Chapter 3: Evaluate Past and Present Performance

Questions from Diagnostic Tool

- Have we arrived at a clear view of our current performance in science relative to subgroups within our state, district comparisons, other states and other countries?
- Have we identified key areas of strength and weakness based on this evidence?
- Have we analyzed the root causes of performance — both successes and areas in need of improvement?
- Have we established clear goals for student performance?
- Have we identified how much instructional time is devoted to science in K–12?
- Have we identified how the current classroom practice aligns to the NGSS shifts?
- Based on past and present performance, have we derived implications for our NGSS implementation plan?
- What are the workforce projections for our state? How many STEM-capable jobs will be added?

As the old cliché goes, you have to know where you have been to know where you are going. Your aspiration has set out the endpoint; to plot the course to it, you will need a clear understanding of your starting point as well. This means digging into your data and other evidence on science instruction and performance — especially those data that are likely to become the basis for measuring the student outcome goals in your aspiration. By establishing a clear and shared view of current performance, you will build the case for the types of strategies that will be most important to pursue for your state. You will also, if necessary, back up the claims in your aspiration with quantitative evidence.

Action Steps

Step 1: Gather the relevant data.
Step 2: Distill key performance patterns and identify root causes.
Step 3: Identify implications for adoption and implementation.

Step 1: Gather the Relevant Data

There are four kinds of data that you can gather, identified by two criteria. First, what is being measured? Outcomes are those measures that are direct measurements of one or more goals for student outcomes, while inputs are leading indicators of those outcomes. Outcomes are obviously the most important measure, but inputs can be useful to measure if they can be directly linked to outcomes and/or they are available more frequently than the outcome measures. A table of potential measures of science performance is given in Figure 6.

FIGURE 6: Potential Measures of Science Performance

Outcomes
• Proficiency results for state science exams • Proficiency results for state math exams • Advanced Placement/International Baccalaureate/dual enrollment science results • National Assessment of Educational Progress (NAEP) science results • Trends in International Mathematics and Science Study results (and link to NAEP results) • Program for International Student Assessment (PISA) science results (and link to NAEP results) • Assessment results for science • Workforce development measures • Percentage of college-bound high school seniors intending to major in a STEM field • Percentage of high school graduates entering a STEM field directly • Percentage of two- or four-year college graduates entering a STEM field • Percentage of students earning STEM-related licenses or certifications • Student interest and self-efficacy in science and engineering • Drop and failure rate in introductory postsecondary science courses
Inputs
• Advanced Placement/International Baccalaureate/dual enrollment science participation • Course-taking rates for lab science and/or other college- and career-ready course of study in science • Percentage of STEM teachers with an in-field credential • Teacher evaluation system results for STEM teachers • Time devoted to instruction • STEM demand in state and job growth in STEM fields

These data will help you understand how large the challenge will be to help your students meet the expectations of the new standards. Moreover, the research behind the NGSS suggests that faithful implementation of the new standards will likely have a substantial and measurable impact on any and all of the above measures.

Second, what type of data are you using? Quantitative data consist of numerical data that are valid to some reasonable standard (e.g., standardized test scores, graduation or attendance statistics). Qualitative data are less statistically valid — they can include spot checks, interviews, information from focus groups and site visits, review of student and educator artifacts, and other “impressions” — but they can be easier to collect. Particularly in the case of qualitative data, your state should look to leverage state and national partners and third-party organizations to collect these data, avoiding relationship biases that might otherwise cloud the quality of the data.

EXERCISE 6: Identify Measures of Science Performance

Objective(s) for participants:

- Agree on a prioritized list of measures to serve as the basis for the analysis of past and present performance.

Instructions:

- Look at the student outcome goals for science (from Exercise 4 in the previous chapter or some other source).
- Discuss and fill in the flipchart template: What are some potential measures to assess these goals?
- Prioritize goals and measures based on importance, availability of data and mix of outcome/input/quantitative/qualitative.

Materials needed:

- List of current student outcome goals for science (if available)
- Flipcharts
- Markers

Exercise notes:

- Because this exercise is meant to identify data for analysis right now, it is important to prioritize measures for which the data/evidence are already available and can be collected easily.
- Depending on whether there are already student outcome goals for science, you may need to spend some time identifying goals at the beginning (again, see Exercise 4 in the previous chapter).

Template for Exercise 6

		What Is Being Measured	
		Outcomes	Inputs
Type of data	Quantitative		
	Qualitative		

Step 2: Distill Key Performance Patterns and Identify Root Causes

Gathering evidence is a good first step, but the raw data alone will not be enough. Your team will need to analyze the information and draw conclusions about your areas of strength and weakness regarding science performance. Moreover, your team will need to understand the root causes of this performance — which in some cases are driven by state policies — so that you can build on your strengths and address your weaknesses. Making this transition from raw data to insight is a critical and often-overlooked step in the process.

We will begin by isolating performance patterns in your evidence. A performance pattern is simply an unusual variation (or unusual consistency) in your data that helps you identify a particular area of strength and/or challenge. Quantitative data on student outcomes are usually best for this part of the process.

For example, you may notice that the percentages of students deemed proficient on your science assessment are consistently lower for your economically disadvantaged students than for their nondisadvantaged peers. You dig into the data and find that this achievement gap persists across every grade level in which the exam is given. Moreover, you find that this gap is bigger than the gaps for every other significant subgroup in your state. You have just identified a pattern that is a weakness for you. At the same time, you might find that some districts or schools are exceptions to the rule, with achievement gaps that are much smaller than the state average. These exceptions also constitute an important performance pattern: a set of schools that demonstrate that science can be a discipline for all students to master.

As this example demonstrates, the key to finding performance patterns is to use the power of comparisons, and even comparisons of comparisons, among students, schools and districts in your data. Where do you begin? Beginning with a hypothesis is helpful. Good data analysis borrows some of its core tenets from scientific methodologies: It involves a consistent cycle of hypotheses about the data, use of the data to test hypotheses, evaluation of the results and revision/revisiting of the hypotheses.

Your hypotheses about performance will help you decide which comparisons of the data to do first. While there is no one correct way to analyze data, a few critical comparisons will help you to get started:

Against history: How are we performing today versus our performance in the past? What is the trend over time?

Among schools and districts: Which schools/districts are consistently outperforming the state average? Which are consistently underperforming?

Among subgroups: What are the largest and smallest achievement gaps? How do they compare across districts and schools and against history?

Against other states and countries: Where does our performance place us in the ranking of other states and countries? Can we draw any inferences about our likely performance against the NGSS? What does that tell us about how far we have to go?

With these analyses in front of you, you will be able to validate or reject your initial hypotheses about performance patterns. These results may lead you to form other hypotheses, which can hopefully be tested by other analyses. As you continue this work, you should eventually home in on a few key patterns that characterize science performance in your state.

Once you have identified a few key performance patterns, you will be in a good position to ask why they exist. Why is science performance strong in some areas but weak in others? What implications do these root causes of performance have for the strategies that you will select to achieve your goals? Again, the cycle of hypothesis and examination of the data will be beneficial. Just as you can form hypotheses about overall performance patterns, you can form hypotheses about the root causes of those performance patterns.

The big difference is that the inquiry phase might take you beyond the initial evidence you gathered — or at least from quantitative to qualitative evidence and from outcomes to the inputs that are linked to those outcomes. For example, suppose that you find a particular school with science performance at the 90th percentile of state performance, more than 50 percent of its student population in traditionally disadvantaged subgroups and no achievement gaps. You have already identified the pattern — an unusual bright spot in science performance — using quantitative data. But what is the cause of the pattern? To understand, you will need to look at (and possibly generate) other evidence, such as through a visit to the school or a phone call to its principal to find out about the school's core practices in science education. This evidence will, in turn, help you to validate, reject or reshape your hypothesis, possibly leading to additional inquiry.

EXERCISE 7: Identify Performance Patterns and Root Causes of Science Performance

Objective(s) for participants:

- Agree on a prioritized list of patterns that characterize science performance in the state.
- Agree on root causes for these patterns and/or on plans to investigate them further.

Instructions:

- Find or prepare one or more sets of analyses comparing historical data from the measures agreed to in Step 1. These may include bar graphs, scatterplots, motion charts or other visual representations of the state's past and present performance on the identified metrics.
- Individually or in pairs, review the data and identify one key performance pattern in the data. Record that on the flipchart template.
- For each performance pattern, record the data to support that pattern, a potential root cause of that pattern and how to investigate that root cause.
- Discuss the identified patterns and root causes in the full group.

Materials needed:

- Data sets
- Flipcharts
- Markers

Exercise notes:

- Performance patterns should be quantitative outcome measures. Examples include:
  - Trends over time (e.g., steady growth or steady decline);
  - Dips or spikes in particular years; and
  - Comparisons (e.g., growth in one subgroup/district but decline in another).
- Root causes should be more qualitative and take into account the inputs that may have led to the performance pattern. Examples include:
  - A new professional development program provided to teachers that caused improved instruction and therefore improved student results;
  - Changes in curriculum or instructional practice;
  - Changes in state policies (rules, regulations, etc.); and
  - A focus on certain districts or certain subgroups.
- Root causes for now are just hypotheses about what may have caused the performance pattern. In the final column, identify how you would investigate those hypotheses further.

Template for Exercise 7

Performance Pattern	Supporting Data	Potential Root Cause	Plan for Investigating the Root Cause

Step 3: Identify Implications for Adoption and Implementation

The eventual objective of all of this work is to derive real and actionable implications for the adoption and implementation plans you are developing for the NGSS. Do any of your negative patterns of performance lend themselves to the case you are building for adoption? Which root causes of performance will you need to attack aggressively, and what kinds of strategies might be best for that? For positive patterns of performance, which strengths can you point to as evidence of momentum for NGSS adoption? Which can be built on, replicated and/or scaled up as part of your implementation plan? There is no one-size-fits-all strategy for every state that is trying to adopt and implement the NGSS, but this step is necessary to make that distinction truly meaningful.

For example, you might find very encouraging data on Advanced Placement passage rates in science but note that participation is uneven across different subgroups of students. If an investigation reveals that one of the root causes of the participation gap is the lack of advanced course availability, then your strategies for implementation will need to focus on access to advanced courses. Or perhaps you find different course requirements by district. Moreover, the equity imperative — the unacceptability of unequal access to world-class science education in your state — will become an important part of the case you make for adoption.

EXERCISE 8: Use Performance Patterns and Root Causes To Identify Implications for NGSS Adoption and/or Implementation Planning

Objective(s) for participants:

- Develop a prioritized list of implications of performance patterns and root causes for NGSS *adoption* planning.
- Develop a prioritized list of implications of performance patterns and root causes for NGSS *implementation* planning.

Instructions:

- Look at the performance patterns and root causes identified in Exercise 7. For each pattern and its root causes, discuss:
  - What strengths can we point to as evidence of momentum for NGSS adoption?
  - What strengths can be built on, replicated and/or scaled up as part of our NGSS implementation plan?
  - Which challenges will become an important part of our case for NGSS adoption?
  - What kinds of strategies will be required to address the major challenges we have identified in the data?
- Discuss and agree on implications and record on the flipchart template.

Materials needed:

- Flipchart template prepopulated with performance patterns and root causes
- Markers

Template for Exercise 8

Pattern or Root Cause	Implications for Adoption Plan	Implications for Implementation Plan

Conclusion

With a clear understanding of the performance patterns in your state and their root causes, you will be positioned to develop your state's role in implementation and the strategies you will use to reach your state goals. That is the subject of the next chapter of this workbook.