STATE SCIENCE STANDARDS: AN OVERVIEW AND ANALYSIS OF REVIEW, REVISION, AND ADOPTION PROCESSES IN STATES IN THE U.S.

Tiffany Neill and Doug Paulson

Since the publication of the *Framework for K-12 Science Education* in 2010 and the subsequent development of the *Next Generation Science Standards* (NGSS) in 2012, 48 states have adopted the NGSS or Framework informed academic standards for K-12 science. These standards have then served to guide curriculum, instruction, and state and classroom assessments across the nation, introducing thousands of teachers and students to phenomenon-driven instruction and the three-dimensions of science. These opportunities, in many ways, have been dependent on supervisors of state science education who have led state standards review, revision, and adoption processes for science at State Education Agencies (SEA)s and other education stakeholders involved in the processes, navigating complex and often politically charged contexts.

Under current federal law, all states are required to adopt challenging content standards in various content areas including science (Every Student Succeeds Act, 2015). However, state legislatures in nearly all states possess the authority to set state academic standards and often task state boards of education or SEAs with reviewing and revising standards. A variety of steps are taken by states to conduct state standards reviews, engage stakeholders in the process, and adopt standards for final use by school districts and teachers to inform instruction.

In this paper we describe the role of state standards in educational systems and the various state standards setting processes utilized within states. We also highlight common themes associated with those processes and tools utilized by various states in state standards review, development or revision, and adoption processes. We acknowledge that our background and experiences in leadership positions at SEAs, guiding and leading state standards review, revision, and adoption processes, shape our perspectives. Therefore, we reference artifacts from an array of SEA websites and state laws directly, in addition to sharing our personal insights related to standards review, revision, and adoption process throughout this paper.

The states profiled in the paper were chosen to illustrate the differing approaches taken in reviewing, revising, and adopting state standards for science.

THE ROLE OF ACADEMIC STANDARDS IN STATE SYSTEMS OF EDUCATION

A standard, as defined by Webster's Dictionary is, "something set up and established by authority as a rule for the measure of quantity, weight, extent, value, or quality". States define standards in different and common ways. The introductory material for the state science standards of Oklahoma (2019) states that, "standards specify what students should know and be able to do as learners of science at the end of each grade level or science course". Oklahoma goes on to describe standards as specific areas of student learning that are considered the most important for proficiency in a discipline at a particular grade or level, signaling that standards are not intended to represent the breadth and depth of all concepts and skills associated with science. Several states, like Massachusetts, support this notion and explain that their standards represent,

"the most essential material for students to know and do" but do not represent "an exhaustive list of all that could be included in a student's science education" (Massachusetts, 2016, p.3). Massachusetts also indicates that, "students should not be prevented from going beyond them [the standards] where appropriate" (Massachusetts, 2016, p.3), a common theme across states for standards and standards implementation. It has long been the intent of state academic standards to describe what students should know and be able to do by the end of grade 12 to ensure students are college, career, and citizen ready without limiting schools, classroom teachers, or students from engaging in teaching and learning experiences that go beyond the standards (NSES, 1996 NGSS, 2013).

Wisconsin's definition of standards as "statements about what students should know and be able to do, what they might be asked to do to give evidence of learning, and how well they should be expected to know or do it" (2017, p.3), intimates that state standards are designed as assessment standards that are to be utilized to design state and local assessments. This is a dominant assertion by most states. Several states refer to their state science standards as a set of performance expectations that are assessable statements of what students should be able to do to demonstrate understanding (California, 2013; Kentucky, 2015; Michigan, 2015). This definition seems to fulfill the purpose of standards as envisioned in the *Framework for K-12 Science Education* (Framework) and its assertion that standards refer to "statements that describe activities and outcomes that students are expected to achieve in order to demonstrate their ability to understand and apply the knowledge described in the disciplinary core ideas" (NAS, 2010, p.18). The Framework goes on to state that, "standards and performance expectations [for science] must be designed to gather evidence of students' ability to apply the practices and their understanding of the crosscutting concepts in the contexts of specific applications in multiple disciplinary areas" (p.18). Currently, 96% of states have adopted standards that align to the vision for science education described in the Framework and NGSS (NSTA, 2023).

Minnesota's approach to academic standards differs slightly from many other states in that they define an academic standard as a "summary description of student learning in a required content area" (Minn. Stat. § 120B.018). Minnesota then provides a set of benchmarks which represent "specific knowledge or skill that a student must master to complete part of an academic standard by the end of the grade level or grand band" (Minn. Stat. § 120B.018). The benchmarks are similar in intent to other state standards or performance expectations.

The Framework proposed that, "standards provide a vision for teaching and learning, but the vision cannot be realized unless the standards permeate the education system and guide curriculum, instruction, teacher preparation and professional development, and student assessment" (NAS, 2010, p. 241). There is often confusion regarding the distinctions between standards, curriculum, instruction, and assessment, the role each component plays in the education system, and their interconnectivity. The Framework defines standards, curriculum, instruction, and assessment as outlined in Table 1.

Table 1

Definitions for Standards, Curriculum, Instruction, and Assessment

STANDARDS	CURRICULUM	INSTRUCTION	ASSESSMENT
Provide guidance to education professionals about the priorities for science education and articulate the learning goals that must be pursued in curricula, instruction, and assessments.	Curriculum refers to the knowledge and practices in subject matter areas that teachers teach and that students are supposed to learn. A curriculum generally consists of a scope, or breadth of content, in a given subject area and of a sequence of concepts and activities for learning. While standards typically outline the goals of learning, curricula set forth the more specific means—materials, tasks, discussions, representations—to be used to achieve those goals.	Instruction refers to methods of teaching and the learning activities used to help students master the content and objectives specified by a curriculum. Instruction encompasses the activities of both teachers and students. It can be carried out by a variety of pedagogical techniques, sequences of activities, and ordering of topics.	Assessment refers to the means used to measure the outcomes of curriculum and instruction—the achievements of students with regard to important competencies. Assessment may include formal methods, such as large-scale standardized state testing, or less formal classroom-based procedures, such as quizzes, class projects, and teacher questioning.

Note: Adapted from "*A framework for K-12 science education: Practices, crosscutting concepts, and core ideas" by* National Research Council. (2012). The National Academies Press.

The role of standards in relation to curriculum, instruction, and assessment are often clarified in state legislation, the front matter of state standards documents, and/or guidance for implementing standards at school or classroom level. Michigan states:

> "They [standards] are not curriculum and they do not specify classroom instruction. Standards should be used by schools as a framework for curriculum development with the curriculum itself prescribing instructional resources, methods, progressions, and additional knowledge valued by the local community" (Michigan, 2015, p.4).

Wisconsin asserts that:

> "Standards are statements about what students should know and be able to do, what they might be asked to do to give evidence of learning, and how well they should be expected to know or do it. Curriculum is the program devised by local school districts used to prepare students to meet standards. It consists of activities and lessons at each grade

> level, instructional materials, and various instructional techniques. In short, standards define what is to be learned at certain points in time, and from a broad perspective, what performances will be accepted as evidence that the learning has occurred. Curriculum specifies the details of the day-to-day schooling at the local level" (Wisconsin, 2017, p.3).

This distinction is imperative as standards and curriculum are often interpreted by many non-educators as synonymous, leading to confusion and assumptions that specific learning activities or instructional materials are prescribed at a state level in standards. Therefore, it is important that states continue to clarify that standards outline what students are expected to know and do in each grade or grade-band, but determinations about ways of teaching, materials utilized to provide instruction, and the order and sequence for instruction over the course of a year or grade-band are left to the determinations of school districts or classroom teachers. Massachusetts explains that "they [standards] do not dictate a manner or methods of teaching. The standards are written in a way that expresses the concept and skills to be achieved and demonstrated by students, but leaves curricular and instructional decisions to districts, schools, and teachers" (Massachusetts, 2016, p.25). Oklahoma guidance states that, "the order of the standards at any grade level is not meant to imply a sequence of topics and should be considered flexible for the organization of any course" (Oklahoma, 2019, p.3). Michigan references similar intent in the introduction to their state standards stating that, "teachers have the flexibility to arrange the standards in any order within a grade level" and that teachers can, "add areas of study to suit the needs of their students and science programs" including, "various applications of science, such as biotechnology, clean energy, medicine, forensics, agriculture, or robotics, would nicely facilitate student interest and demonstrate how the standards are applied in real-world contexts" (Massachusetts, 2016, p.25). Ultimately state standards are intended to be used by local districts, schools, and classroom teachers to make decisions about curriculum, instruction, and assessment and they provide a framework for schools and teachers to develop an aligned science curriculum.

State standards for science do serve to guide state and local assessments. Michigan asserts that, "at the state level, these standards provide a platform for state assessments, which are used to measure how well schools are providing opportunities for all students to learn the content outlined by the standards" (Michigan, 2015, p.4). According to New Jersey, "they [standards] are written as statements that can be used to guide assessment and allow for flexibility in the way that students are able to demonstrate proficiency" (NJDE, 2020, p. 2). Standards also impact other statewide policies, such as considerations for teacher certification and credentials, school improvement, and accountability, to name a few.

FORMAL AND INFORMAL POLICIES AND PRACTICES UTILIZED BY STATES TO REVIEW, REVISE, AND ADOPT STANDARDS

Policies and practices utilized by states to review, revise, and adopt standards vary but maintain common elements. Some of the policies and practices utilized are formal and identified in state laws or administrative rules. Others are utilized by state boards of education or state education agencies to guide the process but are not codified in law. Formal and informal policies and practices leveraged for review and adoption of state academic standards are considerable and often include: (1) preparing data and information to inform the review, (2) adhering to a timeline,

(3) organizing committee structures and compositions, (4) gathering and utilizing stakeholder feedback, (5) obtaining certifications or validation for the standards, and (5) gaining layers of approval. Each of these policies and practices will be explored in further detail in this section with examples from states that have published or shared their policies or practices.

Preparation for State Standard Reviews

As State Boards of Education or State Education Agencies begin standards review processes, an individual or team of individuals is traditionally charged with leading the process. State science curriculum coordinators have traditionally been identified to lead the process for science standards reviews. State science curriculum coordinators are individuals who have been designated by their chief state school officer as having statewide science education as their primary responsibility. State science curriculum coordinator titles include but are not limited to science education specialist, science education consultant, and director of science education.

Although predominantly informal in nature, there are several practices that states engage in to prepare for standards a review process. These practices include reviewing current research on teaching and learning; collecting and organizing feedback from practitioners who have implemented the standards; analysis of trends in state and national assessments; examination of current college and career readiness requirements and assessing the current cultural and political contexts under which the standards may be influenced.

The Role of Research in State Standards Review

Early in the preparation process for standards review, most states examine current research conducted in the subject-area of the standards under review and compile it for committees of stakeholders to consider as reviews are conducted. Prior to the revision of Oklahoma science standards in 2014, an examination of the history of science standards revisions in the state was conducted showcasing the research-based documents utilized to inform standards reviews since 1990 (see Figure 1). The examination showcased that prior to each state standards revision, research informed recommendations had been published and utilized by state standards committees to inform the development of the standards.

Figure 1:

History of Research Utilized to Inform Oklahoma Science Standards Reviews

1989 – Science for All Americans (AAAS)
1990 – Oklahoma Recommended *Learner Outcomes: State Competencies Grades 1-5 and Grades 6, 7-8, and 9-12*
1993 – Benchmarks for Science Literacy (AAAS)
1993 – Oklahoma Priority Academic Standards Skills (*PASS*) Identified process skills for science (content not provided)
1996 – National Science Education Standards (NRC)
1997 – Revision of Oklahoma *PASS* included content standards
2000 – How People Learn (NRC)
2000 – Inquiry and the National Science Education Standards (NRC)
2002 – Revised Oklahoma *PASS* to depict grade level K-8 and 9-12 course subject areas
2005 – How Students Learn: Science in the Classroom (NRC)
2006 – Slight Revision of Oklahoma *PASS*
2007 – Taking Science to School (NRC)
2011 – Slight Revision of Oklahoma *PASS*
2012 – Framework for K-12 Science Education (NRC)
2014 - Oklahoma Academic Standards for Science Adopted

Note: The timeline provided to the authors of this paper but not formally published elsewhere.

Many states have documented the use of research-based reports in Figure 1 in their state reviews as well. States like Minnesota also utilized reports like *Engineering in K-12 Education: Understanding the Status and Improving the Prospects* (NAS, 2009) to inform their standards development and revision processes to include aspects of K-12 engineering education.

Use of Surveys and Focus Groups to Provide Insights on Current Science Standards

Insights from PK-12 educators who have utilized state science standards to guide instruction, curriculum, and assessments in addition to other education stakeholders (e.g., school administrators, higher education faculty, families, and the general public) are often intentionally

collected by states as part of the preparation process for a standards review process. These insights serve as valuable data to guide continuous improvement efforts for standards reviews. Nebraska began the science standards review process in 2016 with the dissemination of a public input survey through formal and informal networks throughout the state. Surveys such as this often include question constructs about clarity, content, and rigor of standards.

Some states host a series of focus groups to inform upcoming standards review processes. Prior to the review of the *Pennsylvania Science and Technology and Environment and Ecology Standards* in 2020, the state conducted numerous focus groups with a variety of education stakeholders in the state, including students using the questions in Figure 2.

Figure 2:

Focus Group Questions Utilized to Collect Stakeholder Input Prior to the Review and Revision of the Pennsylvania Science and Technology and Environment and Ecology Standards

1. What hopes, concerns, and questions do you have for the update of the Pennsylvania Science and Technology/Environment and Ecology Standards?
2. What is your vision for Pennsylvania's updated science standards?
3. What crucial elements should the standards include?
4. What impact should the standards have on teaching and learning in Pennsylvania?
5. What are the strengths and challenges of Pennsylvania's current Science and Technology/Environment and Ecology Standards?
6. What knowledge, skills, and dispositions should be included in the updated standards for all students?

Note: Adapted from, "*Science and Technology and Environment and Ecology Standards: A National Landscape Scan and Pennsylvania Stakeholder Feedback*" by the American Institute for Research (AIR). (2020).

Table 2 showcases the diverse stakeholders engaged in the focus groups process and the number of attendees.

Table 2:

Focus Group Sessions Conducted Prior to Review and Revision of the Pennsylvania Science and Technology and Environment and Ecology Standards

Session	Grades PK–2 Educator	Grades 3–5 Educator	Grades 6–8 Educator	Grades 9–12 Educator	Admin	Higher Ed	Business and Industry	IU	Students	Other
In-person sessions	24	49	99	106	65	30	30	7	14	17
Virtual sessions	11	28	58	108	99	58	101	20	2	25
Total	**35**	**77**	**157**	**214**	**164**	**88**	**131**	**27**	**16**	**42**

Note: Adapted from, "*Science and Technology and Environment and Ecology Standards: A National Landscape Scan and Pennsylvania Stakeholder Feedback*" by the American Institute for Research (AIR). (2020).

The subsequent report, *Science and Technology and Environment and Ecology Standards: A National Landscape Scan and Pennsylvania Stakeholder Feedback* (2020) captures the feedback from the stakeholder focus groups, and connects the feedback with student data, best practices found in other states and research-based recommendations for science, technology, and engineering education.

Washington state consults with a Dual Language Committee and a Multilingual Advisory Committee in their standards review process to gain insights about current standards as part of their preparation process for standards reviews (WOSPI, 2023).

State and National Assessment Data Used to Informs Standards

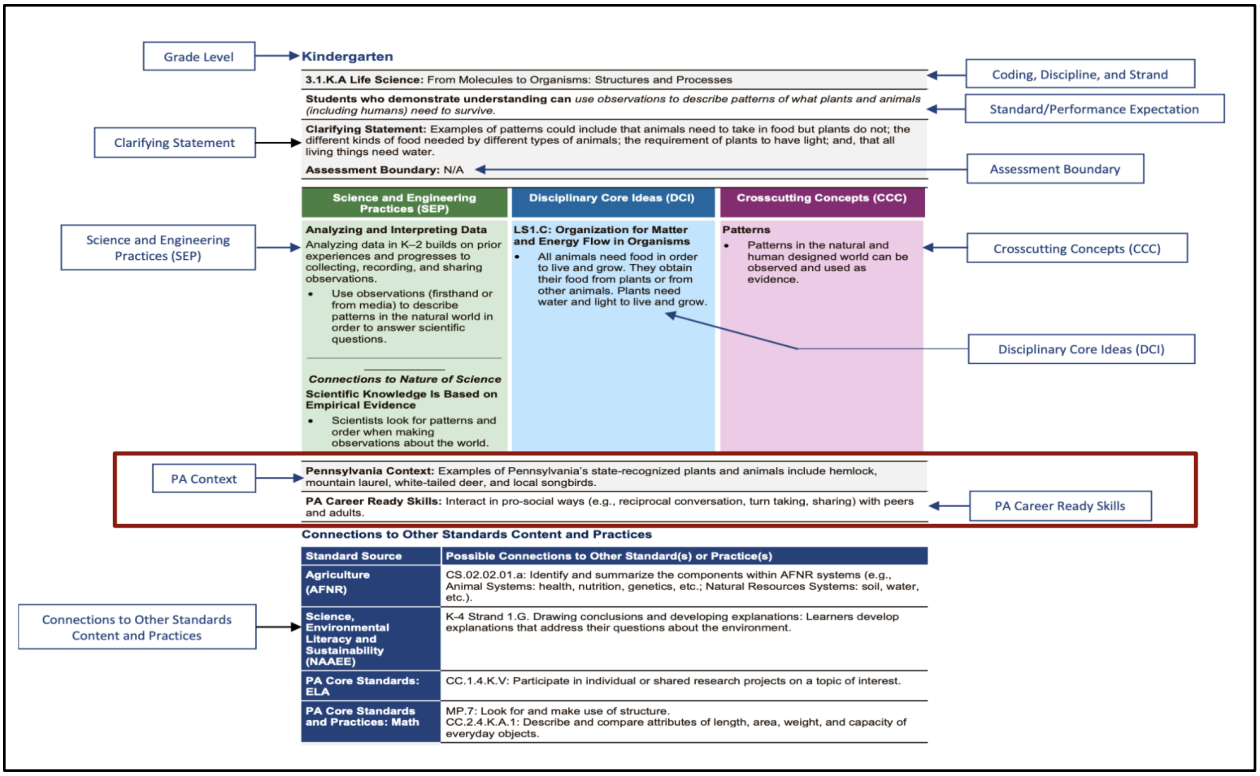
Data servers as an essential component of the standards review process in many states. In Minnesota's most recent science standards review process, student proficiency data from the Minnesota Comprehensive Assessment, the *National Assessment of Educational Progress* (NAEP), and previous data from the *Trends in International Mathematics and Science Study* (TIMSS) were utilized to identify gaps in student learning. Identified gaps were then utilized in the standards review process by committee members to explore where lack of clarity within the standards or potential gaps in student learning might exist as evidence and rationale for proposed changes to standards.

States often consider current trends for college and career readiness in their standards review process. Insights from *The American Diploma Project* (2004) have been utilized by some states to ensure that learning goals exhibited in science standards align with the skills required for post-secondary success. States often engage with representatives of post-secondary institutes, career and technical education, and business and industry to inform standards review processes, often inviting representatives from these sectors to serve on standards committees in some capacity. Pennsylvania prioritized efforts to make a stronger connection between standards and the

commonwealth's goals for post-secondary success in their most recent standards review process. Ultimately, the final version of the Pennsylvania standards reflects opportunities for intentional integration across domains (e.g., environmental stewardship in Environmental Literacy integrated with natural resources from Earth and Space Science) to support post-secondary success. The *Pennsylvania Science, Technology, & Engineering, and Environmental Literacy & Sustainability Standards* (PDE, 2022) also reflect connections to state contexts and to the *Pennsylvania Career Ready Skill*s (PDE, 2023) as showcased in Figure 3.

Figure 3:

Excerpt of Pennsylvania Science, Technology, & Engineering, and Environmental Literacy & Sustainability Standards



Note: Adapted from, "*Pennsylvania Science, Technology, & Engineering, and Environmental Literacy & Sustainability Standards*" by the Pennsylvania Department of Education (PDE), 2022. https://www.education.pa.gov/Teachers%20-%20Administrators/Curriculum/Science/Pages/Science-Standards.aspx

Guiding Principles, Assumptions and Criteria Utilized in Standards Reviews

Some states develop guiding principles or assumptions to guide their standards review process. The guidance principles and assumptions are informed by state laws and research and communicate established non-negotiables for the standards review process. Minnesota established *Assumption for Guiding the Standards Committee Work* (Minnesota, 2018) standards for their science standards review process in 2018-2019 which communicated, among other assumptions, that the *Framework for K-12 Science Education* would inform the standards review

process and that the process must include the contributions of Minnesota American Indian tribes and communities as they relate to the academic standards during the review and revision of their standards. The assumptions that guided Minnesota's science standards review process can be found in Figure 4.

Figure 4:

Minnesota K-12 Academic Standards Review Process – Science 2018-19 Assumptions for Guiding the Standards Committee's Work

Minnesota K-12 Academic Standards Review Process – Science 2018-19

Assumptions for Guiding the Standards Committee's Work

1. A standards review committee will be formed that represents the following stakeholders: teachers, administrators, higher education, business/industry, and citizens. It will include content teachers in physical science, Earth and space science, life science, and engineering. The committee will include geographic and racial diversity.
2. The committee will seek public input through town hall meetings, focus groups and electronic surveys.
3. Members of the standards committee will commit to the committee's meeting schedule and workload.
4. The standards and benchmarks should be aligned with the knowledge and skills needed for college readiness (Minn. Stat. § 120B.021, subd. 4(a)).
5. Technology and information literacy standards must be embedded into the standards in each content area. This may include standards from sources such as the Information and Technology Educators of Minnesota (ITEM) and International Society for Technology in Education (ISTE).
6. Computer science concepts and skills must be integrated into the standards as appropriate. This may include standards from sources such as the *Computer Science Teachers Association Standards*.
7. Science standards should be revised with the assumption that all students will complete three credits, including a biology credit, and either a chemistry or a physics credit. The combination of courses should help students satisfactorily accomplish all the 9-12 science standards.
8. The standards will be informed by *A Framework for K-12 Science Education* and include the dimensions of the scientific and engineering practices, crosscutting concepts, and disciplinary core ideas.
9. The science standards will encompass concepts and skills in nature of science and engineering. They will also include engineering, physical science, life science and earth and space sciences concepts. In addition, at the 9-12 level there will be standards for physics and chemistry courses.
10. Science standards will reflect the scientific facts, laws, and theories of the natural and engineered world.
11. The standards and benchmarks identify the learning that is to be mastered by all students by the end of the grade for K-8 and the band 9-12. As such, they represent the

core, rather than the totality, of a school's science curriculum.

12. Standards for environmental literacy will be identified and/or developed to comply with Minn. Stat. § 115A.073.
13. Standards will align coherently with those for other K-12 subjects, including the Literacy Standards for Science in the *Minnesota K-12 Academic Standards in English/Language Arts*.
14. The committee "must include the contributions of Minnesota American Indian tribes and communities as they relate to the academic standards during the review and revision of the required academic standards." (Minn. Stat. § 12-B/021, subd. 1)
15. The committee will study exemplary standards from other states and countries as well as state, national and international assessment frameworks, and data.
16. The committee will take into account issues related to diversity and equity, including designing standards that provide students with multiple ways of demonstrating competence in science and portraying a true and accurate depiction of science and engineering stakeholders.

Note: The Assumptions for Guiding the Standards Committee's Work was published in Minnesota's committee member's application to participate in the process.

Oklahoma and New Jersey identified *Attributes of Quality Science Standards (*Figure 5*)* in addition to guiding assumptions in their most recent science standards review processes as criteria to guide committee members during their review process.

Figure 5:

Attributes of Quality Science Standards

Attributes of Quality Science Standards

1. Represents a rigorous learning goal.
2. Scientifically accurate.
3. Clear, concise, and comprehensible to science educators.
4. Includes and integrates all three dimensions (crosscutting concepts, science and engineering practices and disciplinary core ideas).
    a. Crosscutting concepts are explicit and direct the performance expectation of the standard.
    b. Selected science and engineering practices are meaningful for the performance expectations of the standard.
    c. Requires the use of core ideas to make sense of phenomenon.
5. Represents a clear component of a progression of learning across grade-bands.
    a. Does not represent a duplication of any other standard.
    b. Represents a balanced distribution across grade-bands.
6. Multiple phenomena can be used to drive instruction leading to student proficiency of measures of the standard (assessment).
7. Standard should lead to instruction that is interesting and relevant to all students in a diverse student population.
8. Represent important science ideas students can use to make sense of phenomenon beyond the classroom.

Note: The Attributes of Quality Science Standards were provided to the authors of the paper by states and were not formally published elsewhere.

While most state practices associated with preparing for a standards review process are informal in nature, some states do have formal policies or structures that guide their preparation practices. For example, Ohio is required to form an advisory group to guide the scope and sequence of the standards review, identify, and recommend resources to be used in the process, determine documents to be referenced, or other state, national or international standards to review.

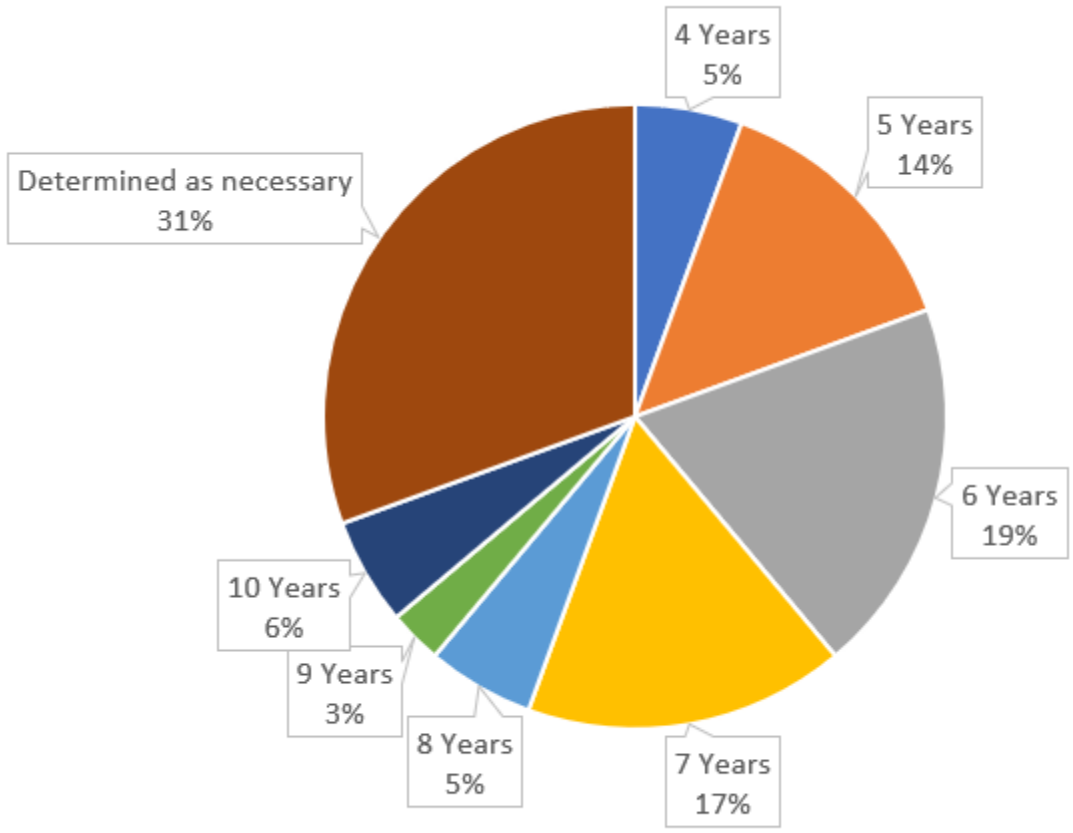
Timeline Considerations for State Standards Reviews

How often are state standards reviewed?

States range in the frequency of their review and revision of state. standards. Table 3 provides an illustration of the frequency of states that have identified timelines and publicly share the data.

Table 3:

Regularity of States Review of Academic Standards

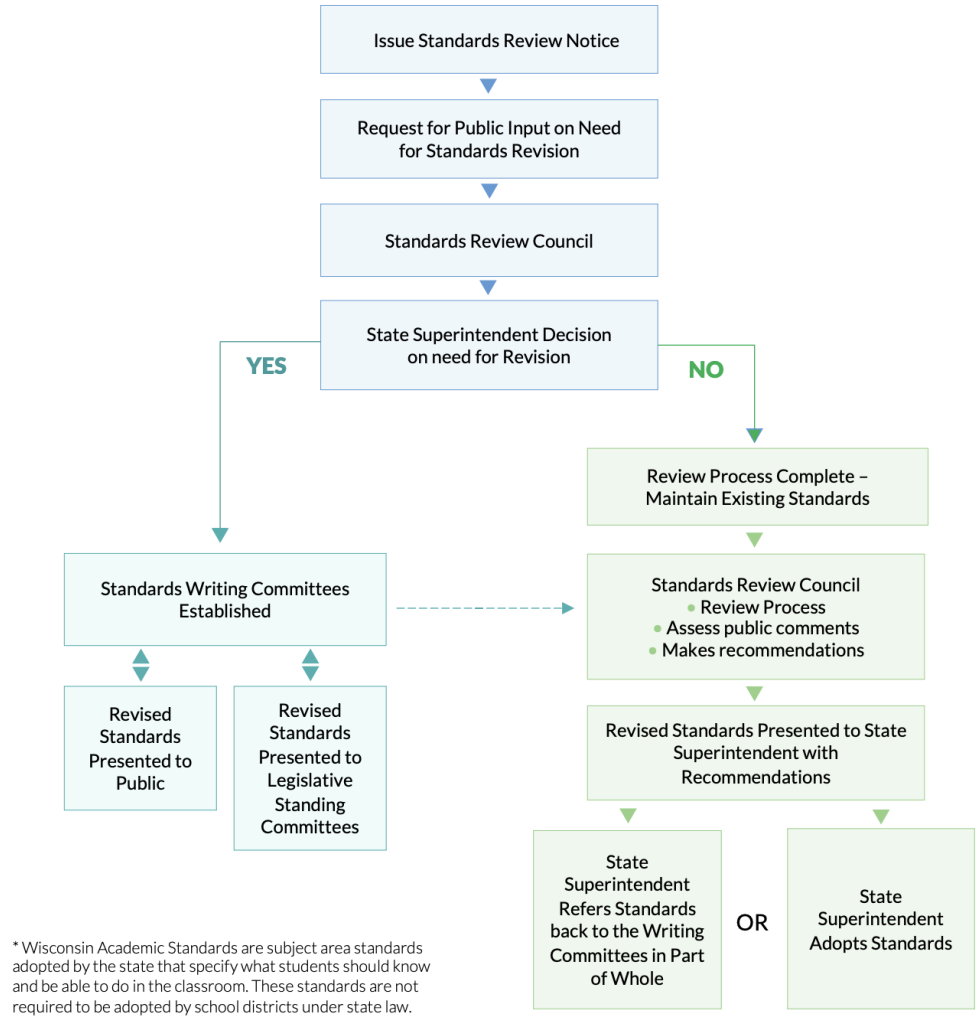


Note: The regularity of state standards reviews, and revision processes include 36 states that publish their timelines.

The regularity of standards reviews is required by law in some states or conducted on a regular cycle in correspondence with state-level instructional material evaluations. In some states cycles for standards reviews have been established by State Boards of Education or State Education Agencies and in others, standards are reviewed when prompted by the entity with legal oversight of the standards due to new research or national recommendations for teaching and learning. Some states, like Wisconsin, seek public comment and convene a standards review council to determine if a standards review process is warranted (see Figure 6).

Figure 6:

Wisconsin's Process for Determining if a State Standards Review is Warranted



Note: Adapted from, The Wisconsin Academic Standards Review and Revision Process", by the Wisconsin Department of Public Instruction, (2022). https://dpi.wi.gov/sites/default/files/imce/standards/New%20pdfs/dpi-standards-review-process.pdf

In Colorado, SEA staff conduct a comparison of existing standards to national and international benchmarks. A report with this analysis is then submitted to the Colorado State Board of Education to determine the extent to which standards should be updated. If the board determines revisions are necessary, a process is then created with stakeholder engagement to review and recommend updates to the board.

How long do state standard review processes take?

Some states, such as Kentucky (Kentucky Revised Statutes (KRS) 158.6453, 2019) and Minnesota (Minn. Stat. § 120b.024), require that standards review processes be conducted within a single school year. Other states do not place time constraints on standards review processes but are often driven by deadlines associated with legislative sessions. In Oklahoma, standards are adopted into administrative rule by the state legislature. Therefore, standards must be submitted to the state legislature by early March of a given year for consideration of approval and approved by the Oklahoma State Board of Education prior to that deadline. However, determinations about the length of time afforded for standards reviews are under the discretion of the State Education Agency (SEA) and have ranged from 12 - 18 months.

Many states publish a timeline for their state standards review process including critical dates associated with process milestones. The Maine standards review process, steps, and timeline are provided in Figure 7.

Figure 7:

Maine Standards Review Process, Steps, and Timeline

Step 1: (Fall) Commissioner gives approval to begin standards review process.
Step 2: (Fall) Public comment period and hearings on current content standards
Step 3: (Winter) Steering Committee: A committee of content area experts who represent the cultural diversity found in Maine and a range of viewpoints as to the content of the standards is formed and tasked to: ● review all comments submitted during the initial public comment period; ● develop a blueprint for the revision of the state standards in their assigned content area; ● address and advise the writing committees when deadlocks occur; and ● determine when the writing teams have completed their work and the standards are ready to be moved on to the next step in the process.
Step 4: (Winter) Maine DOE review and approval of the steering committee's recommended blueprint for standards revision.
Step 5: (Summer) Writing Team: Teams of pk-12 public school teachers who represent Maine's cultural and geographical diversity are formed and broken into smaller groups, facilitated by the Maine DOE content specialist, to revise content standards based on guidance from the Steering Committee.
Step 6: (Summer) The Writing Team submits a draft proposal to the Maine DOE.
Step 7: (Fall) Internal Maine DOE review of standards revision
Step 8: (Fall) The Maine DOE files the standards revision document as proposed rules with the Secretary of State.
Step 9: (Fall) Maine DOE will hold a public hearing followed by a public comment period on the proposed rules.
Step 10: (Winter) Maine DOE prepares and submits provisional adoption of standards revision to the Secretary of State and Legislative Council. The Legislature, once in session in January, will refer the rule as a legislative document to the Education and Cultural Affairs Committee where they will be given an LD Resolve to revise during session
Step 11: (Winter) The Education and Cultural Affairs Committee will hold a public hearing and work session before sending the proposed rules on to the full legislature.
Step 12: (Spring) Final adoption of revised standards by the Maine State Legislature
Step 13: (Spring) The Maine DOE will prepare the standards regulation for final adoption.

Note: Adapted from, "*Maine Standards Review Process*" by the Maine Department of Education. (2023, June 2). https://www.maine.gov/doe/learning/content/standardsreview/steps

Stakeholder Engagement

States include an array of opportunities for stakeholders to engage in their standards review, revision, and adoption processes. The opportunities include serving on advisory panels, committees, participating in focus groups, and providing input during public comment periods or public hearings.

Committees and Advisory Panels

The number of committees and advisory panels, as well as their purposes vary across states. Kentucky law states how many committees and advisory panels are to be utilized in their state standards review and/or revision process, along with requirements for the compositions of those committees and advisories. Table 4 provides an overview of these requirements.

Table 4:

Kentucky State Standards Committee and Advisory Roles and Composition

STANDARDS AND ASSESSMENTS PROCESS REVIEW COMMITTEE	STANDARDS AND ASSESSMENT REVIEW COMMITTEE	ADVISORY PANELS
Role	**Role**	**Role**
Review the process to ensure shareholders had adequate opportunity for input. If the process is found sufficient, the recommendations (without amendment) go to the Kentucky Board of Education for consideration.	Review findings, including public comments/feedback and make recommendations to the process review committee revise or replace existing standards and review assessments to ensure alignment with the standards.	Review the standards and assessments and make recommendations for changes to the review committee.
Composition	**Composition**	**Composition**
● Commissioner of Education - *or designee, as a non-voting member* ● 9 voting representatives of public schools, including: ○ 2 parents of public-school students ○ 1 language arts teacher ○ 1 math teacher ○ 1 science teacher ○ 1 social studies teacher ○ 2 principals ○ 2 superintendents ○ 1 school board member	● 6 public school educators, who teach in the academic content area being reviewed. ● At least 1 representative from higher education ● Other community shareholders	For each grade band - *elementary (K-5), middle (6-8) and high school (9-12)* ● At least six public school educators who teach the content standards being reviewed. ● A representative from an institution of higher education in Kentucky for each grade band.

Note: Adapted from, "*Kentucky Academic Review Process*" by the Kentucky Department of Education (KDE). (2023. June 2). https://education.ky.gov/curriculum/standards/revision/Pages/default.aspx

The nine representatives of the Standards and Assessment Process Review Committee are appointed by the Governor of Kentucky and confirmed by the Senate. On making appointments to the committee, the Governor shall ensure: (1) broad geographical urban and rural representation; (2) representation of elementary, middle, and high school levels; (3) ensure equal

representation of the two (2) sexes, inasmuch as possible; and (4) ensure that appointments reflect the minority racial composition of the Commonwealth (KRS 158.6453, 2019).

The commissioner of education in Kentucky and the president of the Council on Postsecondary Education shall also provide consultants for the standards and assessments review [and development] committees and the advisory panels who are business and industry professionals actively engaged in career fields that depend on the various content areas.

Other states, such as Oklahoma, do not prescribe in law the number and makeup of committees or advisories for standards review processes. During the last two science standards review cycles in Oklahoma, three committees were utilized in the process, comprising over 60 stakeholders. A six-member executive committee was established to oversee the process for standards review. A writing committee, divided into four grade-band working committees (PK-2, 3-5, 6-8, 9-12), was utilized to review and make recommendations for modifications to standards, and a draft committee reviewed writing committee recommendations for additions or modifications to standards prior to the publication of proposed changes for public comment. Most committee members were classroom teachers of science. Other committee members included representatives from institutions of higher education, career technology centers, informal educators, parents and family members of PK-12 students, and representatives from business and industry.

For both the writing and draft committees, Oklahoma utilized an application process to select participants for the committees. The application process was made available to anyone in the state with the executive committee conducting a blind review of the applicants to make selections based on established criterion. This process is commonly utilized by states that do not appoint committee members. Nebraska also utilizes a rubric to determine the expertise and experience applicants have with teaching, curriculum, standards writing, and working with diverse students in their selection process in addition to ensuring geographic representation and balance on the committees.

In Minnesota, one committee is utilized in the standards review process. However, the committee is divided by content area and grade bands. In this structure everyone is involved in conducting research to inform the process, modifying, or writing standards and reviewing feedback on current standards and proposed changes.

Many states prioritize classroom teacher participation on standards review and revision committees as well as diverse representation from geographic locations, school size and classifications, racial and ethnic backgrounds, and experience working with students receiving special education services, English language supports, and other supplemental supports. University faculty, parents and family members of PK-12 students, business and industry representatives, informal educators, administrators, and Indigenous Nations are also included in state standards review and revision processes in several states.

Public Comments and Public Hearings

States utilize a variety of methods to obtain public input on proposed revisions to state standards prior to final adoption or approval of standards. Methods include surveying the public, in-person

meetings, focus groups, or town halls, and public comment opportunities at legislative hearings or state board of education meetings.

Surveys

Surveys are utilized in many states to gather public feedback on state standards from shareholders across a state. Surveys often include high level questions about the quality of standards being proposed for adoption or approval, specific questions about the clarity, coherence, and rigor of standards, and targeted questions regarding concepts or skills that have been added, deleted, or moved across grade levels. Table 5 showcases a few examples of questions utilized in state surveys to gain feedback on standards.

Table 5:

Examples of Survey Questions for Public Feedback on Proposed State Standards

STATE EXAMPLE SURVEY QUESTIONS SEEKING FEEDBACK ON EACH PROPOSED STANDARD	**STATE EXAMPLE SURVEY QUESTIONS SEEKING BROAD FEEDBACK ON PROPOSED STANDARDS**
I agree with the standard as written. The standard should be discarded. Comments required. The standard should be in a different course. Comments required. The standard should be broken up into several, more specific Standards. Suggested rewrite is required. The standard should be rewritten. Reason must be given, and suggested rewrite is required.	Evaluate how effectively the Standards fulfill the three goals on a scale of 1-3. 1 = Does not meet 2 = Somewhat meets 3 = Meets 1. CLARITY: The standards statements are written with clear language for specific grade levels. Explain the ranking. 2. COHERENCE: The standards work together in a horizontal and vertical progression to develop the science literacy of students at every grade level. Explain the ranking. 3. RIGOR: The standards ensure students are prepared for college, career, and citizenry. Explain the ranking.

Note: Survey questions were provided to the authors of this paper by states. Published versions were not available.

Focus Groups or Town Halls

Focus groups or town hall meetings are often utilized in tandem with stakeholder feedback obtained through statewide surveys to inform the standards review and revision process. Focus groups are often facilitated in states to obtain feedback and insights from specific stakeholder

groups (e.g., elementary teachers, special education teachers, parent and family members, educational organizations, racial and ethnic groups). Several states also facilitate focus group meetings with Indigenous Nations to further foster Government-to-Government relations to enhance PK-12 education. Public town halls are also utilized by states to gain feedback on proposed changes to standards and are often set up in congressional districts within a state providing opportunity for in-person public comments on state standards.

Public Comment at Legislative Hearings and State Board of Education Meetings

Most states provided opportunities for individuals to provide feedback on state academic standards through public comments at legislative hearings and/or state board of education meetings where standards are on the agenda for consideration of approval. Those providing public comment during legislative hearings and/or state board of education meetings are often limited to a few minutes.

Expert and Commissioned Feedback

Some states leverage existing partnerships with national and in-state organizations or commission organizations to conduct an analysis of proposed changes to state standards prior to formal adoption to gain a comprehensive analysis of the clarity, coherence, and rigor associated with the standards. Some states gain expert feedback from individuals recognized as scholars in the field of science education or related to a disciplinary domain (e.g., physical science, life science, earth, and space science) to ensure standards align to contemporary research teaching and learning in science education or to ensure standards are scientifically accurate. Other states engage experts in the areas of special education, emerging multilingual instruction, and culturally sustaining practices, to provide feedback on standards.

States often use multiple strategies outlined above to gain public feedback on proposed changes to state academic standards. Minnesota, for example, includes Tribal Consultation, surveys, town hall meetings, and targeted feedback when the department invites specific stakeholders for their expertise in the feedback in their timeline for standards review. This feedback is often organized and returned to advisory or working/writing committees to consider changes to standards prior to final approval. However, in some state cases, the feedback is considered by legislators or state board of education members in final approvals of state standards.

Validation and Approval Processes

Criterion for Approval of Standards

Criteria for state standards approval are often informed by, but not fully described in state law and include both specific content and skills as well as process steps for standards review and revision. Some states refer to specific domains of science, content, and process skills that must be included or emphasized in state science standards or taught by school districts. For example, in Washington State (RCW 28A.150.210, 2011) states that schools must ensure students know and can apply the core concepts of physical and life sciences as part of their basic education experience. In other states, Earth and space science, chemistry or physics may be referenced in state law as required focal areas for instruction. In Oklahoma, the subject matter statutory requirements for academic standards states that, “standards shall be designed to prepare all

students for active citizenship, employment and/or successful completion of postsecondary education without the need for remedial coursework at the postsecondary level" (70 O.S. § 11-103.6, OSCN 2023).

The Utah State Board of Education (USBE, 2022) outlines regulatory requirements for the specific steps or process to be utilized for the review and revision process. Therefore, criterion for approval of state standards in Utah includes assurance the outlined steps have been adhered to. This usually is the responsibility of staff to document the requirements for the process so that the board may validate at the conclusion of the process. Although not specifically outlined in state law, Minnesota utilized the criteria outlined in Figure 8, as criterion for approval of their state standards for science in 2019. Each of the standards were justified in relation to the criteria and evidence of the justification was provided to decision makers prior to approval of the standards.

Figure 8:

Minnesota Criterion for Approval of State Standards

Minnesota Criterion for Approval of State Standards

- The standards should reflect a developmental progression, meaning that they provide a clear sense of increased knowledge and sophistication of skills from one grade level to the next.
- Standards should be useful for defining and supporting good instruction.
- All standards and benchmarks should be able to be assessed at the classroom or district level (e.g., paper and pencil tests, projects, teacher observations and other classroom-based assessments). Standards and benchmarks should have verbs that indicate assessable action. If an anchor standard approach is utilized, only the benchmarks, rather than the standards and benchmarks, should be accessible at the classroom or district level.
- Standards and benchmarks should be an appropriate "grain size:" Standards should be specific enough to provide direction for assessment and to guide curriculum, but broad enough to capture the "big ideas" (i.e., the major concepts and essential skills) and to allow for a variety of curriculum approaches. Each benchmark should be limited to one concept or skill and the concept or skill should be substantive enough to require more than one class period to teach it.
- The knowledge and skills of the content should be reflected in a manageable number of standards and benchmarks.
- There should be consistency in the "grain size" of standards and benchmarks.
- There should be consistent use of terminology within a content area.

Note: The *Minnesota Criterion for Approval of State Standards* was modified from the Council of Chief State School Officers Collaborative work, and the *Minnesota K-12 Academic Standards in Science: Statement of Need and Reasonableness,* MDE. (2021), p.16.

In Kentucky, the Department of Education presents both their state standards and the blueprint for the corresponding state assessment, along with the public feedback on both, to the Joint Committee of the Legislature for approval at the same time. This ensures the proposed standards

can be assessed and that the assessment is developed to provide evidence of student learning on the standards, both criteria for approval for standards in the state.

States are often required to ensure that state standards attend to statutory requirements associated with the disciplinary standards considered for adoption.

Layers of Approval

The layers of approval vary in each state with responsibilities belonging to the state education agency, the state education board, and or the state legislature. For example, in Arkansas one statutory code requires the State Board of Education to develop a comprehensive plan to review and revise the Arkansas Academic Content Standards and Curriculum Frameworks process (Ark. Code Ann. § 6-15-1502, 2005) and a second code requires the Division of Elementary and Secondary Education to review the Arkansas Academic Content Standards and Curriculum Framework process plan on its State Board of Education-approved revision cycle and report to the State Board of Education annually (Ark. Code Ann. § 6-15-1504, 2005).

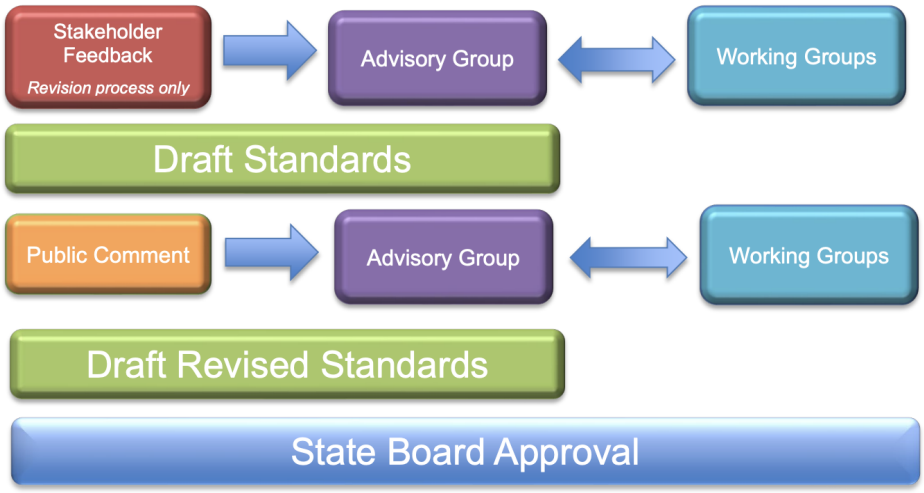
Many states require legislative approval for state standards. In Oklahoma, the State Board of Education approves standards prior to submission of standards to the State Legislature for consideration of approval. In Minnesota the State Legislature requires the State Commissioner of Education to adopt standards into statewide rule as their approval process.

Summary

While state standards review, revision, and adoption processes vary across states, common practices do exist, and all states engage in a multi-step process to inform and carry out a standards review and/or revision process inclusive of multiple stakeholders. Figures 9 and 10 showcase the multi-step processes for standards review, revision, and adoption for Ohio and Oklahoma and serve as examples of standards review, revision, and adoption processes taking place in states.

Figure 9:

Ohio Standards Review and Approval Process



Note: Adapted from, "Ohio's Learning Standards Review Process", by the Ohio State Department of Education (OSDE), (2020). https://education.ohio.gov/getattachment/Topics/Learning-in-Ohio/Standard-Revision-Overview/StandardsRevisonProcess.pdf.aspx?lang=en-US

Figure 10:

Oklahoma Academic Science Standards Review Process 2019-2020

The overarching goal of science education is to ensure that by the end of 12th grade, all students have some appreciation of the beauty and wonder of science; possess sufficient knowledge of science and engineering to engage in public discussions on related issues; are careful consumers of scientific and technological information related to their everyday lives; are able to continue to learn about science outside of school; and have the skills to enter careers of their choice, including (but not limited to) careers in science, engineering and technology. To accomplish this task, the individuals involved in the revision of the Oklahoma Academic Standards for Science are asked to create standards that:

- Are clear, concise, objective, measurable and grade-level appropriate;
- Ensure students are college, career, and citizen ready;
- Do not require a specific teaching methodology or curriculum;
- Develop science and engineering practices that deep understanding of science concepts;
- Exhibit strong progression in learning across grade levels; and
- Support real-world applications by focusing on students explaining a natural phenomenon and designing solutions to problems.

Executive Committee

An Executive Committee was established to assist in planning the revision process for the Oklahoma Academic Standards for Science and to select representatives to serve on Draft and Writing Committees. Executive Committee members also serve as members of the Writing Committee. OSDE extends a special thanks to the following Executive Committee members who are giving their time, service, and expertise to the revision process:

Writing Committee

Through an application process, the Writing Committee was selected to revise the Oklahoma Academic Standards for Science. The committee met on five occasions and numerous times virtually and was composed of 41 representatives from PK-12 education, higher education, and community members from across the state.

Draft Committee

Through an application process, the Draft Committee was selected to review draft standards developed by the Writing Committee and provide feedback. The committee was composed of 27 representatives from PK-12 education, higher education, and community members from across the state. View the full list of Committee members.

Standards Revision Timeline

- March 12, 2019: Standards committee applications opened.
- April 11, 2019: Standards committee applications closed.
- May – November 2019: Writing Committee met to draft standards.
    - May 14, 2019: Writing Committee meeting.
    - June 12, 2019: Writing Committee meeting.
    - July 30, 2019: Writing Committee meeting.
    - September 10, 2019: Writing Committee meeting.
    - October 22, 2019: Writing Committee meeting.
- August – November 2019: Draft Committee met virtually to review and provide feedback on the standards.
- October – November 2019: Focus groups held.
- November 2019: Writing Committee met virtually to address Draft Committee final feedback and focus group feedback.

- November 14th - December 17, 2019: Public Comment period
- January 2020: Writing Committee met virtually to address Public Comment feedback.
- February 27, 2020: The Oklahoma State Board of Education approved the revised Oklahoma Academic Standards for Science
- March 2020: The Oklahoma Academic Standards for Science will be submitted to the Oklahoma State Legislature for consideration

Note: Adapted from, "*Oklahoma Academic Science Standards Review Process 2019-2020*", by the Oklahoma State Department of Education (OSDE), (2019). https://sde.ok.gov/oklahoma-academic-science-standards-review-process

RECOMMENDED POLICIES AND PRACTICES FOR STATE STANDARDS REVIEW, REVISION, AND ADOPTION

Upon analysis of state standards review, revision, and adoption processes across the nation and the authors' collective experiences of over 20 years leading state standards review, revision, and adoption processes at SEAs for all disciplinary standards, the following set of recommendations are offered as guiding principles for states conducting standards review and revision processes.

Recommendation 1: Establish a cycle for review and revision of standards that allows time for implementation of standards. Standards should not be reviewed and revised on a cycle of more than 20 years. If state laws require standards be reviewed less than 10 years after substantive changes to standards have been made, a technical review of standards without substantive changes be included in the cycle of review. An example is provided below for state required to review and/or revise standards every 6 years:

- Year 1 – Process to adopt standards completed.
- Year 6 – Process for routine technical review of standards is completed.
- Year 11 – Process for major substantive review of standards is completed.
- Years 16 -20 – Standards are implemented, evaluated, and reviewed.
- Year 21 - Process to adopt standards completed (cycle repeats).

Recommendation 2: Ensure educator expertise is centered in the review and revision processes of standards review with special consideration for inclusion given to educators with experience implementing the standards under review.

Recommendation 3: Use current research, state level data, and feedback from educators who have implemented current standards to inform a new cycle of review and revision of state standards**.** Standards revisions should be informed by research from the implementation of the standards under consideration for review and/or revision. Revisions should build on existing standards and be based on evidence from research.

Recommendation 4: Identify quality attributes for science standards or criterion for approval of standards to guide and focus the standards review process. Ensure quality attributes and criterion are informed by current research on science teaching and learning and state laws.

Recommendation 5: Center equity in stakeholder involvement and engagement through standards review advisory, writing or working committees, and public comment periods for standard reviews and revisions.

Recommendation 6: Establish a comprehensive and transparent plan for communicating the standards review process, opportunities for stakeholder engagement, and steps for approval.

Recommendation 7: Understand local context, statutory requirements, and cultural connections associated with the standards being reviewed and/or revised.

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