.2.2 Find the area of polygons that can be decomposed into rectangles.</td>
<td>This is a partial match in that there is no expectation in the OAS objective to recognize the additive nature of area or to use that quality in solving problems.</td>
</tr>
</tbody>
</table>
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.

2.GM.1.2 Describe, compare, and classify two-dimensional figures according to their geometric attributes.

This grade 2 OAS addresses the expectation that students will consider the attributes of the two-dimensional figures.

4.GM.1.2 Describe, classify, and sketch quadrilaterals, including squares, rectangles, trapezoids, rhombuses, parallelograms, and kites. Recognize quadrilaterals in various contexts.

This grade 4 OAS objective addresses all of the quadrilaterals in the CCSS counterpart, but it has no requirement to recognize or draw examples that do not belong to any of these subcategories.

In analyzing the alignment between the OAS and the CCSS, it is clear there are examples of single CCSS standards that are broken apart in the OAS over multiple years and multiple standards. For example, it takes two years and seven OAS objectives (4.M.1.4, 4.N.1.5, 4.A.2.1, 4.A.2.2, 5.N.1.1, 5.N.1.3, and 5.N.1.4) to match the elements of CCSS 4.OA.3. Similarly, CCSS 7.G.6 is partially matched with two OAS objectives from grade 7, two from grade 8, and one from high school Geometry, for a total of five standards over three to four years.

There also are differences between the focus of the OAS and the CCSS, as indicated by the grade levels where topics are first introduced. The list below provides several examples.

- Subtraction is not mentioned in kindergarten in the OAS. Subtraction in kindergarten is included in the CCSS, as well as in the standards adopted by Minnesota, Nebraska, Texas, and Virginia. Moreover, Oklahoma is largely alone in not including subtraction in kindergarten.
- The CCSS first work with the associative property in grade 1 (1.OA.3), while the OAS first mention it in grade 2 (2.A.2.3).
- Skip counting begins in grade 1 in the OAS (1.N.1.4) but in grade 2 in the CCSS (1.NBT.4).
- Adding within 100 is grade 1 in the CCSS (1.NBT.4) but is found in grade 2 in the OAS (2.N.2.4).
- CCSS work with unknowns in equations in grade 1 (1.OA.8), but it is not found in the OAS until grade 2 (2.A.2.3).
- CCSS expect fluency with addition and subtraction to 100 in grade 2 (2.NBT.5), but the grade 2 expectation in the OAS is only to 20 (2.N.2.2).
- CCSS students fluently multiply and divide up to 100 in grade 3. OAS waits until grade 4 (but includes factors up to 12).
- CCSS students will be solving multi-step word problems using all four operations in grade 3. OAS students will have to wait until grade 4.
- Fraction equivalence is grade 3 in the CCSS but is not developed until grades 4 and 5 in the OAS.
- The distributive property is developed in grade 3 in the CCSS. The first mention in the OAS is in grade 4.
• Mixed numbers begin in CCSS grade 4, but they begin in the OAS during grade 5
• Fraction multiplication begins in grade 4 in the CCSS, but it is not until grade 6 in the OAS.
• Absolute value (7.N.2.6) comes one year later than in the CCSS (6.NS.7), but there is more emphasis on working with absolute value overall.
• Evaluating expressions with variables (5.A.2.3) comes one year before the CCSS (6.EE.2).
• Volumes with fractional edge lengths (7.GM.1.2) come one year after the CCSS (6.G.2).
• Surface area is introduced in grade 5 (5.GM.2.2) but not explicitly calculated until grade 8 (PA.GM.2.1). In the CCSS students attend to both in grade 6.
• Mean and Median are introduced in grade 5 (5.D.1.1). They are a grade 6 topic in the CCSS (6.SP.5).
• Addition and subtraction of integers are in grade 6 (6.N.2.2) but are a grade 7 topic in the CCSS (7.NS.1b-1c).
• Constructing real-world equations and inequalities is in grade 8 (PA.A.4.3) but is found in the CCSS in grade 7 (7.EE.4).
• Statistical sampling is not addressed until grade 8 (PA.D.2.2) but is found in grade 7 in the CCSS (7.SP.1).
• Probability is first introduced in grade 6 (6.D.2.3) but not until grade 7 in the CCSS.
• Probability of compound events is found in Algebra I (A1.D.2.1) but is found in grade 7 in the CCSS (7.SP.8).
• Performing statistical simulations is in Algebra I (A1.D.2.3) but is a grade 7 topic in the CCSS (7.SP.8c).
• Solving simultaneous linear equations is expected in Algebra I (A1.A.1.3), but it is a grade 8 topic in the CCSS (8.EE.8b).
• Translations, reflections, and rotations are first found in grade 6 (6.GM.4.2) but are a grade 8 topic in the CCSS (8.G.2).
• Volumes of cones and spheres are first seen in high school Geometry (G.3D.1.1) but are in grade 8 in the CCSS (8.G.9)

Specificity

Quality standards are precise and provide sufficient detail to convey the level of performance expected without being overly prescriptive. Those that maintain a relatively consistent level of precision are easier to understand and use. Those that are overly broad or vague leave too much open to interpretation, while atomistic standards encourage a checklist approach to teaching and learning.

The objectives of the current draft of OAS are not, for the most part, overly prescriptive. Neither do they vary widely in grain size when compared across the grade and course levels. However, there are a number of instances where certain benchmarks are vague or too much alike. We provide just a few examples.

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12 The OAS also includes mode.
Examples of Issues with Specificity in the OAS

<table>
<thead>
<tr>
<th>OAS</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.N.3.1 Given a total cost (whole dollars up to $20 or coins) and amount paid (whole dollars up to $20 or coins), find the change required in a variety of ways. Limited to whole dollars up to $20 or sets of coins.</td>
<td>This very narrow objective is so fine-grained that it is really more on the order of an example problem. It might be used to exemplify 4.GM.2.5: “Solve problems that deal with measurements of ... money using addition, subtraction, multiplication, or division as appropriate (customary and metric).”</td>
</tr>
<tr>
<td>A1.N.1.1 Write square roots and cube roots of monomial algebraic expressions in simplest radical form.</td>
<td>This OAS is more specific than the CCSS standard. The CCSS does not require “simplest radical form.”</td>
</tr>
<tr>
<td>A1.A.1.1 Use knowledge of solving equations with rational values to represent and solve mathematical and real-world problems (e.g., angle measures, geometric formulas, science, or statistics) and interpret the solutions in the original context.</td>
<td>This generally stated OAS objective is addressed in the CCSS Standards for Mathematical Practice. Since this OAS is related to linear equations (including absolute value) and systems of linear equations, it is assumed that this will be the mathematical context.</td>
</tr>
</tbody>
</table>

Clarity/Accessibility

*High-quality standards are clearly written and presented in an error free, legible, easy-to-use format that is accessible to the general public.*

The format of the Oklahoma standards is attractive, easy to navigate, and accessible to the general public. The final version of the OAS first provides a by-grade and by-course format for the standards and objectives. That is followed by a second format that displays the standards and objectives for three to four grade levels at a time across the page, so that connections between the grade levels, related to progression topics, can be seen more easily. It is apparent that the authors have made an effort to write the standards in a user-friendly, informal style of language so that all users, even those who do not consider themselves experts in mathematics, can understand them. However, there are instances in the standards and objectives where informally describing a mathematical concept or expectation leads to standards that are inaccurate or ambiguous. When imprecise language is used that obscures or confuses the correct mathematical meaning, it reinforces misguided beliefs about the intended mathematics.
The accompanying side-by-side chart included with this report is comprehensive and provides suggestions and commentary on the clarity issues. The table below provides several examples of the clarity issues in each grade and course of the OAS.

<table>
<thead>
<tr>
<th>OAS Objective</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>K.GM.2.4</strong> Compare the number of objects needed to fill two different containers.</td>
<td>Only if the objects used to fill the containers are of the same size and/or weight can this be about a measurable attribute, such as volume or weight. If not, this is meaningless.</td>
</tr>
<tr>
<td><strong>K.GM.1.2</strong> Sort two-dimensional objects using characteristics such as shape, size, color, and thickness.</td>
<td>There is a mathematical error in this OAS objective, as two-dimensional figures have no “thickness.”</td>
</tr>
<tr>
<td><strong>1.N.1.4</strong> Count forward, with and without objects, from any given number up to 100 by 1s, 2s, 5s and 10s.</td>
<td>The intention of this standard is not clear. For example, would a first grade student be expected to count by 5’s from, say, 7?</td>
</tr>
<tr>
<td><strong>1.GM.1.2</strong> Compose and decompose larger shapes using smaller two-dimensional shapes.</td>
<td>Without seeing 1.GM.1.3 in conjunction with this objective, it may not be completely clear that the “larger shapes” in this OAS objective are two-dimensional. On its own, this OAS objective might be construed as an expectation to use 2-D nets to form 3-D figures.</td>
</tr>
<tr>
<td><strong>1.GM.2.2</strong> Illustrate that the length of an object is the number of same-size units of length that, when laid end-to-end with no gaps or overlaps, reach from one end of the object to the other.</td>
<td>It is imprecise to say, “Illustrate that the length of an object is the number of same-size units of length” since the length of an object is simply the length of that object. However, the measure of that length may be expressed in terms of the number of copies of some other length.</td>
</tr>
<tr>
<td><strong>1.GM.2.3</strong> Measure the same object/distance with units of two different lengths and describe how and why the measurements differ.</td>
<td>The use of “object/distance” is unclear. Is the intention to measure a distance on an object? Is there something else about the object that is intended here?</td>
</tr>
<tr>
<td><strong>2.A.2.1</strong> Use objects and number lines to represent number sentences.</td>
<td>Typically, in a “number sentence” there would be an operation and an equality (or inequality). It is</td>
</tr>
<tr>
<td><strong>Standard</strong></td>
<td><strong>Description</strong></td>
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</tr>
<tr>
<td><strong>2.N.1.5</strong> Recognize <strong>when</strong> to round numbers to the nearest 10 and 100.</td>
<td>It is not clear how educators would interpret the requirement of knowing WHEN to round. It is assumed that this refers to a contextual situation, but that is not made clear. Some examples may be needed for clarity.</td>
</tr>
<tr>
<td><strong>3.GM.2.4</strong> Choose an appropriate measurement instrument and measure the length of objects to the nearest whole yard, whole foot, or half inch.</td>
<td>It is not clear why the choice of limits was made for this OAS. If the nearest whole yard and foot are required, why not a whole inch?</td>
</tr>
<tr>
<td><strong>3.GM.2.7</strong> Count cubes systematically to <strong>identify number of cubes</strong> needed to pack the whole or half of a three-dimensional structure.</td>
<td>It is not clear in this objective that the “number of cubes” must be of equal size. It is also not clear why packing half of a figure would be a desired skill.</td>
</tr>
<tr>
<td><strong>3.N.3.2</strong> <strong>Construct fractions</strong> using length, set, and area models.</td>
<td>This OAS is imprecise. Students are not constructing fractions using these things; rather, they are recognizing a fractional quantity in these things.</td>
</tr>
<tr>
<td><strong>4.A.1.3</strong> Create <strong>growth patterns involving geometric shapes</strong> and define the single operation rule of the pattern.</td>
<td>The meaning and intention of “growth patterns involving geometric shape” is not clear. (How will the shapes be “growing?”)</td>
</tr>
<tr>
<td><strong>4.GM.1.3</strong> Given two three-dimensional shapes, identify <strong>similarities</strong>, and differences.</td>
<td>The comma after similarities is grammatically incorrect.</td>
</tr>
<tr>
<td><strong>4.N.1.7</strong> Determine the unknown addend or factor in equivalent and non-equivalent expressions. (e.g., $5 + 6 = 4 + \Box$, $3 \times 8 &lt; 3 \times \Box$).</td>
<td>It is not clear how “the” unknown addend or factor can be determined in a “non-equivalent expression.” Also the language used here is mathematically inaccurate, as these examples are not expressions, but rather an equation and an inequality.</td>
</tr>
<tr>
<td><strong>4.N.2.1</strong> <strong>Represent and rename</strong> equivalent fractions using fraction models (e.g. parts of a set, area models, fraction strips, <strong>number lines</strong>).</td>
<td>It is not clear why “represent and rename” is used here rather than the clearer and more mathematically precise notion of creating or generating equivalent fractions.</td>
</tr>
<tr>
<td>Standard</td>
<td>Description</td>
</tr>
<tr>
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</tr>
<tr>
<td>5.GM.2.3</td>
<td>Find the perimeter of polygons and create arguments for reasonable values for the perimeter of shapes that include curves.</td>
</tr>
<tr>
<td>5.D.1.1</td>
<td>Find the measures of central tendency (mean, median, or mode) and range of a set of data. Understand that the mean is a “leveling out” or central balance point of the data.</td>
</tr>
<tr>
<td>5.D.1.2</td>
<td>Create and analyze line and double-bar graphs with whole numbers, fractions, and decimals increments.</td>
</tr>
<tr>
<td>5.GM.3</td>
<td>Understand angle and length as measurable attributes of real-world and mathematical objects. Use various tools to measure angles and lengths.</td>
</tr>
<tr>
<td>5.N.1.1</td>
<td>Estimate solutions to division problems in order to assess the reasonableness of results.</td>
</tr>
<tr>
<td>6.A.1.3</td>
<td>Use and evaluate variables in expressions, equations, and inequalities that arise from various contexts, including determining when or if, for a given value of the variable, an equation or inequality involving a variable is true or false.</td>
</tr>
</tbody>
</table>

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true would be solving the equation. How would that be related to evaluating expressions?

<table>
<thead>
<tr>
<th>Standard</th>
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<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>6.N.1.3</strong></td>
<td>Explain that a percent represents parts “out of 100” and ratios “to 100.”</td>
<td>This OAS doesn’t consider percent to be a rate as in the CCSS. In the CCSS a percent is a rate. In the OAS it is at one time a “part” and at other times a ratio. Is a percent both a quantity and a comparison of quantities? It is also not clear what “ratios ‘to 100’” means. Should that be “to hundredths?”</td>
</tr>
<tr>
<td><strong>6.N.3.3</strong></td>
<td>Apply the relationship between ratios, equivalent fractions and percents to solve problems in various contexts, including those involving mixture and concentrations.</td>
<td>There is no clear expectation in the grade 6 OAS for students to calculate percents, though it might be the intention in this standard.</td>
</tr>
<tr>
<td><strong>7.A.4.1</strong></td>
<td>Use properties of operations (limited to associative, commutative, and distributive) to generate equivalent numerical and algebraic expressions containing rational numbers, grouping symbols and whole number exponents.</td>
<td>The limits on exponents in algebraic expressions are not clear in this OAS. The CCSS restrict the work to linear expressions.</td>
</tr>
<tr>
<td><strong>A1.N.1.2</strong></td>
<td>Add, subtract, multiply, and simplify square roots of monomial algebraic expressions and divide square roots of whole numbers, rationalizing the denominator when necessary.</td>
<td>It is not clear when it is necessary to rationalize the denominator.</td>
</tr>
<tr>
<td><strong>A1.A.3.6</strong></td>
<td>Recognize that geometric sequences are exponential using equations, tables, graphs and verbal descriptions. Given the formula f(x)=a(r)^x, find the next term and define the meaning of a and r within the context of the problem.</td>
<td>Given that this and A1.F.2.1 are the only mentions of exponential relationships in Algebra I, it is very unclear what the overall Algebra I expectations are for this mathematical topic. This wording would be better as “geometric sequences can be represented by exponential functions.”</td>
</tr>
<tr>
<td><strong>A1.F.2.1</strong></td>
<td>Distinguish between linear and nonlinear (including exponential) functions arising from real-world and mathematical situations that are represented in tables, graphs, and equations. Understand that linear functions</td>
<td>“Grow by equal intervals” is not quite accurate. The function’s outputs may increase or decrease as the inputs increase. Also, A1.F.2 (the standard, not the objective) seems to imply that percent of change (relative) is the same as rate of change.</td>
</tr>
</tbody>
</table>

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13 There is no OAS similar to A1.A.4.3 for exponential functions.
**grow by equal intervals** and that exponential functions grow by equal factors over equal intervals.

**A1.D.1.3** Interpret graphs as being discrete or continuous.

This OAS objective is related to data that motivate a discrete or continuous graph; however, it does not make that clear. See the wording of A2.D.1.3 for an example.

**G.2D.1** Discover, evaluate and analyze the relationships between lines, angles, and polygons to solve real-world and mathematical problems; express proofs in a form that clearly justifies the reasoning, such as two-column proofs, paragraph proofs, flow charts, or illustrations.

In this OAS standard (not objective) it is not clear what the “relationship between lines, angles, and polygons” would be. By lines’ is “sides” what is intended?

**A2.D.1.2** Collect data and use scatterplots to analyze patterns and describe linear, exponential or quadratic relationships between two variables. Using graphing calculators or other appropriate technology, determine regression equation and correlation coefficients; use regression equations to make predictions and correlation coefficients to assess the reliability of those predictions.

An article seems to be missing here: “…determine [“a” or “the”] regression equation…”

**A2.D.1.3** Based upon a real-world context, recognize whether a discrete or continuous graphical representation is appropriate and then create the graph.

This wording is much clearer than the Algebra I counterpart (A1.D.1.3). However, some mention of data as the basis for the context is still needed.

There are also issues of clarity in the glossary provided in the OAS. There are, for example, a number of terms defined in the glossary that are not used in the OAS. These include “periodic phenomena,” “recursive pattern,” “Remainder Theorem,” and “supposition.” In addition at least one definition, for a continuous graph (of data),

At least one definition results in a very different understanding than what is provided in the CCSS. In the CCSS, “area” is clearly considered an attribute that can be measured (3.MD.5). In the glossary of the OAS, the area is the measurement:

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14 “A graph is continuous if it contains intervals of data points.”

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**Area**: A measurement of the amount of space within a closed two-dimensional shape...
This is a mathematically tenuous position. If area is a measurement, then one figure, measured in two different units, will have two different measures and, by definition, two different areas.\(^{15}\)

The OAS objective 3.N.3.3 is particularly challenging to discern when considered through the definitions provided in the glossary. It mentions decomposition, but the issue is with the meaning of partition:

**3.N.3.3** Recognize unit fractions and use them to compose and decompose fractions related to the same whole. Use the numerator to describe the number of parts and the denominator to describe the number of partitions.

Here is the OAS Glossary definition for partition:

**Partition**: A process of dividing an object into parts or a set into (smaller) subsets. (MA)

Given that a partition is defined as a process, the second part of this standard is incomprehensible. It appears that the OAS expects students to see a denominator as a number of processes.

The OAS, however, does a good job clarifying inverse functions and their connections to compositions of functions:

<table>
<thead>
<tr>
<th>CCSS</th>
<th>OAS</th>
<th>Comments</th>
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<tr>
<td>F.BF.4 Find inverse functions.</td>
<td>A2.F.2.3 Find and graph the inverse of a function, if it exists, in real-world and mathematical situations. Know that the domain of a function ( f ) is the range of the inverse function ( f^{-1} ), and the range of the function ( f ) is the domain of the inverse function ( f^{-1} ).</td>
<td>This OAS pushes beyond the CCSS to deeper understanding of inverse functions.</td>
</tr>
<tr>
<td>F.BF.4b (+) Verify by composition that one function is the inverse of another.</td>
<td>A2.F.2.2 Combine functions by composition and recognize that ( g(x) = f^{-1}(x) ), the inverse function of ( f(x) ), if and only if ( f(g(x)) = g(f(x)) ).</td>
<td>This OAS pushes beyond the CCSS to deeper understanding of inverse functions.</td>
</tr>
</tbody>
</table>

**Measurability**

*Standards should focus on the results, rather than the processes of teaching and learning. They should make use of performance verbs that call for students to demonstrate knowledge and skills, with each standard being measurable, observable, or verifiable in some way.*

Since the standards and objectives of the OAS are generally very procedural, it follows that they are written using language that lends itself to being measurable, observable, or verifiable. They tend to emphasize what students should know and be able to do rather than the process of teaching and learning.

\(^{15}\) The same situation exists for volume in the OAS.
learning. Performance verbs (e.g., create, use, identify, represent, write, apply, solve, determine, etc.) and process verbs (e.g., compare, explain, describe, recognize, etc.) are the lead words for each objective.

Still there are a few objectives with measurability issues in the OAS. For example, in 4.GM.2.5 the expectation is for students to “solve problems that deal with … when to use liquid volumes, when to use mass, …” In this example it is not clear how “knowing when” would be measured or what a problem that deals with “knowing when” would look like. Another example is in grade 6, 6.N.4.2, in which students are expected to “illustrate multiplication and division of fractions to show connections to fractions, whole number multiplication, and inverse relationships.” “Illustrate multiplication and division of fractions and decimals” is clear and measurable, but the remainder of the sentence causes confusion. How would an illustration of operations with fractions show connections to fractions? And how would showing those connections be measured?

**Summary of Mathematics Findings**

The OAS include significant issues related to rigor, coherence, focus, and clarity. While the OAS aim to serve all students, the strong emphasis on procedural standards may leave students in Oklahoma less prepared than their peers in other states. This particularly holds true for students interested in studies or careers in mathematics or STEM-related fields.

Perhaps the most informative comparison in considering college and career readiness is to look directly at the high school expectations for all students that Oklahoma lost and gained in moving from the CCSS to the OAS. The lists below outlines these changes:

**CCSS High School Topics with No Match in the OAS**

- Defining quantities for modeling (see N.Q.2)
- Interpreting expressions (and parts of expressions) in a context (see A.SSE.1)
- The Remainder Theorem (see A.APR.2)
- Using zeros of a polynomial to construct a graph (see A.APR.3)
- Representing constraints by equations (see A.CED.3)
- Explaining steps in solving equations (see A.REI.1)
- Deriving the quadratic formula (see A.REI.4a)
- Explaining intersection points on graphs of equations (see A.REI.11)
- Working with average rate of change on nonlinear functions (see F.IF.6)
- Graphing polynomial functions (see F.IF.7c)
- Using the properties of exponents to interpret expressions for exponential functions (see F.IF.8b)
- Constructing an exponential function given a graph, description, or pairs of points (See F.LE.2)
- Solving exponential models using logarithms (see F.LE.4)
- Working with radian measures (see F.TF.1)
- Explaining the unit circle (see F.TF.2)
- Using trigonometric functions to model periodic phenomena (see F.TF.5)
- Proving the Pythagorean identity (see F.TF.8)
- Describing transformations as functions (see G.CO.2)
- Developing definitions of rigid transformations (see G.CO.4)
- Explaining how triangle congruence criteria work (see G.CO.8)
- Proving theorems about triangles (see G.CO.10 and G.SRT.4)
- Making geometric constructions (see G.CO.12)
- Working with cross-sections (see G.GMD.4)
- Using geometric shapes to describe objects (see G.MG.1)
- Using concepts of density in modeling (see G.GM.2)
- Solving design problems (see G.MG.3)
- Working with two-way frequency tables (see S.ID.5)
- Using residuals to assess the fit of a function (see S.ID.6b)
- Using data to compare two treatments (see S.IC.5)
- Working with conditional probability (see S.CP.3)

**OAS High School Topics That Are Not Addressed in the CCSS for All Students**

- Writing square and cube roots in "simplest radical form" (see A1.N.1.1)
- Rationalizing the denominator (see A1.N.1.2)
- Greater emphasis on absolute value equations and inequalities (see A1.A.1.2, A1.A.2.2)
- Telling the difference between a discrete and continuous graph (see A1.D.1.3) and which is appropriate (see A2.D.1.3)
- Using inductive and deductive reasoning (see G.RL.1.2)
- Assessing a logical argument (see G.RL.1.3)
- Applying ratios derived from three-dimensional figures (see G.3D.1.2)
- Working with (and verifying relations in) 45-45-90 and 30-60-90 triangles (see G.RT.1.2)
- A clear expectation to solve systems of equations with three unknowns (see A2.A.1.8)
- Solving real-world quadratic problems (see A2.A.1.1)
- Synthetic division (see A2.A.1.4)
- Solving logarithm equations (see A2.A.1.6)
- Requiring set and interval notation (A2.F.1.1)
- Graphing rational functions (see A2.F.1.6)
- Connecting inverse functions to composition (see A2.F.2.2), graphs, and domain and range (see A2.F.2.3)
- Converting between exponential and logarithmic forms (see A2.F.2.4)
- Applying the four operations to complex numbers (see A2.N.1.2, (+) in CCSS)

The OAS connect inverse functions to composition of function and add logic. However, Oklahoma has given up many of the important CCSS expectations that focus on understanding and replaced them with explicit expectations for procedures such as synthetic division, rationalizing the denominator, and simplifying radicals.\(^\text{16}\) Minnesota, Virginia, and Nebraska, like the CCSS, do not include matrices, rationalizing the denominator, or synthetic division for all students. Texas works with matrices in

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\(^{16}\) These topics are neither forbidden nor explicit in the CCSS.
Algebra II but connects that work to solving systems of equations. For Oklahoma students, no such connection is made. The OAS are maintaining the old expectation of school mathematics to be a mile wide and an inch deep.

As such, the Oklahoma standards are a set of learning goals that are unique to Oklahoma. Unfortunately, their uniqueness lies in issues of shifted focus, gaps in coherence, lessened rigor for understanding, and a lack of clarity. They are far from world-class. Additionally, Oklahoma districts will be unable to use existing CCSS-aligned textbooks or assessments. New textbooks will have to be authored and adopted and new assessments will have to be designed. Oklahoma educators will find it difficult to adopt, adapt, or share CCSS-aligned grade- or course-level curriculum or open resources to meet the requirements of their new standards.
### Appendix: The Criteria Used for the Evaluation of
College- and Career-Ready Standards in English Language Arts and Mathematics

<table>
<thead>
<tr>
<th>Criteria</th>
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<tbody>
<tr>
<td><strong>Rigor:</strong> What is the intellectual demand of the standards?</td>
<td>Rigor is the quintessential hallmark of exemplary standards. It is the measure of how closely a set of standards represents the content and cognitive demand necessary for students to succeed in credit-bearing college courses without remediation and in entry-level, quality, high-growth jobs. For Achieve’s purposes, the Common Core State Standards represent the appropriate threshold of rigor.</td>
</tr>
<tr>
<td><strong>Coherence:</strong> Do the standards convey a unified vision of the discipline, do they establish connections among the major areas of study, and do they show a meaningful progression of content across the grades?</td>
<td>The way in which a state’s college- and career-ready standards are categorized and broken out into supporting strands should reflect a coherent structure of the discipline and/or reveal significant relationships among the strands and how the study of one complements the study of another. If college- and career-ready standards suggest a progression, that progression should be meaningful and appropriate across the grades or grade spans.</td>
</tr>
<tr>
<td><strong>Focus:</strong> Have choices been made about what is most important for students to learn, and is the amount of content manageable?</td>
<td>High-quality standards establish priorities about the concepts and skills that should be acquired by graduation from high school. Choices should be based on the knowledge and skills essential for students to succeed in postsecondary education and the world of work. For example, in mathematics, choices should exhibit an appropriate balance of conceptual understanding, procedural knowledge and problem solving skills, with an emphasis on application. In English language arts, standards should reflect an appropriate balance between literature and other important areas, such as informational text, oral communication, logic, and research. A sharpened focus also helps ensure that the cumulative knowledge and skills that students are expected to learn is manageable.</td>
</tr>
<tr>
<td><strong>Specificity:</strong> Are the standards specific enough to convey the level of performance expected of students?</td>
<td>Quality standards are precise and provide sufficient detail to convey the level of performance expected without being overly prescriptive. Standards that maintain a relatively consistent level of precision (“grain size”) are easier to understand and use. Those that are overly broad or vague leave too much open to interpretation, increasing the likelihood that students will be held to different levels of performance, while atomistic standards encourage a checklist approach to teaching and learning that undermines students’ overall understanding of the discipline. Also, standards that contain multiple expectations may be hard to translate into specific performances.</td>
</tr>
<tr>
<td><strong>Clarity/Accessibility:</strong> Are the standards clearly written and presented in an error-free, legible, easy-to-use format that is accessible to the general public?</td>
<td>Clarity requires more than just plain and jargon-free prose that is also free of errors. College-and career-ready standards also must be communicated in language that can gain widespread acceptance not only from postsecondary faculty but also from employers, teachers, parents, school boards, legislators, and others who have a stake in schooling. A straightforward, functional format facilitates user access.</td>
</tr>
<tr>
<td><strong>Measurability:</strong> Is each standard measurable, observable, or verifiable in some way?</td>
<td>In general, standards should focus on the results, rather than the processes of teaching and learning. College and career-ready standards should make use of performance verbs that call for students to demonstrate knowledge and skills and should avoid using those that refer to learning activities — such as “examine,” “investigate,” and “explore” — or to cognitive processes, such as “appreciate.”</td>
</tr>
</tbody>
</table>