

Protect Your Body, Filter Your Water

DEVELOPER: Teach Engineering
GRADE: 8 | DATE OF REVIEW: April 2022



Protect Your Body, Filter Your Water

EQUIP RUBRIC FOR SCIENCE EVALUATION

OVERALL RATING: R

TOTAL SCORE: 5

CATEGORY I: NGSS 3D Design Score	CATEGORY II: NGSS Instructional Supports Score	CATEGORY III: Monitoring NGSS Student Progress Score
2	1	1

[Click here to see the scoring guidelines.](#)

This review was conducted by the [Science Peer Review Panel](#) using the [EQUIP Rubric for Science](#).

CATEGORY I CRITERIA RATINGS	CATEGORY II CRITERIA RATINGS	CATEGORY III CRITERIA RATINGS
A. Explaining Phenomena/ Designing Solutions Adequate	A. Relevance and Authenticity Extensive	A. Monitoring 3D Student Performances Adequate
B. Three Dimensions Adequate	B. Student Ideas Extensive	B. Formative Inadequate
C. Integrating the Three Dimensions Adequate	C. Building Progressions Inadequate	C. Scoring Guidance Inadequate
	D. Scientific Accuracy Extensive	D. Unbiased Tasks/Items Extensive
	E. Differentiated Instruction Inadequate	

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Summary Comments

Thank you for your commitment to students and their science education. NextGenScience is glad to partner with you in this continuous improvement process. It is obvious that this lesson was thoughtfully crafted, and it has many strengths that may not be apparent from the ratings. The lesson has a central focus on a problem that students are designing solutions for, and the lesson is engaging and provides students with the opportunity to take part in three-dimensional learning authentically. The reviewers were pleased to see so much of the previous feedback used to improve the lesson.

During revisions, the reviewers recommend paying close attention to the following areas:

- **Providing students with opportunities to build on their prior understandings.** Although students can integrate the three dimensions, it is unclear as to how their prior learning can be built upon to improve their understanding. Consider providing support for teachers to specifically customize student learning based on their prior understanding as well as any prior conceptions that they may have.
- **Providing opportunities for ALL students to meet the expectations outlined.** Although there are some opportunities for meeting the needs of some learners, sufficient supports are not currently included to help ensure that teachers can address the needs of diverse learners. Consider providing explicit support to teachers to meet the needs of all levels of learners.
- **Providing instructional next steps for teachers that facilitate progressions in student learning.** Specific rubrics and teacher materials that explicitly describe to teachers what to look for and how to make adjustments to instruction to meet the students' needs are critical for student success. These supports would ideally be clear for both students and teachers.

Note that in the feedback below, black text is used for either neutral comments or evidence the criterion was met and purple text is used as evidence that doesn't support a claim that the criterion was met. The purple text in these review reports is written directly related to criteria and is meant to point out details that could be possible areas where there is room for improvement. Not all purple text lowers a score; much of it is too minor to affect the score. For example, even criteria rated as Extensive could have purple text that is meant to be helpful for continuous improvement processes. In these cases, the criterion WAS met. The purple text is simply not part of the argument for that Extensive rating.

CATEGORY I

NGSS 3D DESIGN

I.A. EXPLAINING PHENOMENA/DESIGNING SOLUTIONS

I.B. THREE DIMENSIONS

I.C. INTEGRATING THE THREE DIMENSIONS

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I.A. EXPLAINING PHENOMENA/DESIGNING SOLUTIONS

Making sense of phenomena and/or designing solutions to a problem drive student learning.

- i. Student questions and prior experiences related to the phenomenon or problem motivate sense-making and/or problem solving.
- ii. The focus of the lesson is to support students in making sense of phenomena and/or designing solutions to problems.
- iii. When engineering is a learning focus, it is integrated with developing disciplinary core ideas from physical, life, and/or earth and space sciences.

Rating for Criterion I.A. Explaining Phenomena/Designing Solutions

Adequate
(None, Inadequate, Adequate,
Extensive)

The reviewers found adequate evidence that learning is driven by students making sense of phenomena or designing solutions to a problem because students use their new understanding of the targeted DCI in order to design a solution to the problem of pharmaceuticals in the drinking water. **However, the targeted DCI is not essential for students' learning in order to design a working solution to the problem.**

The lesson is focused on a real-world problem that drives the learning as students design a solution to the problem—drinking water contamination due to various pharmaceuticals and hormones. For example:

- Students are introduced to the problem by interpreting an image that shows pills coming out of a water faucet into a bottle.
- Students watch a video describing changes in fish anatomy due to prescription drugs in waterways. The video also discusses a concern over drugs that show up in drinking water for humans.
- Students study an infographic titled, “Unprescribed: Drugs in the Drinking Water,” which details the path taken by drugs from production to drinking water.
- An optional podcast is also provided to give more information about the problem students are asked to solve.

The problem drives student learning in the lesson. Students are told they will act as environmental engineers that will design a filtration device. The device they create should be one to be implanted in a water treatment system. The goal of the device is to remove estrogen and other organic compounds from drinking water as a final step in the filtration system.

Learning is driven by student questions during the presentation of the lesson problem. For example:

- After the image of the pills coming out of the faucet, the teacher is instructed to “...ask students to share what questions they have. (Example: Why are there pills coming out from the faucet?)

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Where did the pills come from? What kind of pills are they? What does this mean? Is it harmful to us?) Write down student questions on the board. Tell students we are going to answer some of these questions today.”

- After completing an initial Claim-Evidence-Reasoning Graphic Organizer, the teacher is instructed to say, "Now that you are familiar with the problem, what question(s) do you have? Encourage students to revisit their questions they wrote down at the beginning.”
- “Give students time to brainstorm solutions to the problem and what they could do in order to solve it.” However, although students are given a chance to brainstorm solutions, **they are still expected to use the solution provided by the teacher.**
- Students return to the problem to iterate on their solution based on learning and feedback. On Day 2, students modify their prototype based on the data collected from Day 1.

Engineering is the focus of this lesson; students develop the following DCI **prior to their solution to the design problem rather than while they design their solution.** ESS3.C: **Human Impacts on Earth Systems.** *Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.* Then students are asked “So, what solutions exist to remove these containments from our drinking water and just how effective are they?” The teacher is guided to “Give students time to brainstorm solutions to the problem and what they could do in order to solve it. Have them think about how a potential model would look, what the different components of the system would be and how the components would interact with each other.” Students complete a Claim-Evidence-Reasoning Graphic Organizer answering the question, “How does the human activity of improper disposal of pharmaceuticals affect the environment and living things?” based on the information presented in the video and infographic. The teacher is told “Allow students to present their CER along with their designs to the class. Tell students they should imagine they are pitching their solution to their local water treatment facility.”

Suggestions for Improvement

Consider providing guidance that would help students take ownership of the solution they use. For example, students could research before they brainstorm to help ensure that their ideas will be more closely aligned to the provided solutions, and facilitation notes could be provided to the teacher to help guide student brainstorming in a productive direction. Alternately, the materials list could be expanded so that students are able to explore their own ideas.

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I.B. THREE DIMENSIONS

Builds understanding of multiple grade-appropriate elements of the science and engineering practices (SEPs), disciplinary core ideas (DCIs), and crosscutting concepts (CCCs) that are deliberately selected to aid student sense-making of phenomena and/or designing of solutions.

- i. Provides opportunities to *develop and use* specific elements of the SEP(s).
- ii. Provides opportunities to *develop and use* specific elements of the DCI(s).
- iii. Provides opportunities to *develop and use* specific elements of the CCC(s).

Rating for Criterion I.B. Three Dimensions

Adequate
(None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that the materials give students opportunities to build understanding of grade-appropriate elements of the three dimensions because the claimed SEPs and CCCs in this lesson allow students to use and develop them to create a solution to the lesson problem. However, the ESS DCI element is not fully developed to the point where students would have a deep competence and the ability to apply their knowledge in another context.

Science and Engineering Practices (SEPs) | Rating: Extensive

The reviewers found extensive evidence that students have the opportunity to use and develop the SEPs in this lesson because grade-appropriate elements are claimed in the lesson that drive students to design a solution to the problem of contaminated water.

Asking Questions and Defining Problems

- Ask questions that can be investigated within the scope of the classroom, outdoor environment, museums, and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles.
 - This element is claimed in the Educational Standards for Performance Expectation MS-ESS3-3.
 - “Now ask students to share what questions they have. (Example: Why are there pills coming out from the faucet? Where did the pills come from? What kind of pills are they? What does this mean? Is it harmful to us?) Write down student questions on the board. Tell students we are going to answer some of these questions today” (page 5).
 - “Once all students have a good understanding, tell students: ‘Now that you are familiar with the problem, what question(s) do you have?’ Encourage students to revisit their questions they wrote down at the beginning. Listen to student responses, guiding students to ask what solutions might exist to help remove pharmaceuticals and other organic compounds from the water” (page 7).

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Developing and Using Models

- *Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs.*
 - Students develop a water filtration model and then test the effectiveness of the model. “In their lab notebooks, students record the chlorine concentration, the time it took the water to move through the filter, and the amount of water retrieved from their filters.” However, although students record the input (original chlorine concentration) and output (chlorine concentration after treatment), students do not refer to them as representing inputs and outputs.

Constructing Explanations and Designing Solutions

- *Apply scientific ideas or principles to design, construct, and/or test a design of an object, tool, process, or system.*
 - Students use the Engineering Design Process to design, construct, and test a tool to filter chlorine out of water to simulate removing pharmaceuticals from drinking water.

Engaging in Argument from Evidence

- *Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (Strike-out text is not claimed by the materials.)*
 - Students complete two CER graphic organizers that answer the questions, “How does the human activity of improper disposal of pharmaceuticals affect the environment and impact living things?” and “What solutions exist to help remove these compounds from our drinking water and how effective are they?”
 - Students do not present an oral argument in this lesson.

Disciplinary Core Ideas (DCIs) | Rating: Adequate

The reviewers found adequate evidence that students have the opportunity to use or develop the DCIs in this lesson because grade-appropriate DCI elements are claimed by the materials that drive students to develop possible solutions to the problem of drinking water contaminated with pharmaceuticals. Although students partially use and develop some of the claimed Earth and Space Science (ESS) DCI elements in this lesson, students are not supported to develop deep competence in the ESS DCI element that would allow students to apply their learning in more than one context.

ESS3.C: Human Impacts on Earth Systems

- *Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth’s environments can have different impacts (negative and positive) for different living things.*
 - Students watch a news video about drinking water contaminated by pharmaceuticals, and they study an infographic describing how pharmaceuticals contaminate drinking water. In the video, it is described how increased estrogen in the environment has contributed to fish changing from males to females.

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- The infographic states, “traces of pharmaceutical chemicals and hormones have been detected in the drinking water of 14% of the nation, or 41 million Americans in 24 major metropolitan areas” and, “the greatest immediate concern is for the health of aquatic organisms.”
- This lesson does not address the extinction of species or how changes to Earth’s environments can have positive impacts for living things. It is also specific to only one human activity that can significantly alter the biosphere, and therefore students might not be able to generalize this DCI to another context.

ETS1.B: Developing Possible Solutions

- *Models of all kinds are important for testing solutions.*
 - Students create an initial model to filter the contaminated water and then on the second day adjust their design based on the data and feedback received to create a second model to test how well it filters the chlorine. They therefore **begin to implicitly** develop this understanding.

ETS1.C: Optimizing the Design Solution

- *The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution.*
 - Students create a model, test it, and then make modifications to their filtration model to gain better test results. They therefore **implicitly** begin building an understanding of part of this element.

Crosscutting Concepts (CCCs) | Rating: Adequate

The reviewers found adequate evidence that students have the opportunity to use and develop the CCCs in this lesson because students engage in grade-appropriate elements in service of designing the solution to the pharmaceuticals in drinking water problem. **However, there is a mismatch between claims and evidence of CCC use. Students are only supported to use some of the CCCs at an elementary grade level.** Note that student use of elementary-level CCC elements is normal and expected. It is only considered as negative evidence if a middle school-level element is claimed while students only use the elementary-level CCC element.

Cause and Effect

- *Cause and effect relationships may be used to predict phenomena in natural or designed systems.*
 - This element was claimed, **but reviewers didn’t see evidence of its use in the lesson.** Instead, reviewers found the following evidence of student use of an element from the 3–5 grade band: *Cause and effect relationships are routinely identified, tested, and used to explain change.*
 - After students view the image, “Guide student discussion to have students think about what causes the pills to end up in the cup and what effect that might have.”

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- After students view the video and review the infographic, “Have students identify what causes and effects result from this problem.”
- As an assessment, students complete a CER to answer the question, “What solutions exist to help remove pharmaceutical compounds from our drinking water and are they effective?”

Systems and System Models

- *Models can be used to represent systems and their interactions—~~such as inputs, processes and outputs—and energy and matter flows within systems.~~* (Strike out text is not claimed by the materials.)
 - As students brainstorm solutions to the lesson problem, “Have them think about how a potential model would look, what the different components of the system would be and how the components would interact with each other.”
 - As students begin the design process, “Remind students that they will be creating models to represent a water filtration system.”
 - While students are working, the teacher is encouraged to ask, “How does your prototype model represent a water filtration system?” Students will also answer this question in their lab book.

Suggestions for Improvement

Science and Engineering Practices

- Consider claiming only the portion of the **Developing and Using Models** SEP element that this lesson addresses.

Disciplinary Core Ideas

- Consider claiming only the portion of the ESS and ETS DCI elements that this lesson addresses.
- This element was removed between the first draft of the lesson and the current draft, but with a slight adjustment, it could still be developed in this lesson: *There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.*

Crosscutting Concepts

Consider clarifying claims about CCC usage and either ensuring that students are supported to use the claimed middle school-level CCC elements or to state when students are meant to use corresponding elementary-level elements.

I.C. INTEGRATING THE THREE DIMENSIONS

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Student sense-making of phenomena and/or designing of solutions requires student performances that integrate elements of the SEPs, CCCs, and DCIs.

Rating for Criterion I.C. Integrating the Three Dimensions

Adequate
(None, Inadequate, Adequate,
Extensive)

The reviewers found adequate evidence that student performances integrate elements of the three dimensions in service of designing solutions to problems because for the central activity of this lesson, students use all three dimensions to build, test, and describe their results in their lab book. *However, this single performance doesn't include a science DCI and students are not supported to engage in three-dimensional learning in a grade-appropriate way in other parts of the lesson.*

The central event is for students “to design a filtration device that could be implemented in a water treatment system to effectively remove estrogen and other organic compounds from drinking water as a final step in the filtration system” (page 8). After students develop an understanding of the problem of pharmaceuticals in drinking water by integrating the DCI ESS3.C **Human Impacts on Earth Systems** with the SEP **Asking Questions and Defining Problems**, students then apply their understanding to design a solution to the problem. Students develop models (SEP) to test possible solutions (DCI) in which they were able to explain the components of the system (CCC) that they proposed to solve the problem of contaminated water. Students conclude the lesson by reflecting on the performance of their designs (SEP **Engaging in Argument From Evidence**) with regards to what worked well and what could be improved. Therefore, the following three dimensions are used together to solve a problem:

- SEP: *Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs.*
- CCC: *Models can be used to represent systems and their interactions.*
- DCI: *Models of all kinds are important for testing solutions.*

Suggestions for Improvement

Consider supporting students' opportunities to use and develop middle school-level elements of all three dimensions more often in the lesson (see specific suggestions for each dimension under Criterion I.B). This would provide more chances for grade-appropriate three-dimensional learning.

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OVERALL CATEGORY I SCORE:

2
(0, 1, 2, 3)

Lesson Scoring Guide – Category I

Criteria A–C

3	Extensive evidence to meet at least two criteria and at least adequate evidence for the third.
2	Adequate evidence to meet all three criteria in the category.
1	Adequate evidence to meet at least one criterion in the category but insufficient evidence for at least one other criterion.
0	Inadequate (or no) evidence to meet any criteria in the category.

CATEGORY II

NGSS INSTRUCTIONAL SUPPORTS

II.A. RELEVANCE AND AUTHENTICITY

II.B. STUDENT IDEAS

II.C. BUILDING PROGRESSIONS

II.D. SCIENTIFIC ACCURACY

II.E. DIFFERENTIATED INSTRUCTION

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II.A. RELEVANCE AND AUTHENTICITY

Engages students in authentic and meaningful scenarios that reflect the practice of science and engineering as experienced in the real world.

- i. Students experience phenomena or design problems as directly as possible (firsthand or through media representations).
- ii. Includes suggestions for how to connect instruction to the students' home, neighborhood, community and/or culture as appropriate.
- iii. Provides opportunities for students to connect their explanation of a phenomenon and/or their design solution to a problem to questions from their own experience.

Rating for Criterion II.A. Relevance and Authenticity

Extensive
(None, Inadequate, Adequate,
Extensive)

The reviewers found extensive evidence that the materials engage students in authentic and meaningful scenarios that reflect the real world because students experience the scenario describing the problem as directly as possible, and there is a connection to students' lives and communities.

The problem and classroom activities are engaging and relevant to students' lives. For example:

- At the beginning of the lesson students are asked, "Who drank a glass of water today? Does anyone know what is in a glass of water?"
- Students watch a video describing the effects of pharmaceutical contaminants in waterways on organisms.
- Students study an infographic that delineates the path taken by pharmaceuticals in order to end up in drinking water.

Teachers are supported to make this lesson relevant to the area in which students live. For example, they are told "Find and share information about contaminants in your local waterways to help students better relate. The EPA's How's My Waterway? interactive application is a great tool to learn about your community's water quality, including any drinking water contaminants. The EPA also provides access to all local Consumer Confidence Reports (the annual drinking water quality report from your water supplier) which indicates the source of water and what's in it, including any levels of contaminants and the EPA's health-based standard (maximum contaminant level) for comparison."

Activity extensions are provided that relate to the students' communities. For example:

- "If time permits, consider having students scale the best design in the class to their local full-scale water treatment system. For example, a full-scale water treatment system can filter 4.5 million gallons per day, which is the city of Marlborough, MA's average daily water use."

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- “Have students research their local community's water treatment facility and determine what water treatment methods are used. Plan for a site visit to the facility if possible.”

Suggestions for Improvement

- Consider how to provide scaffolding for teachers who live in communities where there is no municipal water supply, such as drilled artesian wells.
- Consider providing support for teachers to address potential social or emotional sensitivity to the image of the glass filled with pills.
- Consider providing support for teachers to cultivate student questions that come from their experience, community, or culture.

II.B. STUDENT IDEAS

Provides opportunities for students to express, clarify, justify, interpret, and represent their ideas and respond to peer and teacher feedback orally and/or in written form as appropriate.

Rating for Criterion II.B. Student Ideas

Extensive
(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials provide students with opportunities to both share their ideas and thinking and respond to feedback on their ideas because when tasked with building a filtration model, students share ideas and evaluate the benefits in each design. Students also have a chance to receive feedback and to then modify their design based on feedback.

Student ideas about their design solution are cultivated, justified, and revised over the course of the lesson. For example:

- Students have an opportunity to express ideas with each other when they begin the engineering design process. “Direct groups to start by brainstorming at least three different designs keeping in mind the criteria and constraints they previously discussed.”
- During the CER activity, students answer the question, “What solutions exist to help remove these compounds from our drinking water and how effective are they?” giving them an opportunity to justify the effectiveness of the solutions.
- Students have an opportunity to share their ideas with their group. “After groups have brainstormed multiple designs, direct them to discuss the merits of each design, comparing them to each other in order to select the most-promising design (or combine various ideas into one most-promising design) given the criteria and constraints they previously discussed.”

Opportunities for students to receive feedback and revise their designs are provided. For example:

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- After teams have brainstormed ideas, “Have each team share their designs with another team and provide feedback on each other’s designs. Allow students to revise their designs based on team feedback if needed.”
- At the beginning of day 2, “Allow teams to make improvements based off team feedback and from Day 1’s testing.”
- “The teacher can provide each group with feedback on their designs and then allow student groups time to make modifications based on teacher feedback.” However, this is phrased as optional rather than as an expected step in the lesson.

Suggestions for Improvement

The mention of providing teacher feedback in the lesson would provide more evidence related to this criterion if it were not a suggestion (“can provide”), but a definite step in the lesson sequence.

II.C. BUILDING PROGRESSIONS

Identifies and builds on students’ prior learning in all three dimensions, including providing the following support to teachers:

- i. Explicitly identifying prior student learning expected for all three dimensions
- ii. Clearly explaining how the prior learning will be built upon.

Rating for Criterion II.C. Building Progressions

Inadequate
(None, Inadequate, Adequate, Extensive)

The reviewers found inadequate evidence that the materials identify and build on students’ prior learning in all three dimensions because although the learning progresses logically throughout the lesson, the stated pre-requisite knowledge does not identify learning from prior grades in elements of all three dimensions in order to help students build toward the targeted elements.

The lesson lists DCIs that are expected prior learning along with lessons that could help teachers provide the prerequisite learning for their students, but it does not list expected prior learning for all three dimensions. Related evidence includes:

- “Students should have prior knowledge of the water cycle (ESS2.C) and how increases in consumption of natural resources impact Earth’s systems (MS-ESS3-4).”
- Additional support is also provided. “It is important for students to have an understanding of the basic steps of the water treatment system to be able to comprehend that contaminants can result in our drinking water even after undergoing treatment.”
- The reviewers did not find evidence of expected prior learning listed for SEPs and CCCs.

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Suggestions for Improvement

- Consider identifying (at the element level) what learning students are expected to come in with for all three dimensions and then explaining how this learning will be added to throughout the lesson.
- Consider providing guidance for how teachers can build upon students' prior learning in designing a solution to the lesson problem.

II.D. SCIENTIFIC ACCURACY

Uses scientifically accurate and grade-appropriate scientific information, phenomena, and representations to support students' three-dimensional learning.

Rating for Criterion II.D. Scientific Accuracy

Extensive
(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials use scientifically accurate and grade-appropriate scientific information because there is no evidence of misinformation in any part of the lesson.

Related scientific information in the lesson includes:

- Video: <https://www.youtube.com/watch?v=XKCpeflOIUw>" (page 6)
- Infographic:
https://www.teachengineering.org/content/wpi_/activities/wpi_protect/wpi_protect_activity1_image.jpg" (page 6)
- USGS's podcast on [Emerging Contaminants, Pharmaceuticals in S. Carolina Rivers & Streams](#) (page 6)
- EPA's [How's My Waterway?](#) interactive application (page 6)
- The EPA also provides access to all local [Consumer Confidence Reports](#) (the annual drinking water quality report from your water supplier) page 6)

The information presented is scientifically accurate and grade appropriate for students to understand the connection between humans and their impact on the environment.

Suggestions for Improvement

- Consider including information for the teacher about potential misconceptions students may bring to this lesson.
- Consider adding robust background information for a teacher that may not have deep scientific expertise in these topics.

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II.E. DIFFERENTIATED INSTRUCTION

Provides guidance for teachers to support differentiated instruction by including:

- i. Supportive ways to access instruction, including appropriate linguistic, visual, and kinesthetic engagement opportunities that are essential for effective science and engineering learning and particularly beneficial for multilingual learners and students with disabilities.
- ii. Extra support (e.g., phenomena, representations, tasks) for students who are struggling to meet the targeted expectations.
- iii. Extensions for students with high interest or who have already met the performance expectations to develop deeper understanding of the practices, disciplinary core ideas, and crosscutting concepts.

Rating for Criterion II.E. Differentiated Instruction

Inadequate
(None, Inadequate, Adequate, Extensive)

The reviewers found inadequate evidence that the materials provide guidance for teachers to support differentiated instruction because the lesson is intended to be presented to all students in the same way, with minimal consideration for emerging multilingual learners and students who have already met the performance expectation. There are no strategies provided for learners with special needs or learners who read well below grade level. Guidance is provided for students in “lower grades”, but it is not clear what the specific needs are of students in lower grades.

Guidance is provided for lower grades, but it is unclear how this would meet the needs of individual students. For example:

- When students write their first CER, the suggestion is given, “For lower grades, consider completing this as a class as described in the Activity Scaling.”
- When completing online research, the suggestion is given, “For lower grades, consider completing this as a class as described in the Activity Scaling.”
- It is also suggested that for lower grades the Summary Engineering Design Report be optional.

Guidance is provided for “Advanced Students,” but not necessarily students who have already met the performance expectations or have a high interest in the subject matter. The teacher is told, “for advanced students, have students research other effective methods to filter water. Challenge students to come up with an argument for how their researched method compares to the use of activated carbon. Additionally, students can brainstorm how socio-economically disadvantaged areas can clean their water on a limited budget and present their ideas to the class.”

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Differentiation for multi-lingual learners is minimal and only addresses Spanish-speaking students. The teacher is told “For multilingual learners, consider providing research articles in a different language. For example, the following are great articles in Spanish that can be used for research.”

Suggestions for Improvement

- Consider providing differentiation strategies throughout the lesson, rather than just at the end.
- Consider providing scaffolding supports for the final report such as graphic organizers or templates.
- Differentiation strategies would ideally provide teachers with information on how to adjust instruction for specific students.
- Strategies for English learners would ideally go beyond providing content in students’ native languages. See the resources below:
 - <https://stemteachingtools.org/brief/27>
 - <https://stemteachingtools.org/brief/33>

OVERALL CATEGORY II SCORE:

1
(0, 1, 2, 3)

Lesson Scoring Guide – Category II

Criteria A-E	
3	At least adequate evidence for all criteria in the category; extensive evidence for at least one criterion.
2	Some evidence for all criteria in the category and adequate evidence for at least four criteria, including A
1	Adequate evidence for at least two criteria in the category
0	Adequate evidence for no more than one criterion in the category

CATEGORY III

MONITORING NGSS STUDENT PROGRESS

III.A. MONITORING 3D STUDENT PERFORMANCES

III.B. FORMATIVE

III.C. SCORING GUIDANCE

III.D. UNBIASED TASK/ITEMS

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III.A. MONITORING 3D STUDENT PERFORMANCES

Elicits direct, observable evidence of three-dimensional learning; students are using practices with core ideas and crosscutting concepts to make sense of phenomena and/or to design solutions.

Rating for Criterion III.A. Monitoring 3D Student Performances

Adequate
(None, Inadequate, Adequate,
Extensive)

The reviewers found adequate evidence that the materials elicit direct, observable evidence of students using practices with core ideas and crosscutting concepts to make sense of phenomena or design solutions because the materials elicit some direct, observable evidence that students are integrating multiple dimensions in service of problem solving. However, there are missed opportunities to include all three dimensions in two of the major student tasks.

The materials provide an opportunity for students to produce direct artifacts of their learning. Below is an example of a task that requires students to use grade-appropriate SEP and DCI elements. The task minimally requires students to use a CCC element.

- The Lab Book/Journal provides observable evidence in two dimensions. The expectations include, “Require each student's lab book to contain design ideas, prototype sketches and a description of the functionality and results from prototype testing. Expect students to include observations and hypotheses about their prototype designs and material use. Direct them to document their reasoning for each design they built and tested.”
 - In this task, students use the following:
 - **SEP: Developing and Using Models.** *Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs.*
 - **DCI: ETS1.B: Developing Possible Solutions.** Models of all kinds are important for testing solutions.
 - Students minimally use the following CCC as students are not expected to refer to their model as a system or refer to the components of the system.
 - **CCC: Systems and System Models.** *Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems. (Strike out text is not claimed by the materials.)*
 - Students are asked, “What are they key parts of the filtration device and their purpose? How do the different components of the device interact together?”

The lesson includes two CER writing activities. One provides evidence of three-dimensional learning, however, there is a missed opportunity for them both to be three-dimensional performances.

- Students complete a CER writing activity by answering the question, “How does the human activity of improper disposal of pharmaceuticals affect the environment and impact living things?” This CER includes some partial evidence of use of the following elements:

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- **Engaging in Argument from Evidence (SEP):** *Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.*
- **ESS3.C: Human Impacts on Earth Systems (DCI):** *Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.*
- **Cause and Effect (CCC):** *Cause and effect relationships may be used to predict phenomena in natural or designed systems.*
- Students complete a CER writing activity by answering the question, "What solutions exist to help remove pharmaceutical compounds from our drinking water and are they effective?" **This CER includes only one element:**
 - **Engaging in Argument from Evidence:** *Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.*
 - **This CER can be written without students' knowledge of any of the claimed DCI or CCC elements.**

Suggestions for Improvement

- Consider using explicit ideas from the CCC element as a requirement for students to demonstrate their knowledge during a three-dimensional assessment.
- Consider rephrasing the second CER question to require students to demonstrate knowledge in all three dimensions.
- Consider providing students with a graphic organizer to support students in creating their Summary Engineering Design Report.

III.B. FORMATIVE

Embeds formative assessment processes throughout that evaluate student learning to inform instruction.

Rating for Criterion III.B. Formative

Inadequate
(None, Inadequate, Adequate,
Extensive)

The reviewers found inadequate evidence that the materials embed formative assessment processes throughout that evaluate student learning and inform instruction because although some formative assessments are tied to multiple dimensions, **there is no indication how these tasks could be used to adjust instruction and no suggestions are provided as to what can be offered as feedback to students.** Related evidence includes:

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- *Claim-Evidence-Reasoning:* “Have students complete the Claim-Evidence-Reasoning Graphic Organizer to answer the following question: How does the human activity of improper disposal of pharmaceuticals affect the environment and impact living things?”
- *Lab Book/Journal:* “Individually assess students based on the design and redesign documentation in their lab books or journals. Require each student's lab book to contain design ideas, prototype sketches and a description of the functionality and results from prototype testing. Expect students to include observations and hypotheses about their prototype designs and material use. Direct them to document their reasoning for each design they built and tested. For full credit, require students to answer the following Guiding Questions for the design portion of the lab book:
 - What are you trying to accomplish in the design of your water filtration device?
 - What are different ways to use the materials provided in your filtration device?
 - How can you control water flow to enable the chlorinated water to react with the activated carbon?
 - What is the purpose of each portion of the water filtration device your group decided to build?
 - What are the results of your water filtration device's test?
 - In what step of the water filtration process would you implement your design?”
(page 8)
- Guidance is not provided on how to use different levels of student performance to adjust instruction accordingly.
- There is a missed opportunity to use the Lab Book/Journal as an ongoing, formative assessment. There are also missed opportunities during student discussions that could be used as formative assessments if direction were provided to the teacher to do so.

Suggestions for Improvement

- Consider including opportunities for the teacher to stop and assess student learning. These opportunities could provide guidance to the teacher as to how to proceed based on the responses from students. Guiding questions could be included as part of the procedure.
- Formative assessments also would ideally be tied to grade-appropriate elements of all three dimensions. Consider using STEM Teaching Tools Brief 18 to develop meaningful formative assessment opportunities throughout the lesson: <http://stemteachingtools.org/brief/18>.
- Consider providing guidance for educators on how to extend students' learning if formative assessment reveals that students are already proficient with the targeted learning.

III.C. SCORING GUIDANCE

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EQUIP RUBRIC FOR SCIENCE EVALUATION

Includes aligned rubrics and scoring guidelines that provide guidance for interpreting student performance along the three dimensions to support teachers in (a) planning instruction and (b) providing ongoing feedback to students.

Rating for Criterion III.C. Scoring Guidance

Inadequate
(None, Inadequate, Adequate, Extensive)

The reviewers found inadequate evidence that the materials include aligned rubrics and scoring guidelines that help the teacher interpret student performance for all three dimensions. *Assessment targets are not provided for elements of all three dimensions, and there is no guidance as to how rubrics can be used to plan instruction.*

This lesson provides 2 scoring rubrics:

- Engineering Design Report Scoring Rubric: This rubric assesses Criteria and Constraints, Brainstormed Designs, Design Description and Discussion, Results, Analysis, and Redesign and Discussion. Guidance is specific to this task and provides descriptions of different levels of score. *However, it is unclear how this rubric is connected to the elements of each dimension the materials are intended to assess.*
- Claim Evidence Reasoning Graphic Organizer Examples: An example CER graphic organizer is provided for each of the CER questions asked during the lesson. *However, it is unclear how this is to be used as scoring guidance as it serves essentially as an answer key.*

Suggestions for Improvement

- Consider listing element-level scoring targets for each major assessment opportunity.
- Consider adding a rubric for the CER graphic organizers or consider adding several examples for each question that show a range of responses.
- Consider designing guiding supports or tools to provide teachers with enough information to facilitate modification of instruction based on student response and ongoing targeted feedback to individuals.
- Consider how any scoring guidance provided to teachers could be made available to and accessible for students so that they may understand the learning targets and be able to interpret their own performance level.

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EQUIP RUBRIC FOR SCIENCE EVALUATION

III.D. UNBIASED TASK/ITEMS

Assesses student proficiency using methods, vocabulary, representations, and examples that are accessible and unbiased for all students.

Rating for Criterion III.D. Unbiased Task/Items

Extensive
(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials assess student proficiency using accessible and unbiased methods, vocabulary, representations, and examples because both the problem used in the lesson and the assessments provided are appropriate for all learners.

Several strategies are used in this lesson to present information and measure student learning in a way that is sensitive to a variety of learners. For example:

- The problem used in this lesson is described using different modalities. Students view a symbolic image, watch a video, and study an infographic.
- The vocabulary provided in this lesson is grade appropriate and definitions are provided for lesson specific words. However, there is a missed opportunity to include visual representations in the vocabulary materials.
- Students use multiple modalities in their Lab Book/Journal. They are expected to write and draw to represent the progression of their solution over the course of the lesson.

Suggestions for Improvement

- Consider adding an activity or adjusting an activity so that it allows students a choice in how they demonstrate their knowledge (e.g., orally versus through drawing).
- Consider adding graphic representations of vocabulary words.
- Consider providing examples of alternatives to how students could demonstrate their learning as part of the Engineering Design Report.

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OVERALL CATEGORY III SCORE:

1
(0, 1, 2, 3)

Lesson Scoring Guide – Category III

Criteria A-D

3	At least adequate evidence for all criteria in the category; extensive evidence for at least one criterion
2	Some evidence for all criteria in the category and adequate evidence for at least three criteria, including A
1	Adequate evidence for at least two criteria in the category
0	Adequate evidence for no more than one criterion in the category

SCORING GUIDES

SCORING GUIDES FOR EACH CATEGORY

LESSON SCORING GUIDE – CATEGORY I (CRITERIA A–C)

LESSON SCORING GUIDE – CATEGORY II (CRITERIA A–E)

LESSON SCORING GUIDE – CATEGORY III (CRITERIA A–D)

OVERALL SCORING GUIDE

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Scoring Guides for Each Category

Lesson Scoring Guide – Category I (Criteria A–C)	
3	Extensive evidence to meet at least two criteria and at least adequate evidence for the third.
2	Adequate evidence to meet all three criteria in the category.
1	Adequate evidence to meet at least one criterion in the category but insufficient evidence for at least one other criterion.
0	Inadequate (or no) evidence to meet any criteria in the category.

Lesson Scoring Guide – Category II (Criteria A–E)	
3	At least adequate evidence for all criteria in the category; extensive evidence for at least one criterion.
2	Some evidence for all criteria in the category and adequate evidence for at least four criteria, including A
1	Adequate evidence for at least two criteria in the category
0	Adequate evidence for no more than one criterion in the category

Lesson Scoring Guide – Category III (Criteria A–D)	
3	At least adequate evidence for all criteria in the category; extensive evidence for at least one criterion
2	Some evidence for all criteria in the category and adequate evidence for at least three criteria, including A
1	Adequate evidence for at least two criteria in the category
0	Adequate evidence for no more than one criterion in the category

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OVERALL SCORING GUIDE	
E	Example of high quality NGSS design —High quality design for the NGSS across all three categories of the rubric; a lesson or unit with this rating will still need adjustments for a specific classroom, but the support is there to make this possible; exemplifies most criteria across Categories I, II, & III of the rubric. (total score ~8–9)
E/I	Example of high quality NGSS design if Improved —Adequate design for the NGSS, but would benefit from some improvement in one or more categories; most criteria have at least adequate evidence (total score ~6–7)
R	Revision needed —Partially designed for the NGSS, but needs significant revision in one or more categories (total ~3–5)
N	Not ready to review —Not designed for the NGSS; does not meet criteria (total 0–2)