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FUTURELAB+
A GENENTECH SCIENCE EDUCATION PROGRAM

NGSS Innovations and Design Principles Feedback: Summative Review Unit 8, PD 1

Contents

Executive Summary

Sponsored by Genentech, Futurelab+ brought together a coalition of partners to develop an innovative, modular, 2-year biotechnology curriculum, along with instructional materials, to expose students and educators to the breadth of education and career pathways across biotechnology. To increase adoption and access to such curricula in California and beyond, the modular curriculum was designed to align with the California Career Technical Education (CTE) Model Curriculum Standards for Biotechnology, meet at least 1 year of the University of California (UC) science (D) subject requirement, and incorporate some of the three-dimensional learning innovations of the Next Generation Science Standards (NGSS). The 2-year biotechnology curriculum has four core units per year; each core unit has nine lessons and a lab that each take approximately 1 week to complete (9–10 weeks for the full unit). In total, the biotechnology curriculum has 72 lessons and eight labs that span 2 full instructional years. Because the Futurelab+ biotechnology curriculum is modular, teachers can select specific units and materials to design biotechnology courses that are relevant and appropriate for their students and teaching environments.

As an organizational partner, the American Institutes for Research® (AIR®) provided external feedback about alignment of the curriculum to the three sets of standards to Futurelab+ curriculum developers during the formative period of the biotechnology curriculum. AIR is now providing external feedback and evidence regarding each unit of the final curriculum's alignment to each set of standards in three series of reports: CTE, UC science (D) subject requirement, and NGSS. The eight reports in the NGSS series provide feedback about aspects of NGSS in a sample of the curriculum (one lesson from each unit). AIR randomly selected PD 1 (Analyzing Community Needs and Proposal Identification) from Unit 8 (Community Science) for this report. **This review was completed on materials received April 18, 2022, and has not been updated to reflect any revisions made to materials since then.**

Of note, because the primary design element of the curriculum was alignment to CTE, AIR used the NGSS Lesson Screener (not the Educators Evaluating the Quality of Instructional Products [EQuIP] Rubric) to identify aspects of the curriculum that incorporate NGSS. The EQuIP Rubric is typically used to determine whether a unit was designed for the NGSS. **Because the curriculum was designed to align primarily to CTE standards, it was not expected that the curriculum would meet all NGSS criteria.** Nevertheless, in their current form, the materials from Unit 8, PD 1, **meet three lesson screener criteria** and **approach the remaining three lesson screener criteria**. AIR created the *approaching* rating to indicate where a modification to materials would increase the rating to *adequate*. NGSS criteria, ratings, and recommendations are summarized in Exhibit 1.

Exhibit 1. NGSS Criteria, Ratings, and Recommendations

	Criterion	Rating
NGSS Shifts	**A. Explaining Phenomena or Designing Solutions**	Adequate
	B. Three Dimensions	▪ DCI: Adequate ▪ SEP: Adequate ▪ CCC: Approaching Overall rating: Approaching
	C. Integrating the Three Dimensions for Instruction and Assessment	Approaching
Features of Quality Design	**D. Relevance and Authenticity**	Adequate
	E. Student Ideas	Adequate
	F. Building on Students' Prior Knowledge	Approaching

Note. DCI = disciplinary core ideas; SEP = science and engineering practices; CCC = cross-cutting concepts.

- **Criterion A: Explaining Phenomena or Designing Solutions** *(Adequate).* All activities in the lesson help students increase their understanding of what issues, problems, or challenges in their community could be addressed with DNA identification technology.
- **Criterion B: Three Dimensions** *(Approaching)*. There is sufficient evidence that the current materials give students opportunities to build their understanding of science and engineering practices (SEPs) and disciplinary core ideas (DCIs). To fully meet this criterion, materials should allow students to explicitly develop or demonstrate their understanding of cross-cutting concepts (CCCs), such as patterns or cause and effect.
- **Criterion C: Integrating the Three Dimensions for Instruction and Assessment** *(Approaching)*. There is sufficient evidence that materials give students opportunities to build their understanding of both SEPs and DCIs. To fully meet this criterion, materials should provide students an opportunity to demonstrate their understanding of CCCs, such as prompting students to consider or identify patterns that exist between different area maps or within interview responses they collect.
- **Criterion D: Relevance and Authenticity** *(Adequate)*. The reviewers found adequate evidence that the materials engage students and teachers in authentic scenarios that reflect the real world. Throughout the lesson, students identify an issue within their community that is of concern to them. Then they identify community organizations, leaders, and members who can provide insight into the issue. Finally, students create surveys and interview questions to collect data about their community.
- **Criterion E: Student Ideas** *(Adequate)*. The reviewers found adequate evidence that the materials provide students with opportunities to share their own ideas and provide feedback about their peers' ideas, both of which are essential science skills. Students identify community members and organizations that can provide important feedback on an issue they have selected. Then they develop interview questions and a survey to collect feedback from those community members. Their peers provide feedback on the data collection instruments.
- **Criterion F: Building on Students' Prior Knowledge** *(Approaching)*. There is insufficient evidence that the materials identify and build on students' prior learning in all three dimensions. The materials make little to no connection between prior knowledge in the SEPs and CCCs that students are expected to have and learn in the unit. However, the materials clarify students' expected level of proficiency with the DCIs and CTE content learning in the unit. **Explicit connections to students' prior learning concerning SEPs and CCCs could improve alignment to this criterion.**

AIR's review also included feedback regarding alignment of the lesson to three of the eight Futurelab+ guiding principles: equity, adaptability, and industry driven. Unit 8, PD 1, materials met all three of these guiding principles:

- ***Equity*.** The lesson focuses on providing students the opportunity to make observations and identify an issue that is meaningful to them. Students also have the opportunity to conduct research within their local communities to learn how that issue may be addressed, which provides opportunities for students to give voice to community issues that concern and may directly impact them.
- ***Adaptability*.** Materials appear to be adaptable and allow teachers to move between virtual, in-person, or hybrid settings, using different synchronous and asynchronous teaching methods.
- ***Industry Driven*.** Students take on the roles of geographic information systems (GIS) developers, public opinion researchers, and project managers to use data collection tools to identify and investigate important issues within their community.

Methodology

Released in 2013, the NGSS were developed by a consortium of states, teacher associations, and nonprofit organizations. The purposes of NGSS are to (1) combat ignorance of science, (2) create common teaching standards, and (3) develop greater interest in science among students so that more students choose to major in science in technology. The focus on the purposes requires changes in how science is taught and the materials used to teach science. These changes, or innovations, shift the focus of science instruction from an abstract recall of facts to students demonstrating proficiency by engaging in scientific practices.

Three dimensions are integrated into the NGSS and throughout NGSS-aligned materials: SEPs, CCCs, and DCIs.

Methods

The 2-year biotechnology curriculum consists of four core units each year. Each core unit has nine lessons and a lab. As is typical with NGSS-aligned lessons, a lesson consists of more than one class period of instruction to allow students the opportunity to develop their knowledge and understanding more fully. Lessons and labs take approximately five 45-minute instructional periods to complete. In its entirety, the biotechnology curriculum has 72 lessons and eight labs and covers 2 instructional years.

AIR was asked to provide feedback and evidence of incorporation of some of the three-dimensional learning innovations common to the NGSS on a sample of the biotechnology curriculum. **Because the curriculum was designed to align primarily to CTE standards, it was not expected that the curriculum would meet all NGSS criteria.**

In addition, there are significant similarities between the innovations measured by the NGSS Lesson Screener and the University of California (UC) science (D) subject requirement, as shown in Exhibit 2. For this reason, AIR selected to use the NGSS Lesson Screener for supporting evidence of three-dimensional learning.

Exhibit 2. Similarities Between UC Science Requirements and Measured Innovations

There are significant similarities between the UC science (D) subject requirement and the NGSS Lesson Screener criteria. Specific course content guidelines of the A–G Policy Resource Guide are briefly summarized here, with notations about which Lesson Screener criteria include the same or similar requirements.

- Explicitly integrate the eight NGSS SEPs (Lesson Screener Criteria B and C); this requirement is mentioned multiple times.
- Draw content generally from the NGSS (Lesson Screener Criteria B and C) and Common Core State Standards for Literacy in History/Social Studies, Science, and Technical Subjects.
- Provide opportunities for students to participate in all phases of the scientific process and require students to discuss ideas with other students (Lesson Screener Criteria B, C, D, and E).
- Be explicit about formative and summative assessment practices (Lesson Screener Criteria B, C, and E).
- Include real-world problems that engage all students in science learning (Lesson Screener Criteria A, D, and E).
- Specify minimum mathematics course requirements.
- Reserve at least 20% of class time for teacher-supervised, hands-on laboratory activities.
- Incorporate technology (to the extent possible) to increase access and computer-based skills for students.

NGSS Lesson Screener

The NGSS Lesson Screener, developed by Achieve in collaboration with the National Science Teaching Association, is a framework for collecting evidence on (1) whether a lesson being developed or revised is on the right track for incorporating NGSS innovations, (2) if a lesson warrants further review using the EQuIP Rubric, and (3) to what extent a group of reviewers have a common understanding of the NGSS or of designing lessons for the NGSS. Because these materials were designed primarily to align to CTE standards, with aspects of NGSS and three-dimensional learning incorporated, using the Lesson Screener was more appropriate than using the EQuIP Rubric.

The NGSS Lesson Screener includes six criteria (labeled A–F). The first three Lesson Screener criteria (A–C) consider evidence of three NGSS shifts: (A) Explaining Phenomena or Designing Solutions, (B) Three Dimensions (of learning), and (C) Integrating the Three Dimensions for Instruction and Assessment. The last three NGSS criteria (D–F) consider features of quality design: (D) Relevance and Authenticity, (E) Student Ideas, and (F) Building on Students' Prior Knowledge.

Each screener criterion lists several indicators that help determine the extent to which a lesson incorporates an innovation. In other words, these indicators, or descriptions, denote whether the lesson materials meet a criterion. **A rating of *adequate* or higher means that the lesson meets the criterion.**

Possible criterion ratings on the NGSS Lesson Screener include the following:

- None (no evidence to meet the criterion)
- Inadequate (limited evidence to meet the criterion or direct evidence that the materials are not aligned)
- Adequate (enough evidence to meet the criterion)
- Extensive (more than enough evidence to meet the criterion)

For this curriculum review, AIR added an *approaching* rating to the NGSS criterion ratings. This new rating indicates where a slight modification to materials would increase the rating to *adequate*.

Sampling

To complete the series of NGSS Lesson Screener reviews, AIR sampled one lesson in each of the eight core units for a total of eight NGSS alignment and evidence reviews. **AIR randomly selected four of the lessons; the other four lessons were re-reviews of materials AIR reviewed during the formative review process.** AIR randomly selected PD 1 (Analyzing Community Needs and Proposal Identification) from Unit 8 (Community Science) for this report.

Two AIR staff independently and then collaboratively reviewed Unit 8, PD 1, to provide impartial evidence of where in the lesson and to what extent NGSS innovations are incorporated. After each AIR reviewer independently completed the review and provided a rationale for the ratings on each indicator, the team met to arrive at a final rating for each criterion (see Exhibit 3).

Exhibit 3. Lesson Review Process

Following the Lesson Screener standard review protocol, the AIR review team

- individually reviewed the lesson to record criterion-based evidence,
- individually made suggestions for improvement,
- collaboratively discussed findings to make a final rating determination, and
- summarized findings into a report.

Feedback and Evidence: Unit 8, PD 1

AIR found evidence that Unit 8, PD 1, materials meet three of the six NGSS criteria identified by the Lesson Screener and are approaching the remaining three criteria. All six criteria and evidence supporting AIR's ratings are discussed in detail in this section (see summary in Exhibit 1).

NGSS Ratings and Evidence

Rating for Criterion A: Explaining Phenomena or Designing Solutions: *Adequate*

The reviewers found adequate evidence within the lesson that learning is driven by students making sense of phenomena. The goal of each activity reviewed in PD 1 is to give students the opportunity to apply various data collection tools to identify important issues within their community. Students then analyze the data they collect and prepare an initial funding proposal to obtain "funding" for their project to address a community issue they have identified.

The lesson materials achieve the *adequate* rating for this criterion because they include examples of opportunities and support for students making sense of the phenomena, as evidenced by the following activities:

- **Day 1 Activities.** The lesson begins with an opening activity in which students generate maps of places within their community where they spend a lot of time. Students then reference these maps to identify potential obstacles and opportunities for developments that can be addressed through DNA identification technology (Teacher Section, pp. 5–6).
- **Days 2–8 Activities.** Students assume the role of a public opinion researcher. They first identify community leaders who are knowledgeable about the area. Then they develop a survey or interview to ask those leaders questions about what they've noticed in the maps (Teacher Section, pp. 7–10).

Rating for Criterion B: Three Dimensions: *Approaching*

The reviewers found that, although the materials do not fully meet this criterion by providing opportunities to build understanding of grade-appropriate elements in **all three dimensions**, the materials *approach* this criterion. Specifically, there is sufficient evidence that materials give students opportunities to build their understanding in both SEPs and DCIs. Alignment of materials to this criterion could be increased if the materials provided students explicit opportunities to develop their understanding of CCCs, such as patterns. Although reviewers found examples of where CCCs could be incorporated or referenced, particularly with respect to patterns within maps or data, teachers who are new to NGSS would need additional guidance about where and how to incorporate this dimension.

The following bulleted evidence supports the *approaching* rating for this criterion because the lesson materials include examples of opportunities and support for students explicitly developing their understanding of elements of both SEPs and DCIs:

SEPs, including:

- **Asking Questions and Defining Problems.** Define a design problem that can be solved through the development of an object, tool, process or system that includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. Students spend time developing questions for community members to help identify possible solutions to a selected problem within their community. Students ultimately propose a solution to the problem with the goal of obtaining mock funding for their project (Teacher Section, p. 8).

- **Analyzing and Interpreting Data.** Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) to make valid and reliable scientific claims or determine an optimal design solution. Students analyze data they collect from surveys and interviews to identify issues within their community and inform their proposed solutions (Teacher Section, p. 8).

DCIs, including:

- **Engineering Design.** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. As noted earlier, throughout the lesson students are working to identify an issue currently impacting their community that can be addressed through DNA identification (Student Section, p. 14).

Rating for Criterion C: Integrating the Three Dimensions for Instruction and Assessment: *Approaching*

The reviewers found that, although the materials do not fully meet this criterion by providing opportunities to build understanding of grade-appropriate elements in **all three dimensions**, the materials *approach* this criterion. Specifically, there is sufficient evidence that the materials give students opportunities to build their understanding of both SEPs and DCIs. Aligning materials to this criterion could be increased if the materials provided students with explicit opportunities to demonstrate their understanding of various CCCs, such as by identifying patterns between student-generated maps or within survey data they collect. As with Criterion B, reviewers found examples of where CCCs could be incorporated or referenced throughout the lesson; however, teachers who are new to NGSS would need additional guidance about where and how to incorporate this dimension.

The following bulleted evidence supports the *approaching* rating for this criterion because the lesson materials include examples of opportunities and support for students to explicitly demonstrate their understanding of elements of both SEPs and DCIs:

SEPs, including:

- **Asking Questions and Defining Problems.** Define a design problem that can be solved through the development of an object, tool, process or system that includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. Students spend time developing questions for community members to help identify possible solutions to a selected problem within their community. Students ultimately propose a solution to the problem with the goal of obtaining mock funding for their project (Teacher Section, p. 8).
- **Analyzing and Interpreting Data.** Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) to make valid and reliable scientific claims or determine an optimal design solution. Students analyze data they collect from surveys and interviews to identify issues within the community and inform their proposed solutions (Teacher Section, p. 8).

DCIs, including:

- **Engineering Design.** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. As noted earlier, throughout the lesson students are working to identify an issue currently impacting their community that can be addressed through DNA identification (Student Section, p. 14).

Rating for Criterion D: Relevance and Authenticity: *Adequate*

The reviewers found adequate evidence that the materials engage students in authentic and meaningful scenarios that reflect the real world because the materials provide opportunities for students to engage with materials in a meaningful way. Throughout the lesson, culturally responsive teaching strategies are included with a link to information about how to incorporate them.

The following bulleted evidence supports the *approaching* rating for this criterion:

- **Day 1 Activities.** Students refer to community journal entries they made in a previous lesson and add to their journal in response to the prompt "Think about the topic area you chose (environment, food and safety, human interest). How does this topic fit into one or more of the communities to which you belong? What concerns do people in those communities have related to that topic? What problems exist that need to be solved?" (Teacher Section, p. 5).
- **Days 2–8 Activities.** Students assume the role of a public opinion researcher and identify key community members to contact for interviews, surveys, or focus groups for gathering feedback and insights into the topic area they chose. Students then develop and conduct the interviews, surveys, or focus groups to inform the development of a project proposal (Teacher Section, pp. 7–10).

Rating for Criterion E: Student Ideas: ***Adequate***

The reviewers found adequate evidence that the materials provide students with opportunities to share their own ideas as well as provide feedback about their peers' ideas. Several opportunities exist for students to reflect on their own thinking, including adding to prior journal entries, developing survey and interview questions, conducting a survey, and providing feedback on their peers' work.

The following bulleted evidence supports the *approaching* rating for this criterion:

- **Day 1 Activities.** As noted in Criterion D, students refer to community journal entries they made in a previous lesson and add to their journal in response to a prompt that asks them to consider problems they have observed within their community (Teacher Section, p. 5).
- **Days 3–8 Activities.** Students provide peer feedback on student presentations, identifying what they did well and where their peers could improve in the development of their proposal (Student Section, p. 15).

Rating for Criterion F: Building on Students' Prior Knowledge: ***Approaching***

The reviewers found inadequate evidence that the materials identify and build on students' prior learning in all three dimensions because the materials make little to no connection between expected prior learning in the CCCs and learning in the unit. However, the materials do make several references to student prior learning, including building on their understanding of issues that impact their community (Teacher Section, p. 5) and applying various data collection methods they have refined throughout their learning (Teacher Section, p. 8). As with Criteria B and C, alignment of materials to this criterion could be increased if the materials provided explicit connections to students' prior learning in the CCCs. For example, asking students what patterns they would expect to see in a similar community and what variables may impact those patterns.

Futurelab+ Design Principles

Although several Futurelab+ design principles (Exhibit 4) overlap with the Lesson Screener criteria, especially concerning Principle 1 (Equity) and Principle 6 (Education Standards Aligned), AIR was asked to look for evidence of the design principles independent of NGSS. Within this section, AIR provides feedback regarding the principles of Equity, Adaptability, and Industry Driven.

Feedback about the principle of Education Standards Aligned can be surmised from the CTE alignment matrix and summary evidence reports provided for each unit.

Feedback about the principle of California Focus can be surmised from the California Subject Matter D report prepared for each unit. No formal evaluation tool was created or used to provide this feedback.

Feedback is not provided about all principles because the focus of other principles relates to the design of the materials.

Exhibit 4. Futurelab+ Principles

1. **Equity** | **Prioritize** meeting the needs of the most **underserved students** using socially responsible language.
2. **Adaptability** | Empower and equip teachers and students to **seamlessly move between virtual and in-person learning** environments.
3. **Industry Driven** | Reflect **in-demand biotech skills** and **career-laddering opportunities.**
4. **Teacher Voice** | Informed by **teacher input** and must be **teacher-demand driven.**
5. **Teaching Breadth and Inclusivity** | Build to engage a **broad set of teachers.**
6. **Education Standards Aligned** | Demonstrate **relevance** and **validity** with educators.
7. **Open Source** | Opt for **open frameworks** over proprietary approaches.
8. **California Focus** | Prioritize **California state standards and educational contexts** as a foundation for future scaling efforts nationwide.

Equity

Unit 8, PD 1, focuses on providing students the opportunity to make observations and identify an issue meaningful to them. Students also have the opportunity to conduct research within their local communities to learn how that issue may be addressed; this provides opportunities for students to give voice to community issues that concern and may directly impact them. Some students may struggle with developing interview questions or conducting interviews; however, teachers receive guidance on how to support those students.

Adaptability

Unit 8, PD 1, materials appear adaptable and allow teachers to move between virtual, in-person, or hybrid settings using different synchronous and asynchronous teaching methods. Futurelab+ may consider giving suggestions to teachers during professional learning activities or in notations on the website for where and how lessons could be moved between platforms.

Industry Driven

In Unit 8, PD 1, students take on the roles of GIS developers, public opinion researchers, and project managers to use data collection tools to identify important issues within their community.

Resources

Achieve & National Science Teachers Association. (2016). *NGSS lesson screener*. https://www.nextgenscience.org/screener

California Department of Education. (2007). *Career technical education framework for California public schools: Grades seven through twelve*. https://www.cde.ca.gov/ci/ct/sf/documents/cteframework.pdf

California Department of Education. (2017). *California career technical education model curriculum standards*. https://www.cde.ca.gov/ci/ct/sf/documents/healthmedical.pdf

Sacramento City Unified School District. (n.d.). *Protocols for culturally responsive learning and increased student engagement*. https://www.scusd.edu/sites/main/files/file-attachments/protocols_0.pdf?1445031253

Appendix A. Lesson Screener Criteria

	Criterion	Description
NGSS Shifts	**A. Explaining Phenomena or Designing Solutions**	The lesson focuses on supporting students to make sense of a phenomenon or design solutions to a problem.
	B. Three Dimensions	The lesson helps students develop and use multiple grade-appropriate elements of the SEPs, DCIs, and CCCs, which are deliberately selected to aid student sensemaking of phenomena or designing of solutions.
	C. Integrating the Three Dimensions for Instruction and Assessment	The lesson requires student performances that integrate elements of the SEPs, CCCs, and DCIs to make sense of phenomena or design solutions to problems, and the lesson elicits student artifacts that show direct, observable evidence of three-dimensional learning.
Features of Quality Design	**D. Relevance and Authenticity**	The lesson motivates student sensemaking or problem solving by taking advantage of student questions and prior experiences in the context of the students' homes, neighborhoods, and communities, as appropriate.
	E. Student Ideas	The lesson provides opportunities for students to express, clarify, justify, interpret, and represent their ideas (i.e., making thinking visible) and to respond to peer and teacher feedback.
	F. Building on Students' Prior Knowledge	The lesson identifies and builds on students' prior learning in all three dimensions in a way that is explicit to both the teacher and the students.

Note. DCI = disciplinary core ideas; SEP = science and engineering practices; CCC = cross-cutting concepts.

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