THE STATE OF STATE SCIENCE EDUCATION POLICY: ACHIEVE'S 2018 SCIENCE POLICY SURVEY

Introduction

In 2013 and 2018, the National Science and Technology Counsel (NSTC) released reports to raise awareness about the rapid growth in Science, Technology, Engineering, and Mathematics (STEM) occupations. The report also pointed to the distressing unequal access to STEM education for Americans, saying, "For the United States to maintain its preeminent position in the world it will be essential that the Nation continues to lead in STEM, but evidence indicates that current educational pathways are not leading to a sufficiently large and well-trained STEM workforce to achieve this goal."[1] Similarly, the most recent U.S. Department of Education Office of Civil Rights data collection found that some advanced mathematics courses were offered at only 65 percent of U.S. high schools, and that schools enrolling larger percentages of black and Latino students were less likely to offer these advanced courses.[2]

One of the ways states are addressing the projected increases in STEM careers and the lack of growth in how many students are pursuing STEM education is through the adoption and implementation of new science standards that incorporate engineering and make connections to mathematics. For initiatives to have a long-term impact on the state education system, change needs to happen at all levels of the system - from the classroom level up through state policies. Science standards implementation efforts have been deliberately focused on figuring out ways to impact instruction at the classroom level, but sustaining these efforts will mean addressing state-level policies beyond adopting new standards. To better understand the degree to which science standards implementation efforts are impacting state science education policies, Achieve administered a Science Policy Survey in the summer of 2018 to state education agencies (SEAs). This report summarizes the key survey results and provides an overview of states' K-12 education policies and goals in science. It also aims to identify where states may need to adjust science education policies to create more coherence among policies, elevate examples of state leadership, and to encourage states to take steps to strengthen and develop their programs based on the evidence and resources available.

Background

Achieve has a longstanding history of documenting state policies supporting college and career readiness. Over the past ten years, nearly all 50 states and the District of Columbia have completed an annual Achieve survey of state progress in adopting college- and career-ready policies on academic standards, graduation requirements, aligned assessments, and data and accountability systems. In 2018, Achieve surveyed states on their efforts to adopt and implement science policies to provide an overview of the current state of science education.

Achieve administered the 2018 Science Policy Survey to SEA science leaders. Forty-nine states and the District of Columbia submitted survey responses.[3] The survey focused on states' development and adoption of policies in the following key areas:

1. **Standards Adoption and Implementation:** Adopting new science standards is a necessary first step to improve science education. We asked states about how their focus was shifting to bring the standards to students, including policies related to elementary and middle school instructional time, the courses and experiences required to graduate from high school, and how the quality of courses is assured.

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[1] National Science and Technology Counsel, Federal Science, Technology, Engineering, and Mathematics (STEM) Education 5-Year Strategic Plan (Washington, D.C: 2013)

[2] 2015-16 Civil Rights Data Collection, STEM Course Taking. https://www2.ed.gov/about/offices/list/ocr/docs/stem-course-taking.pdf

[3] South Dakota chose not to participate in the survey.

2. **Assessment of Student Learning:** If science education is improving through the adoption and implementation of new standards, it is also key for states to utilize assessments that evaluate the new and improved learning of science education. We asked states how and when they assess science and how their assessments are changing in the coming years.
3. **Goals and Accountability for Science Education:** All states have recently created new accountability systems for schools and districts. We asked states how and whether they are integrating science into their new systems and whether they set statewide goals (e.g., through their state accountability systems) around improving science education.

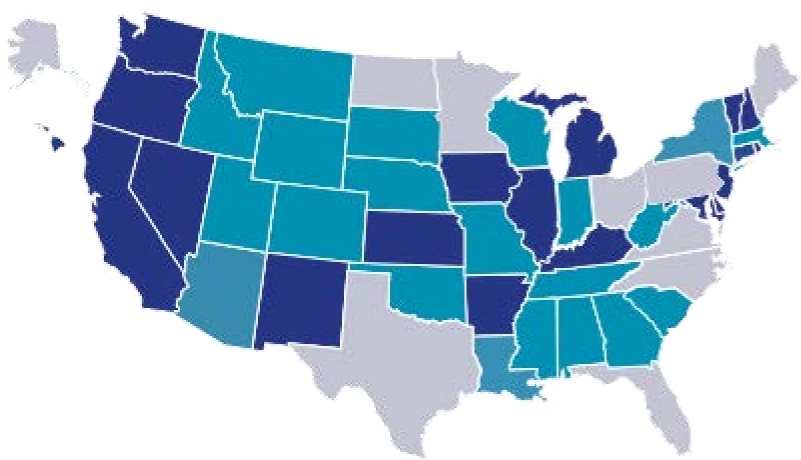
The following report is based on data and information collected through the Science Policy Survey and supplemented with related research and policy information available in states.

Standards Adoption and Implementation

High academic standards help set the bar for all students, especially those typically underserved in the science classroom, and are an important part of ensuring that students graduate from high school ready for college, career, and citizenship. Adopting and implementing new science standards is a foundational policy step to catalyze improvements in science education. Though standards do little by themselves, they can help drive system improvements. Effectively implementing new standards includes coordinated planning that reviews state policies and takes a systems-level approach to support changes on multiple levels. Effective implementation of science standards means considering things like: time allocated for science at the elementary level, high school graduation requirements, purchasing new instructional materials, providing sustained professional learning to support changes in instructional practice, developing new assessments, and many other local and state routines and practices.

Since the introduction of the National Research Council's *A Framework for K-12 Science Education (Framework)* in 2012 and the Next Generation Science Standards in 2013, most states have shown considerable consistency around selecting and adopting new science standards. As shown in Figure 1, **40 states and the District of Columbia**[5] (shown in blue and teal) indicated that their science standards are based on the *Framework*. These states – and their districts – educate more than two-thirds (68.9 percent) of all students enrolled in K–12 public education in this country. Of the 40 states and D.C., **19 states and D.C.** (shown in blue) have adopted the Next Generation Science Standards.

Figure 1: Science Standards Across the U.S. [4]



Finally, of the 10 states that did not report science standards based on the *Framework*, eight have indicated an ongoing or upcoming review of their K–12 academic standards in science between

[4] Since the survey's administration in Summer 2018, a number of states have made changes to their standards, which resulted in Achieve's editing of states' responses to reflect updated information. New Mexico adopted the NGSS after the survey was administered. Ohio adopted revised standards in 2018 and indicated that there are connections to the *Framework* in these standards, but the state's model content frameworks that show these connections won't be released until fall of 2019. Utah has adopted middle school standards based on the *Framework*; the elementary and high school standards are currently in public review. North Dakota adopted science standards based on the *Framework* in February 2019. As of April 2019, Maine adopted the NGSS.
[5] South Dakota is included in these counts; however, the state did not participate in the Survey.

2018 and 2020; these states may adopt new standards based on the *Framework* or the Next Generation Science Standards.

Based on the widespread adoption of the NGSS, or standards based on the *Framework*, there is considerable agreement about the content that all students need to learn. However, more work remains to ensure that high schools provide students the opportunity to learn and demonstrate mastery of this content. The following sections examine important issues related to elementary, middle, and high school science standards implementation.

Science Instructional Time

Instructional time in elementary and middle school science has historically been an area of concern due to the pressure placed on districts, principals, and teachers to prioritize English Language arts (ELA) and mathematics. Because students take state-mandated, high(er) stakes assessments for ELA and mathematics earlier and more frequently than for science – science often is not tested until 5th grade and only occurs once per grade band – and because states weight ELA and mathematics more heavily in their accountability systems, many elementary schools greatly reduced the amount of time allocated to science. Although adequate research on a recommended number of hours in science education at the elementary level is not available, there is evidence demonstrating the importance of teaching science education at a younger age. The National Research Council reported that "in contrast to the commonly held and outmoded view that young children are concrete and simplistic thinkers, the research evidence now shows that their thinking is surprisingly sophisticated. Important building blocks for learning science are in place before they enter school".[6] Despite this evidence, only 19 states (AL, FL, ID, LA, MD, MA, MN, MS, MO, NE, NH, NY, NC, OR, PA, SC, TX, WV, WI) reported that they have a specific policy regarding instructional time for science in grades K-5.

Table 1: State Guidance on Instructional Time for Science in Grades K-5 and 6-8

Guidance	Sample State Guidance
Recommendation without specific mention of instructional time	Pennsylvania states "planned instruction aligned with academic standards in science shall be provided to every student every year in the primary program." Texas states that districts "must ensure that sufficient time is provided for teachers to teach and for students to learn… science." Wisconsin states "it is a legal requirement to teach science weekly at the elementary level and meet science standards."
Recommendation of instructional time	Alabama recommends 30 min/day of science in grades 1-3 and 45 min/day in grades 4-6. Missouri recommends 150 min/week for science in grades 1-3 and 200 min/week for grades 4-6.

However, when examined closely, as shown in Table 1, most of the reported policies were vague and/or recommendations that did not indicate a specific time committed to science education in elementary school. Similar trends are also observed within science education in the middle school grades. While a slightly higher number of states (21, including the 19 aforementioned states plus HI and NM) reported a policy regarding instructional time for science in grades 6-8, the inconsistency in science education persists in middle school.

Recommendation 1: States should consider policies that establish expectations for the time devoted to science instruction at the K-5 levels. Without these policies, students receive widely disparate science learning experiences, many of which do not prepare them for middle or high school science.

[6] National Research Council. 2007. Taking Science to School: Learning and Teaching Science in Grades K-8. Washington, D.C.: The National Academies Press. https://doi.org/10.17226/11625.

Middle School Course Sequences

The Survey also asked states how they structure their middle school science course sequences. The majority of states and the District of Columbia reported that they do not specify any curricular organization for grades 6–8. In other words, districts and schools are responsible for packaging the standards into course experiences for students. Some states offer multiple options. For instance, Florida offers "both discipline-specific and a sequence of comprehensive science courses in middle grades." California "provides two different course models the Discipline-specific Course Model and the Preferred Integrated Model." Although compelling research for whether discipline-specific or integrated courses is better for middle school science education is lacking, different sequences can have a negative impact on students that move from one district to another—they can miss sizable sections of learning when districts are teaching science in different sequences.

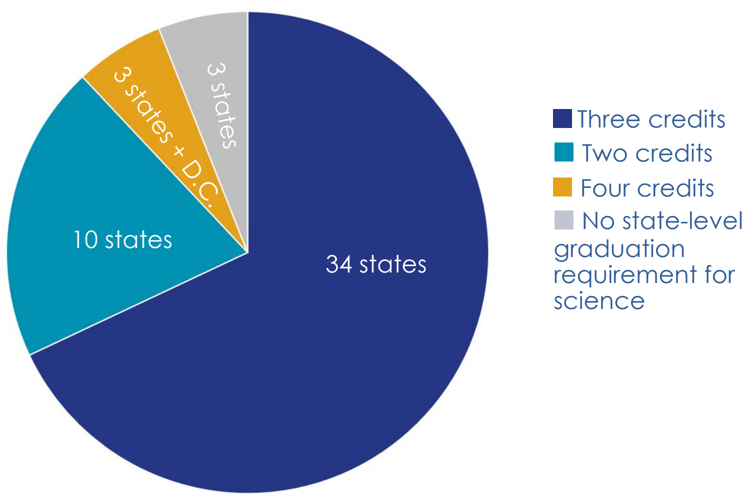
Recommendation 2: States and districts should consider policies that establish more similar course sequences for middle school. This could be a state policy, or districts agreeing to use the same sequence. Ensuring that students are set up for success regardless of their zip code helps to ensure equity for students.

High School Requirements

High school course requirements help ensure all students have access and exposure to the full range of their state's college- and career-ready standards. Participating in rigorous science courses in high school is also one way to increase the number of students pursuing careers in science-related fields. These requirements are typically listed as a number of science credits that are expected and/or specified courses in particular science disciplines.

High School Science Courses Required to Graduate

Figure 2: How Many Science Credits Do Students Need to Graduate?



When examining high school graduation requirements in science, it is necessary to consider both the number of credits (e.g., courses or units) required of students as well as the specific scientific domain requirements (e.g., biology, chemistry, physics). Achieve's research has found both the number of credits and specific courses states require for graduation in science vary widely; most requirements are not likely to ensure all students have access to the learning necessary to meet the high school science standards, particularly those states that require less than three credits of science instruction to graduate. As shown in Figure 2, **37 states and the District of Columbia** require students to complete at least three credits of science prior to graduation, **10 states** require two credits of science, and **three states** allocate graduation requirements determinations for science to local districts.[7]

In terms of content of the required coursework, states range from providing no specificity or guidance on the courses, to specifying some topics or concepts to be covered, to specifying each of the courses a student must take to graduate. **Twenty-five states and the District of Columbia** specify that students must take biology, while the remaining **25 states** provide little to no specificity

[7] The science requirements reflected in this data are for the diplomas students are automatically defaulted into absent any action. To see more about specific science graduation requirements for each state, visit https://highschool.achieve.org/data-explorer.

about the kinds of courses that students need to take. These decisions are left to districts, schools, and/or students.

At the time of our survey, five states had proposals under development to revise the statewide minimum high school graduation requirements for science. However, the vast majority of states that have adopted the NGSS or other standards based on the *Framework* have not yet made changes to the science courses students must pass to graduate from high school.

Recommendation 3: States and districts should establish policies and procedures that ensure that the graduation requirements for science match the expected science learning for all students as established in their state standards.

Substitutions for Science Graduation Requirements

Twenty-nine states responded to the survey that they allow non-science courses, including CTE coursework, postsecondary courses, or computer science courses, to be substituted for science requirements. The majority of states that allow for course substitution require two or three science credits for graduation (see Table 2). In these states, students who elect to substitute a science course may graduate from high school having taken only one or two science courses, which makes it nearly impossible for these students to have access to learn the full scope of their state's science standards.

Table 2: Which States Allow Courses to be Substituted for Science Requirements?

Number of Science Credits Required for Graduation	States that Allow a Non-Science Course to Earn a Science Credit
2	Alaska, California, Connecticut, Illinois, Nevada, Washington
3	Arizona, Florida, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, New Mexico, New York, North Carolina, Ohio, Oregon, Tennessee, Vermont, Virginia, Wisconsin, Wyoming
4	Alabama, District of Columbia, Georgia, Mississippi

Over the last few years, many states have adjusted graduation course requirements policies to add computer science as a potential way to satisfy science or mathematics course requirements. Although the addition of computer science in high school is valuable due to the booming growth in the industry, states must carefully weigh the tradeoffs before allowing computer science to take the place of a mathematics or science course, particularly as it may have implications for whether a student is eligible for postsecondary admission.

Recommendation 4: States and districts should establish policies and procedures to ensure that courses that substitute for science credit do not limit access to science learning for all students as established in their science standards.

Systems for Determining Quality and Content of High School Science Courses

Even in states with similar standards, states' expectations for what students need to learn in science in high school varies considerably. Within states, high school course titles and requirements may vary, but the quality and consistency of courses should not. While 11 states replied that they have no mechanism in place to monitor high school science courses, the remaining states reported using a mix of the following approaches to determine the quality of high school science courses:

- Standards-based courses: Less than half of states (21) indicate that they require course standards to monitor the quality, consistency, and rigor of the required high school courses.

- End of course assessments: 22 states responded that they require at least one standards-aligned end-of-course assessment; however, these assessments range in content and often assess only one domain of science.[8]
- Course or materials evaluations: Many states require that courses be evaluated and approved by a state agency, such as the State Education Agency, State Board of Education, or higher education institutions. Three states responded that they conduct course audits of curricular and instructional materials to verify quality.
- "Laboratory" science courses: Though the term is somewhat antiquated as the *Framework* and the NGSS have shifted our understanding of how investigations and engineering design should be woven into student science learning, one way that states have historically identified more advanced science courses is with the designation of "laboratory" science. While several states reference "laboratory" science courses in their graduation requirements (19 states plus the District of Columbia), the definition of what constitutes a "laboratory" course varies. Fifteen states indicated they have guidance or a definition for such a course (e.g., at least 20% of the instructional time is required to include laboratory experiences), but for many, it is up to interpretation of the course developer and may not be a meaningful distinction.

Recommendation 5: States should make certain that districts have appropriate policies and/or guidance with respect to high school course pathways so that students have access to learning the established science standards. Parents and students need clear communication about the implications of selecting different courses in high school. This should include, at a minimum, an evaluation of which standards are addressed in which courses. Internal measures of course quality that go beyond simply aligning them to standards can help improve instruction for all students.

Assessment of Student Learning

Fully meeting the vision set forth by the *Framework* and *Framework*-aligned standards requires high-quality and aligned assessments that can provide actionable information to students, teachers, and families. Because of the fundamental shifts in student performance expected by three-dimensional assessments, new science standards require states to redesign their statewide systems of assessment, including developing new assessments to meet federal testing requirements in science.

Elementary and Middle School Assessments

Of the 40 states and D.C. that have adopted new standards, 39 states and D.C. will be transitioning to new science assessments in grades 3–8 during their implementation timeline. The single exception is Arkansas, which is planning to continue using ACT Aspire as their assessment across content areas in grades 3–8. Most states will continue to administer science assessments once per grade band, consistent with the federal testing requirements for science within the Every Student Succeeds Act (ESSA). Three notable exceptions include Louisiana and Tennessee, which are developing new assessments for their three-dimensional science standards to be administered in each grade 3–8, and South Carolina, which will assess students in grades 4, 6, and 8.

High School Assessments

Similar trends exist in state approaches to high school science assessments: 37 states and D.C. responded in the survey that they are developing or currently administering new assessments designed for their new science standards. Some states, like Washington, are transitioning away from a single biology end-of-course assessment (EOC) as their high school assessment used for

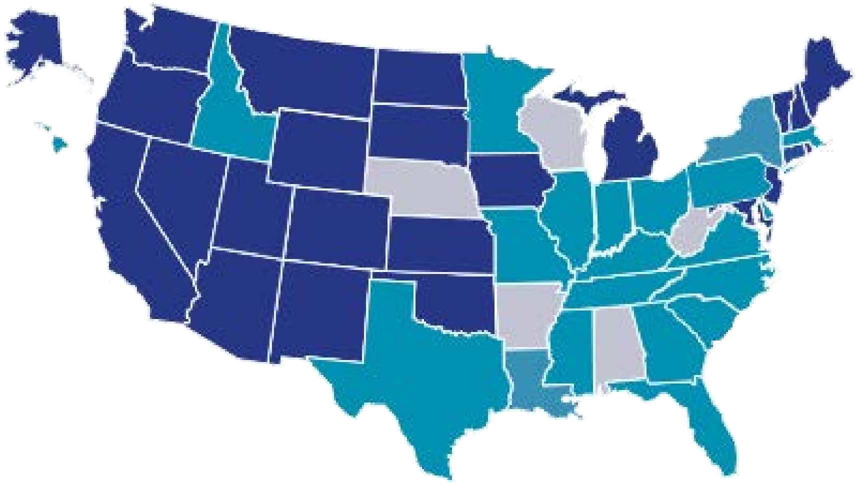
[8] https://www.achieve.org/publications/2017%E2%80%9318-state-high-school-science-assessments

accountability purposes and toward a comprehensive high school assessment that includes life, physical, and earth and space science; other states, like Kentucky are keeping their biology EOC, but transitioning the content of the assessment to align with the life science performance expectations in new standards.

Across the country, states fall into one of three assessment types:

- **Twenty-four states** (shaded blue) administer a comprehensive (e.g., end of grade) science assessment (or assessments) that is administered to all students in a cohort at the same time regardless of the courses the student has taken in high school.[9] Of these, 15 states administer their assessment at the end of 11th grade, six states do so in the 10th grade, and two states allows districts to choose when in high school to administer the assessment. One additional state assesses students in ninth and tenth grade.

Figure 3: The High School Science Assessment Landscape



- **Twenty-two states** (shaded teal) use an end-of-course (EOC) assessment (or assessments) that students take upon completion of the requisite coursework regardless of grade level. In other words, students take the appropriate EOCs for the science courses in which the student is enrolled. All 22 states administer a biology or life science assessment. Seven of these states have also developed assessments of other disciplines, including physical science, chemistry, physics, earth science, and technology/engineering.
- **Five states** (shaded gray) administer a college entrance exam such as the ACT or SAT.[10]

Most states with new standards have committed to implementing new assessments designed to measure whether students have met those standards, with most states still in transition toward new assessments. For states administering college entrance exams as their high school science assessment, this means being cautious about how those assessments are used, and what other incentive structures and feedback loops exist to signal the transition of teaching and learning.[11] For states developing new assessments across the K-12 spectrum, this means 1) including measures to ensure the quality, rigor, and alignment of new tests are an intentional component of the design process, and 2) decisions about assessment design and the appropriate use of scores and reporting are made transparent to stakeholders, such that data from state assessments are used effectively.[12] Developing new science assessments is challenging, but it is critical that states get them right.[13]

Recommendation 6: If assessments are to be used to make decisions about student, teacher, and school progress, it is essential that those assessments are high-quality and aligned to the state's standards,[14] and that they signal and monitor student performances that are consistent with the expectations of the standards.

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[9] Kentucky is transitioning from an EOC assessment to a summative assessment with the content of the assessment to align with standards in physical science, life science, earth and space science, and engineering design.

[10] https://www.achieve.org/college-admissions-tests-accountability. Arkansas administers ACT Aspire. See more here: https://www.achieve.org/college-admissions-tests-accountability

[11] https://www.achieve.org/college-admissions-tests-accountability

[12] https://www.achieve.org/college-admissions-tests-accountability [11] https://www.achieve.org/publications/task-annotation-project-science-systems

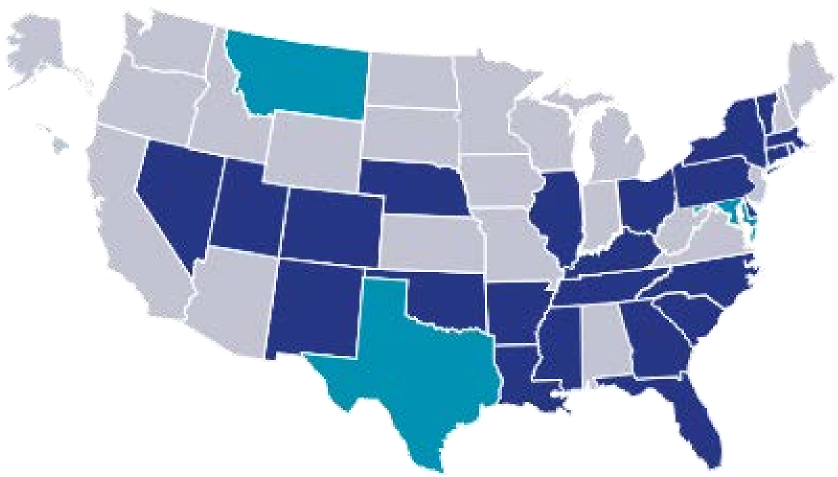
[13] https://www.achieve.org/transforming-science-assessment

[14] https://www.achieve.org/files/Criteria03202018.pdf

Goals and Accountability for Science Education

Until the passage of No Child Left Behind (NCLB) in 2001, many states did not know whether the achievement of traditionally underserved students (e.g., low-income students, students of color, students with disabilities) in a school differed from the achievement of their more advantaged peers. In addition, many states also did not measure, in a regular and comparable way, whether these students were performing similarly to other students in key academic areas. Since that time, states and districts have prioritized mathematics and English language arts (ELA) and their associated assessments because these were the subjects that most affected their evaluations at a local or federal level. This laser-like focus on mathematics and ELA resulted in the narrowing of curriculum for students.

Figure 4: State Use of Science Measure(s) in Accountability Systems



■ State science assessment results included in accountability system for elementary, middle, and high schools
■ State science assessment results included in accountability system for elementary and middle schools only

The passage of the Every Student Succeeds Act (ESSA) provided states the opportunity to craft new goals and strategies for science education and to broaden the focus of their accountability systems beyond mathematics and ELA. State ESSA plans also provided states an opportunity to evaluate their priorities for science education. Achieve's research[15] found that **24 states** (blue on the map) included results from their state science assessment in their accountability system for elementary, middle, and high schools. **Three additional states** (shaded teal on the map) included results from their science assessment in their accountability system for elementary and middle schools (but not high schools), bringing the total to **27 states** including a measure of science in some way in their accountability system. Notably, states are incorporating science measures differently, both in terms of what they are including – most are focusing on science proficiency, but a few are also holding schools accountable for student growth on science assessments – as well as how much weight the science measures carry within the accountability system. States' weighting of science measures ranges from less than one percent to more than 24 percent of a school's accountability rating.[16]

Setting goals for science achievement in a state plan, alongside those goals for mathematics and ELA, is an important indicator of a state's commitment to improving science education. However, our research on states' goals found that states rarely included baseline data, interim, and long-term goals for where they hope to move the needle on student science achievement.[17] Well-articulated goals serve numerous critical purposes, including clarifying the state's aspirations and priorities for its students, schools, and the future of the state more broadly; focusing policy, practice, and resources on the most effective strategies to achieve their goals; and signaling the need to adjust course along the way if a state is not meeting its trajectory. It is hard to improve science performance if there are not ambitious but achievable goals that describe what success looks like, where the state is starting from in terms of science achievement, and the strategies to get there.

Recommendation 7: States and districts should set goals for students in science. States and districts must own and manage their goals, developing and communicating a clear strategy to stakeholders for achieving them.

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[15] https://states.achieve.org/essa-tracker
[16] Ibid.
[17] https://www.achieve.orgfilesAchieve_STEMreport7.12.17.pdf

Conclusion

Moving systems is difficult, complicated work. Although states have been increasingly active in developing science standards, developing and supporting resources for implementation, and addressing system-wide issues during implementation, there are many significant disparities that are critical to address. Science learning that is available to all students continues to depend on where students reside. Changes to policies that impact access to science education for all students to prepare them for the lives beyond high school and work in well-paying, in-demand STEM careers remain necessary.

Acknowledgements

Achieve would like to thank the state education agency staff for their time and cooperation in completing the survey. We would also like to express gratitude to the Carnegie Corporation for providing generous funding for this report and the broader work to support the implementation of the Next Generation Science Standards.

Recommendations At A Glance

1. States should consider policies that establish expectations for the time devoted to science instruction at the K-5 levels. Without these policies, students receive widely disparate science learning experiences, many of which do not prepare them for middle or high school science.

2. States and districts should consider policies that establish more similar course sequences for middle school. This could be a state policy, or districts agreeing to use the same sequence. Ensuring that students are set up for success regardless of their zip code helps to ensure equity for students.

3. States and districts should establish policies and procedures that ensure that the graduation requirements for science match the expected science learning for all students as established in their state standards.

4. States and districts should establish policies and procedures to ensure that courses that substitute for science credit do not limit access to science learning for all students as established in their science standards.

5. States should make certain that districts have appropriate policies and/or guidance with respect to high school course pathways so that students have access to learning the established science standards. Parents and students need clear communication about the implications of selecting different courses in high school. This should include, at a minimum, an evaluation of which standards are addressed in which courses. Internal measures of course quality that go beyond simply aligning them to standards can help improve instruction for all students.

6. If assessments are to be used to make decisions about student, teacher, and school progress, it is essential that those assessments are high-quality and aligned to the state's standards, and that they signal and monitor student performances that are consistent with the expectations of the standards.

7. States and districts should set goals for students in science. States and districts must own and manage their goals, developing and communicating a clear strategy to stakeholders for achieving them.