# Lesson 13: How can we use our science ideas and societal wants and needs to evaluate arguments around design solutions?

**Previous Lesson** *We compared arguments about speed limits, considering both science ideas and societal impacts. We constructed a Gotta-Have-It Checklist and used the list to develop explanations of how criteria and design solutions can increase vehicle safety.*

**This Lesson**

Investigation

1 day

We use the Argument Comparison Tool to compare arguments relevant to our community using our science ideas as well as societal constraints and ethical issues. We survey community members about local problems with our transportation system.

**Next Lesson** *We will identify driving-related problems we care about, then consider the scope of these problems and physics models to narrow down to a single problem per group. We will consider cause and effect to prioritize criteria, then get peer feedback on how to model this system. We will then identify reasonable approximations and develop our proposal in a format we choose.*

**BUILDING TOWARD NGSS**

HS-ETS1-3, HS-PS2-2, HS-PS2-3, HS-PS2-1

### What students will do

**13.A** Evaluate and compare competing arguments for a design solution based on scientific knowledge and principles, prioritized criteria, limitations (e.g., tradeoffs), constraints, and societal and ethical impacts. (SEP: 7.1; DCI: ETS1.B.1; Connections to Engineering, Technology, and Applications of Science: Influence of Science, Engineering, and Technology on Society and the Natural World)

### What students will figure out

- Science ideas alone cannot capture the whole picture related to tradeoffs, and societal impacts must be considered.
- Tradeoffs are evaluated when making decisions about safety from a scientific perspective, and societal wants and needs are messy; there

is not always one correct answer to design solution arguments.

## Lesson 13 • Learning Plan Snapshot

| Part | Duration | | Summary | Slide | Materials |
|---|---|---|---|---|---|
| 1 | 5 min | | **NAVIGATE: IDENTIFY RISK AND REASONS TO DRIVE**<br>Reflect on the risk involved with driving and why we still drive. Introduce arguments for choices that can reduce or increase risk. | A-B | *Science-Ideas Argument Comparison*, *Societal-Impacts Argument Comparison* |
| 2 | 5 min | | **READ ARGUMENTS**<br>Set up for the argument task using the *Argument Comparison Tool* and read selected arguments. | C | *Science-Ideas Argument Comparison*, *Societal-Impacts Argument Comparison*, *Argument Comparison Tool*, readings based on topic selection |
| 3 | 17 min | | **COMPARE AND EVALUATE ARGUMENTS**<br>Provide time for students to evaluate their arguments and complete the *Argument Comparison Tool*. | D | *Science-Ideas Argument Comparison*, *Societal-Impacts Argument Comparison*, *Argument Comparison Tool*, readings based on topic selection |
| 4 | 15 min |  | **MAKE SENSE OF THE ARGUMENTS**<br>Revisit community agreements. Facilitate a Consensus Discussion using the structure from the accompanying teacher reference. | E-F | *Argument Comparison Tool*, readings based on topic selection, Community Agreements, chart paper, chart paper markers |
| 5 | 3 min | | **NAVIGATE**<br>Reflect on classmate contributions and introduce the home learning. | G-I | *Community Interview*, half sheet of notebook paper |

*End of day 1*

## Lesson 13 • Materials List

| | per student | per group | per class |
|---|---|---|---|
| Lesson materials | • *Science-Ideas Argument Comparison*<br>• *Societal-Impacts Argument Comparison*<br>• *Argument Comparison Tool*<br>• readings based on topic selection<br>• *Community Interview*<br>• half sheet of notebook paper | | • Community Agreements<br>• chart paper<br>• chart paper markers |

## Materials preparation (60 minutes)

Review teacher guide, slides, and teacher references or keys (if applicable).

Make copies of handouts and ensure sufficient copies of student references, readings, and procedures are available.

**Prior to teaching this lesson, select relevant arguments and readings:**
Review the teacher references to use with the *Argument Comparison Tool*:

- *Lift Kit Argument* (student readings at an 8th grade reading level)
- *Weight Limit Argument* (student readings at a 6th grade reading level)
- *Public Transportation Argument* (student readings at an 8th grade reading level)

Pick one set of readings/arguments that you feel would be most relevant or interesting to your students and their community.

Make sure to identify the accompanying readings for each argument and have them readily accessible for students.
If you decide to let students choose the argument to explore as a class, make sure that all arguments are added to a place that is easily accessible for students to preview before making a decision.

On day 2, students will complete an exit ticket on a half sheet of notebook paper. Consider turning this exit ticket into a Google form. To do this, create the following setup in a Google form:

- Title the form: Contributions of my classmates in period #.

- Include the question: Record one instance from today of when a classmate's contributions helped you figure something out. Who was it, what was it, and how did it help you figure something out?

## Lesson 13 • Where We Are Going and NOT Going

### Where We Are Going

This lesson is designed to coherently build new ideas related to the following disciplinary core idea:

- **ETS1.B.1 Developing Possible Solutions:** When evaluating solutions, it is important to take into account a range of constraints, including ~~cost,~~ safety, ~~reliability,~~ and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)

The investigation in this lesson will look at the reality of arguments around engineering design and unknowns of systems within the real world. The purpose of this argument discussion is to bring tradeoffs to light and problematize specific designs within a complex, real world context.

The argument comparison and evaluation in this lesson is designed to support students toward the Next Generation Science Standards (NGSS), "Understanding the Scientific Enterprise: The Nature of Science in the Next Generation Science Standards" (Appendix H). The relevant understandings elements read as follows:

- **Science as a human endeavor:** Science and engineering are influenced by society and society is influenced by science and engineering.
- **Science addresses questions about the natural and material world:** Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions.
- **Science addresses questions about the natural and material world:** Science knowledge indicates what can happen in natural systems—not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge.
- **Science addresses questions about the natural and material world:** Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues.

This lesson utilizes scaffolded engagement with SEP7 using the *Argument Comparison Tool*. In this lesson, they will complete the *Argument Comparison Tool* with a partner and discuss it as a class. In Lesson 15, students will use a version of this tool within the assessment task.

Note that one of the lesson-level performance expectations associated with this lesson does not include a crosscutting concept. While it is rare for OpenSciEd to not include a crosscutting concept as part of a lesson-level performance expectation, this lesson is aligned with the ETS performance expectation that we are building toward in this unit (HS-ETS1-3), which lists the following "Connections to Engineering, Technology, and Applications of Science" statement as a third dimension of the performance:

- **Influence of Science, Engineering, and Technology on Society and the Natural World:** New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ETS1-1) (HS-ETS1-3)

In addition, this lesson features a formal conversation about risk and why people engage in risky behavior, such as driving. This lesson engages students in beginning to consider possible tradeoffs with risk and why science does not always reflect the needs of society. This idea of risk tradeoffs will be built upon in future lessons as we weigh the risks highlighted by science ideas against the societal needs of driving. This criterion of risk mitigation is pinned against constraints along with social, cultural, and environmental tradeoffs. This will primarily occur during the comparison of arguments around design solutions across Lessons 12-15.

### Where We Are NOT Going

Throughout this lesson, students consider tradeoffs related to vehicle design based on human safety, but also on societal equity, and possibly the environment. Note that students will not be doing an economic cost-benefit analysis in this lesson, but they will be thinking critically about societal costs and benefits related to decision making.

Students will not be encountering or co-developing definitions for new vocabulary in this lesson.

# LEARNING PLAN for LESSON 13

## 1 · NAVIGATE: IDENTIFY RISK AND REASONS TO DRIVE

5 min

MATERIALS: *Science-Ideas Argument Comparison*, *Societal-Impacts Argument Comparison*

Project **slide A**. Take a moment to read over the advisory and use tools or strategies from *Student Mindfulness Resource* to support students in this lesson. Before moving forward, double-check with all students to make sure they are prepared to engage in today's learning.

Say, *In the last few lessons we have been asking questions about what we should do to keep everyone safer. We talked about if we should wear seat belts, if we should install airbags, and if we should build less-rigid crumple zones. Even driving itself is a should-we decision. If driving is so risky, should we even drive or ride in vehicles at all?*

Project **slide B**. Ask students to think about the prompts on the slide.

- *If driving is so risky, why do we even drive or ride in vehicles at all?*
- *What kinds of decisions do people in our community make related to cars and driving that could affect driving risk?*

**Have a conversation about risk and benefits.** Discuss the reasons why someone would still want to ride in or drive vehicles, and establish that even though those potential risks are present, they are worth the benefits. Determine that we can also engage in behaviors such as being attentive and using safety features to negate or avoid collisions and that some safety features aren't available to everyone. Example prompts and responses are below.

| Suggested prompt | Sample student response |
|---|---|
| *Driving seems risky. Why do we even drive or ride in vehicles at all?* | Because we need to get places, and we can't always walk.<br><br>Transportation gets us places faster.<br><br>We need to deliver goods and perform services. Transportation allows us to do that quicker than walking. |
| *Is every person that ever drives going to get into a collision? What do you perceive our risk really is?* | I don't think every single person who gets into a car is going to be in a collision. |

| | |
|---|---|
| | I think it depends on where you drive, how much you drive, and how you drive. |
| *What kinds of decisions do people in our community make related to cars and driving that could affect driving risk?* | If you're a risky driver who is distracted and speeding you're more likely to be in a collision. If you follow the rules there's less of a chance. |
| *So is the risk ever going away?* | No, but we can make sure to watch out for ourselves as we drive.<br><br>The risk will always be there, but the risk is less for those who practice safe driving habits. |
| *How could we possibly reduce our risk?* | By paying attention.<br><br>By making choices that reduce injuries in collisions. |

Say, *It sounds like we have done a lot of thinking around what safety features might be doing and what we can do to reduce our risk. There are many ideas out there that might reduce risk, but like we have identified, sometimes that risk might be justified..*

Say, *There is debate around many of these issues.*

Explain that, like in the last lesson, the class is going to use the *Argument Comparison Tool* to dig into an issue relevant to our community involving risks for ourselves and others as we use our roads. Introduce which topic you have prepared materials for. If you have not already returned *Societal-Impacts Argument Comparison* to students, do so at this time so that they can review the feedback on their previous arguments. Consider also having students get out *Science-Ideas Argument Comparison* to use while completing *Argument Comparison Tool*.

Options of argument sets for use with the *Argument Comparison Tool*

- Should we allow lift kits? (See *Lift Kit Argument*.)
- Should we increase truck payloads? (See *Weight Limit Argument*.)
- Should we prioritize public transit over personal vehicles? (See *Public Transportation Argument*.)

**ADDITIONAL GUIDANCE**

**Note about introducing ableism:** If you choose the public transit arguments, students might bring up ideas about ability and access. Be sure to support students in identifying and examining their biases about ability. Tell students that when we believe or express that having a disability is worse than not having a disability, this

is called *ableism*. It is important to note that this does not include things such as a disabled person talking about struggles they have because of their disability or complaining about pain associated with their disability. You can connect the discussion to how students understand other types of discrimination.

For more resources about identifying and combating ableism, visit https://www.apa.org/ed/precollege/psychology-teacher-network/introductory-psychology/ableism-negative-reactions-disability and *Information about Ableism*.

**Introduce the chosen argument sets to students.** Below is some sample language that might be helpful to introduce the arguments to students.

| Chosen argument | Example language |
|---|---|
| *Lift Kit Argument* | *We have a lot of people who use lift kits in our community for different purposes. While these lift kits may be beneficial to some, others have stated that they might present a risk to the safety of others around the lifted vehicle. Let's consider, should we allow the use of lift kits on vehicles?* |
| *Weight Limit Argument* | *One issue we have identified is the presence of heavy trucks in our community. Some people argue that these trucks should have payload limits, while others advocate for more goods being delivered in the trucks. Let's consider, should we limit or increase the payloads of trucks on our roads?* |
| *Public Transportation Argument* | *One thing we have identified is the issue of so many cars being on the road. Some people argue that a solution to this is increased public transit, while others believe that this could create inefficiencies. Let's consider, should we be investing in public transit solutions in our community?* |

**ALTERNATE ACTIVITY**

You may find more than one argument relevant or interesting for your students. Consider providing all three argument sets to students on a digital platform. Introduce all three arguments and poll students for the argument that they feel is the most relevant to them. Allow students to choose the argument that they engage with (payloads, lift kits, or public transit) throughout the rest of this lesson component.

## 2 · READ ARGUMENTS

5 min

MATERIALS: *Science-Ideas Argument Comparison*, *Societal-Impacts Argument Comparison*, *Argument Comparison Tool*, readings based on topic selection

**Introduce readings for argument comparison and evaluation activity.** Present **slide C**. Distribute to students the selected arguments and the *Argument Comparison Tool*.

**Explain the process.** Explain to students that we will look at two separate arguments and evaluate both to determine which argument has the most merit from both a scientific and a social perspective. After that, the class will get the chance to discuss their ideas around which argument makes the most sense and why. Remind students that many arguments and decisions have multiple factors behind them, just like when someone decides to buy a certain style or type of vehicle.

Take a moment and identify which article is argument 1 and which is argument 2. Allow students to add a shorthand to the top of each argument column on the *Argument Comparison Tool*, such as "Argument FOR X" or "Argument AGAINST X." For an example of this, look at the tables in the accompanying teacher reference for your chosen argument.

Put students in pairs and give them time to read both arguments. ✱

### ✱ ATTENDING TO EQUITY

**Universal Design for Learning:** Consider providing an alternate *representation* of the two readings and instructions in a virtual space so that students can enable a text-to-speech program that can read the selections to them. This can reduce barriers to accessing the text. A read-aloud could also be done for the whole class as students annotate the text, and then students could shift to completing the tables in partner pairs. This would increase access for all students.

## 3 · COMPARE AND EVALUATE ARGUMENTS

17 min

MATERIALS: *Science-Ideas Argument Comparison*, *Societal-Impacts Argument Comparison*, *Argument Comparison Tool*, readings based on topic selection

**Compare and evaluate arguments.** Present **slide D**. Have students work through one article at a time and evaluate each one in full before proceeding to the second article. Once both articles have been evaluated, ask students to go back to the second table and reconsider each question, since a new perspective might have emerged as they read each article.

Give students 20 minutes to complete the *Argument Comparison Tool* in partners. ✱
Give students time to compare the two arguments using the *Argument Comparison Tool*. Use the teacher reference associated with the topic you selected to help guide students in their potential responses.

- Should we allow lift kits? (See *Lift Kit Argument*.)
- Should we increase truck payloads? (See *Weight Limit Argument*.)
- Should we prioritize public transit over personal vehicles? (See *Public Transportation Argument*.)

### ✱ SUPPORTING STUDENTS IN ENGAGING IN ARGUMENT FROM EVIDENCE

Through the use of the *Argument Comparison Tool*, students are evaluating competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g., economic, societal, environmental, and ethical considerations).

## 4 · MAKE SENSE OF THE ARGUMENTS

15 min

MATERIALS: *Argument Comparison Tool*, readings based on topic selection, Community Agreements, chart paper, chart paper markers

**Revisit agreements and select a new focal community agreement.** Project **slide E**. Remind students that these arguments have very different viewpoints, and it is also likely that some students will identify more with an argument than others in the class based upon our unique experiences. We will still need to make sure to adhere to our agreements as we engage in the comparison and evaluation of these arguments.

Direct students to look back at their community agreements again. Ask students to identify one area that the class can focus on as they engage in this process and whether they think the focal agreement that the class chose together from Lesson 12 should be changed after having engaged in this process once before. Remind students that it should be an agreement that helps us engage in productive discourse.

Allow students to choose the focus for the discussion and ask students to justify why that agreement focus is important. Rewrite this specific community agreement somewhere highly visible, as the class did in Lesson 12, and reference this focus when students begin to have disagreements. ✱

**Facilitate a Consensus Discussion around the *Argument Comparison Tool*.** Present **slide F**. Facilitate the discussion using the structures on the slide and provided within the teacher guidance associated with your chosen topic.

- *Lift Kit Argument*
- *Weight Limit Argument*
- *Public Transportation Argument*

**ASSESSMENT OPPORTUNITY**

**What to look for/listen and what to do:** Use the detailed guidance given in the teacher references (*Lift Kit Argument*, *Weight Limit Argument*, or *Public Transportation Argument*) to assess students' argumentation related to societal and ethical impacts for the topic you have selected for your class. (SEP: 6.5, 7.1; DCI: ETS1.B.1; Connections to Engineering, Technology, and Applications of Science: Influence of Science, Engineering, and Technology on Society and the Natural World)

**Building toward: 13.A** Evaluate and compare competing arguments for a design solution based on scientific knowledge and principles, prioritized criteria, limitations (e.g., tradeoffs), constraints, and societal and ethical impacts. (SEP: 7.1; DCI: ETS1.B.1; Connections to Engineering, Technology, and Applications of Science: Influence of Science, Engineering, and Technology on Society and the Natural World)

### ✱ ATTENDING TO EQUITY

**Universal Design for Learning:** Revisiting the Community Agreements that the students established for respectful classroom engagement provides opportunity for student self-regulation and minimizes threats. This makes *engagement* with class more accessible to students.

### ✱ SUPPORTING STUDENTS IN DEVELOPING AND USING SCALE, PROPORTION, AND QUANTITY

**Connections to Nature of Science:** Science and engineering are influenced by society, and society is influenced by science and engineering.

The argumentation tasks guide students in considering not just the science aspect of engineering but also the societal aspect of engineering. These two influences guide tradeoff decisions as well as criteria and constraints that are used by engineers and policy makers alike. In all three arguments, societal tradeoffs are qualitatively weighed against the risk and what the science ideas support. These tradeoffs and considerations provide a feedback loop that is present in almost all areas of engineering design.

Help students see that these tradefoffs are not just important in physics, but across disciplines. In order to make decisions about cars, we need to think about physics ideas, but we also need to think about human biology, and the chemical structure of materials that make up the car.

### ✱ SUPPORTING STUDENTS IN THREE-DIMENSIONAL LEARNING

If you choose to have students look at tradeoffs due to payload weight limits, consider making an explicit connection to HS-ESS3-6: Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity. Help students see that more massive vehicles affect Earth's systems, and how that will affect humans, plants, and animals over time.

## 5 · NAVIGATE

3 min

MATERIALS: *Community Interview*, half sheet of notebook paper

**Close the argumentation.** Project **slide G**. Distribute a half sheet of paper to each student. At the end of the discussion, ask students to use the half sheet of paper to complete an exit ticket. Have them document one way in which their thinking was pushed today and who helped them see or consider a different perspective to the argument by responding to the three questions on the slide:

- *Who was it?*
- *What was it?*
- *How did it help you figure something out?*

Ask students to put their names on their papers and turn this in at the end of class.

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|---|---|
| **ADDITIONAL GUIDANCE** | At the beginning of the next period, consider creating a class shout-out board or another way of acknowledging those who helped move our classroom community forward. |

**Motivate looking at other issues in our community.** Display **slide H**. Say, *We have done a lot of work to understand the role of safety features in a collision and how they can reduce risk in a collision. We've also considered how these engineering ideas can be shaped by both the science and societal wants and needs, such as the arguments we explored in this lesson.*

Ask students, *What other should-we questions can you think of in our community that could affect traffic safety?*

Allow students to share any other issues surrounding transit that they may have.

Say, *It sounds like we have a lot of ideas, but while our classroom has noticed some issues, maybe others in our community have noticed issues that we have not been able to see yet.*

 **Distribute *Community Interview*.** Display **slide I**. Explain that students will have the opportunity to interview a trusted member of their home or local community and gain perspectives about something in our community that might put some people more at risk than others because of cars or driving. Introduce the *Community Interview* here and go over the document with students.

Say, *Let's interview folks outside our class to get a broader picture of what problems we could tackle to make our community safer. Use this sheet to organize answers to two questions: "What is something in our community that might put some people more at risk than others because of cars or driving?" and "What is something that has made you feel safer when you are driving, walking, or taking public transit?"*

# Additional Lesson 13 Teacher Guidance

| | |
|---|---|
| **SUPPORTING STUDENTS IN MAKING CONNECTIONS IN ELA** | CCSS.ELA-LITERACY.RI.11-12.1 Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.<br><br>Students read competing arguments and then use textual evidence to analyze the claims, priorities, tradeoffs, and connections to science ideas within each argument. They then use these analyses to evaluate which argument has more merit. |

**CCSS.ELA-LITERACY.WHST.9-10.1.A** Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.

Students engage in comparison and evaluation of two arguments and identify the claims of each argument. Students make a claim on which argument has the most merit based on evidence they have extracted from the text and organized within the provided comparison tables.