Assessment

There are a variety of assessment approaches in *A Natural Approach to Chemistry*. These are distributed throughout the Student Book and Lab Investigation Manual (LIM). This third edition contains new assessment items written for the NGSS performance expectations for HS-PS1 and HS-PS3 (the matter and energy standards, respectively) that were written to conform to the Evidence Statements provided with these standards.

Assessment opportunities to support both formative and summative assessments can be found in the program resources.

Formative Assessments

Formative assessments are used by teachers and students during instruction to provide feedback to adjust ongoing teaching and learning in order to improve students' achievement of intended instructional outcomes. Support for formative assessment can be found :

- *In the Student Book, in the GETTING STARTED section for each chapter*. This section uses a hands-on investigation or short video clip to introduce the introductory phenomenon and the Driving Question Board techniques to generate student questions that can help teachers better understand student prior knowledge for lesson planning.
- *In the Lab Investigation Manual*. Formative assessments are integrated in the investigations. Notice there are two forms of lists in the investigations; numbered lists (1, 2, 3,...) and lettered lists (a, b, c,...). The lettered lists are formative assessments. They pose questions that are meant to stimulate group discussion, discussion with the teacher, and reflection on what has been observed.

Formative assessments have two critical and important functions.

1. They provide real-time feedback on understanding to both teacher and student, during the actual learning process so learning activities can be adjusted immediately.
2. They focus reflection and discussion on specific aspects of an experience to facilitate learning. Reflection is essential to real learning and without directed prompts, most students will "do" but not "think" enough about what they did to learn from it.

Formative assessments in *A Natural Approach to Chemistry* primarily appear in the Investigations. We know that reflection and group discussion are crucial steps in learning through investigation. The lettered questions (formative assessments) focus student thinking on what the investigation is telling them. Without reflection, students might just play with chemistry and not necessarily learn anything!

For example, in Investigation 2C—*One in a Million*, students use a spectrophotometer to measure concentration of a dye solution by comparing its light absorption with a calibration graph they constructed themselves by measuring known concentrations.

After using the spectrophotometer technique to determine the concentration of an unknown solution students are asked the following questions:

a. What does the spectrophotometer measure?

b. How low of a concentration of dye is visible to the eye? This is called the limit of detection by eye.

c. How low of a concentration of dye is detectable to the spectrophotometer? What is the limit of detection by this instrument?

In many classrooms, the lettered questions are raised by the teacher and time is allotted for group discussion. Someone from each group might present an answer to question a, a different group question b, and another question c. *Use the formative assessments because they are an essential part of the learning process.* Without them many students will not spend enough mental activity processing and understanding what they have seen and done.

Summative Assessments

Summative assessments are generally used at the end of a unit of instruction in order to determine whether students have mastered key learning goals. In this third edition of *A Natural Approach to Chemistry*, the "key learning goals" also includes the relevant NGSS performance expectations (PEs) for HS-PS1 and HS-PS3, the matter and energy standards, respectively. The resources for summative assessments include:

- *Chapter Review items (in the Student Book)*. Each chapter typically includes 60-90 items that assess understanding of vocabulary and qualitative and quantitative problems at a variety of difficulty levels. These are listed by chapter section and can be assigned on an as-needed basis as students work their way through the chapter. The Teacher Edition provides detailed solutions, including stepwise support for problems of a quantitative nature. (These questions can also be used as formative assessments as you progress through chapter sections.)
- *Skill Sheets (in the Teacher Edition)*. Each chapter section is supported by Skill Sheets for students working below, at, and above grade level.
- *Item Banks (in the Teacher Edition and online portal)*. Each chapter has an item bank of roughly 50 new questions that assess understanding of vocabulary and qualitative and quantitative problems at a variety of difficulty levels. They can be assigned on an as-needed basis or all at once at the end of the chapter.
- *PE assessments (in the Teacher Edition)*. These can be found in a tabbed section of the Teacher Edition. Each of the PEs in HS-PS1 and HS-PS3 has several items to assess student mastery – what students should know or be able to do – at the end of instruction.

The evidence statements[5] were designed to articulate how students can use the practices to demonstrate their understanding of the DCIs through the lens of the CCCs, and thus, demonstrate proficiency on each PE. The evidence statements do this by clarifying:

- How the three dimensions could be assessed together, rather than in independent units
- The underlying knowledge required for each DCI
- The detailed approaches to science and engineering practices
- How crosscutting concepts might be used to deepen content- and practice-driven learning

The NGSS online summary of the purpose and structure of the evidence statements describe how to use the statements, limitations of their use, development and process criteria, and more. Educators are cautioned that even though the evidence statements are listed individually for each performance expectation, this does not necessarily mean they should be measured individually or that PEs should be taught or assessed individually. Nevertheless, and all irony aside, these evidence statements are presented individually and we have chosen to develop items to support them as such. Teachers are free to use individual items or to combine elements from more than one PE as they see fit. In keeping with the recommendations of the NGSS, while we of course provide suggested answers, we do not provide scoring rubrics. Except where noted on the individual items, we have provided our sense of the difficulty of the items (easy, medium, advanced), and provided responses at the "proficient" level. Some items use a common scenario for all items of the PE (e.g., HS-PS1-5 uses the Haber process for industrial production of ammonia) while others use different scenarios according to the level of the evidence statement.

[5] https://s3.amazonaws.com/nstacontent/tst0811_33.pdf?AWSAccessKeyId=AKIAIMRSQAV7P6X4QIKQ&Expires=1668776634&Signature=bmd3YE6f%2bQkqXGXI9YTqJZBSZxs%3d