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Engaging all students, including multilingual learners, in arguing from evidence

By Alison Haas, Elizabeth Reid, Scott E. Grapin, Abigail Schwenger, and Julie Park

ABSTRACT

Engaging in argument from evidence is an important science and engineering practice in the *Next Generation Science Standards* (*NGSS*). In the *NGSS* classroom, all students are expected to engage in argument from evidence. However, argument can be difficult for many students, especially multilingual learners (MLs). Thus, argument is a major focus of our yearlong fifth-grade *NGSS*-designed curriculum that integrates science and language. As we have been iteratively field-testing and revising the curriculum in collaboration with teachers over multiple years, we have refined our approach to argument. The purpose of this article is to describe our approach to engaging all students, especially MLs, in arguing from evidence. First, we describe our approach to argument for MLs: (a) prioritize meaning-making, (b) scaffold the argument process through varied interactions, and (c) make visible what "counts" as a strong argument in science. Then, we illustrate this approach using a fifth-grade classroom example. Finally, we analyze the classroom example according to the three aspects of our approach to argument for MLs.

Keywords: 3–5; *NGSS*; K–12 Framework; engaging in argument from evidence; differentiation; physical science

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Engaging in argument from evidence is one of the eight science and engineering practices in the *Next Generation Science Standards* (*NGSS*). As described in *A Framework for K–12 Science Education* (NRC 2012) and the *NGSS*, by Grade 12, students should be able to recognize that the major features of scientific arguments are claims, data, and reasons; construct a scientific argument showing how data support a claim; and identify possible weaknesses and flaws in arguments. While engaging in argument is a critically important practice in science disciplines, it is often difficult for students in science classrooms (Chen, Hand, and Park 2016), especially for multilingual learners (MLs; González-Howard, McNeill, and Ruttan 2015). At the same time, language-intensive practices such as argument provide opportunities for MLs to use language in purposeful ways (Lee, Quinn, and Valdés 2013), for example, when they collaborate with their peers and teacher to develop their arguments.

In this article, we describe our approach to engaging all students, especially MLs, in arguing from evidence. First, we describe our approach to argument for MLs. Then, we illustrate this approach using a fifth-grade classroom example. Finally, we analyze the classroom example according to the three aspects of our approach to argument for MLs.

Our Approach to Argument

Argumentation is a process for reaching agreements about explanations and design solutions. As students argue from evidence, they support claims with evidence and reasoning (McNeill, Krajcik, and Hershberger 2012). Arguing from evidence can be particularly beneficial for MLs, as they use language for a purpose in a community of practice (González-Howard and McNeill 2016).

The practice of arguing from evidence is featured prominently in our yearlong fifth-grade *NGSS*-designed curriculum that integrates science and language for all students, especially MLs. In the 3–5 grade band, students are expected to construct and/or support an argument with evidence, data, and/or a model (NGSS Lead States 2013). As our curriculum is currently undergoing a multiyear field trial in a large linguistically diverse urban school district, we have been able to iteratively test and refine our approach to argument. We describe three aspects of our approach and why these aspects are particularly beneficial for MLs.

Prioritize Meaning-Making

Perhaps the single most important aspect of our approach is prioritizing meaning-making over structure. Rather than starting with the claim, evidence, and reasoning (CER) structure that is the hallmark of argument in science, we first emphasize meaning-making by providing opportunities for students to discuss and develop their ideas. By giving students space to think about and articulate their answer to a question (which will eventually become their claim), and how they know (which will eventually become their evidence and reasoning), we keep the focus on the purpose of arguing from evidence (e.g., to reach agreement about the best explanation for a phenomenon). In our earlier attempts to engage students in argument, we found that having students complete the CER structure too early in instruction came at the expense of meaning-making. When we delayed introducing the CER structure and prioritized meaning-making, the structure became not only more accessible but also more meaningful.

Scaffold the Argument Process Through Varied Interactions

Students need opportunities to engage in multiple interactions as they argue from evidence. We scaffold the argument process by embedding varied interactions (i.e., partner, small group, and whole class). These interactions are carefully sequenced such that students first co-construct an argument as a whole class. Then, they collaboratively construct an argument with a partner. Finally, students progress to construct an argument independently (WIDA Consortium 2020). This scaffolding is particularly beneficial for MLs, as it provides opportunities for them to develop their arguments using both oral language (e.g., discussing ideas with a partner) and written language (e.g., constructing a written argument independently).

Make Visible What "Counts" as a Strong Argument in Science

We provide students with examples, both oral and written, of strong and weak arguments. When students are provided such examples, they become more explicitly aware of what "counts" as quality in a science argument. Providing examples (and counterexamples) frequently and throughout the argument process is particularly beneficial for MLs, as it makes visible the language resources that support argumentation in science (e.g., use of specific data as evidence for a claim).

Illustrating Our Approach

Ms. Reid is a science cluster teacher, meaning she teaches science to all fifth-grade students in her school. She teaches four science classes, with a total of 84 students. Students receive science instruction three times per week. Of the 84 students in Ms. Reid's fifth-grade science classes, 47 are classified by the district as English Language Learners.

In Unit 1 of our curriculum, a physical science unit, students experience the phenomenon of garbage in their school and community. First, students plan and carry out an investigation in which they record the weight and properties (e.g., color, texture, reflectivity) of different materials (e.g., paper, soda can) before and after crushing them. Ms. Reid takes appropriate safety precautions for handling materials, especially the soda can, which can become sharp when crushed. The investigation plan requires students to wear appropriate safety gear, including safety goggles. Additionally, Ms. Reid instructs her students to crush the soda can with their feet.

After completing the investigation, Ms. Reid has students share patterns they identified in the data. For example, students identify that there was no change in the properties of color, texture, or reflectivity for any of the materials. Then, using their investigation data as evidence, students engage in argument to answer two questions: (a) When materials are crushed, does the *type* of material change? and (b) When materials are crushed, does the *amount* of material change? (The full lesson can be downloaded for free at [*nyusail.org*]. This lesson is Lesson 2-2 of the garbage unit.).

Ms. Reid tells students that the class will focus on the first investigation question, "When materials are crushed, does the *type* of material change?" She has students think about their answer to the question and why they think that is the answer (in other words, how they know). Ms. Reid has students write down their answer and how they know on a sticky note. When they finish, students put their sticky note on the chart paper corresponding to their claim (see Figure 1).

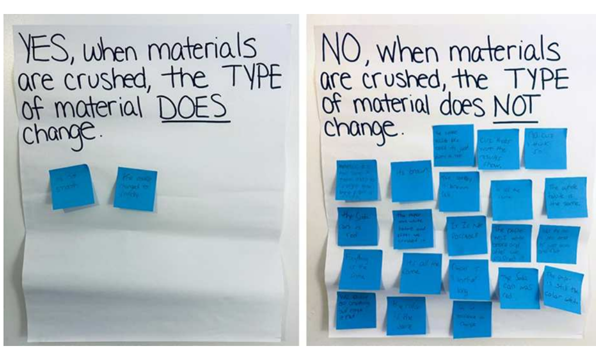
Once students have finished posting their sticky notes, Ms. Reid introduces the terms *claim* and *evidence* by saying, "A claim answers a question that we have investigated. We have two claims posted on the board. When we use data to make a claim, we call those data *evidence*. Let's look at some of the evidence you wrote on your sticky notes and see if we can come to class consensus about what makes evidence strong."

Ms. Reid talks through several sticky notes with the class to establish criteria for evidence. For example, Ms. Reid grabs a sticky note that reads, "The paper was white before and after we crushed it." The class decides that this is strong evidence because it is based on the data they collected. Ms. Reid continues this process until the class establishes three criteria for evidence:

1. Evidence is based on data. It is not an opinion.
2. Evidence is data to support a claim. It shows why the claim is true.
3. Evidence is specific. It refers to specific parts of the data.

FIGURE 1

Example sticky notes from Ms. Reid's class.



Ms. Reid records the agreed-upon criteria on chart paper and posts it in the classroom.

Next, Ms. Reid guides students to evaluate additional examples of evidence using the criteria. For example, the class decides that, while "the soda can was red" is based on data (first criterion) and specific (third criterion), it does not support the claim that the type of material does not change (second criterion) since it does not compare the properties of the soda can before and after crushing. The class revises the sticky note ("the soda can was red before and after crushing") and then places the revised sticky note on top of the original.

Once the class revises the evidence on the chart paper, they come to consensus on a claim: No, when materials are crushed, the type of material does not change. Finally, the teacher addresses reasoning. Ms. Reid describes, "Arguments have one more piece called *reasoning*. Reasoning is when you describe why you chose the evidence you did. For example, Valeria shared evidence that there were no changes in color and reflectivity for any of the materials. What do properties, like color and reflectivity, have to do with our claim?" The students talk in small groups and then share with the class. Together, the class comes to consensus, and Ms. Reid summarizes the reasoning, "We know that materials are identified by their properties. Since materials are identified by their properties and none of the properties changed, crushing a material does not change the type of material." Ms. Reid concludes by modeling for students how to write the full argument as she thinks aloud (see Table 1).

During the next class period, Ms. Reid asks students to answer the second question ("When materials are crushed, does the *amount* of material change?") in small groups. She has students place a sticker on their investigation sheet to indicate evidence they might want to use to answer the question (see the example in Figure 2).

After sharing places they marked for evidence, students discuss claims to answer the question with their group. Then, students write the argument with a partner (see sample argument from an ML in Figure 3). In subsequent units in our yearlong curriculum, students write their arguments independently as they develop proficiency with the science and engineering practice.

Students complete a formative self-assessment of their arguments (called a "Self and Peer Check!" in the curriculum; see Figure 4). Then, students revise their arguments based on the self-assessment. For example, the student whose argument appears in Figure 3 identified the need to clarify and revise their reasoning (from "this shows the same amount" to "the same weight before and after shows the same amount of matter"). While the self-assessment serves as a formative assessment, the teacher engages in summative assessment of each student's argument using a rubric (see Figure 5).

Analysis of the Classroom Example

In this section, we analyze the classroom example according to the three aspects of our approach to argument.

TABLE 1

Ms. Reid's think-aloud.

Argument Component	Think-Aloud Description or Writing Modeled on the Board	Description
Question	Think-aloud description	*We know the question we are trying to answer. We can write that question here.*
	Writing modeled on the board	When materials are crushed, does the type of material change?
Claim	Think-aloud description	*Our claim answers the question. We agreed on a claim.*
	Writing modeled on the board	No, when materials are crushed, the type of material does not change.
Evidence	Think-aloud description	*The evidence comes from the data we collected. The evidence is based on data, supports our claim, and is specific.*
	Writing modeled on the board	The soda can was red, smooth, and shiny before and after crushing. The paper was white, smooth, and dull before and after crushing.
Reasoning	Think-aloud description	*Reasoning connects the evidence to the claim. I ask myself, "Why did I include that evidence?" I included the properties in my evidence because I know that materials are identified by their properties.*
	Writing modeled on the board	Since materials are identified by their properties and none of the properties changed, crushing a material did not change the material.

FIGURE 2

Student investigation sheet with star stickers marking potential evidence.

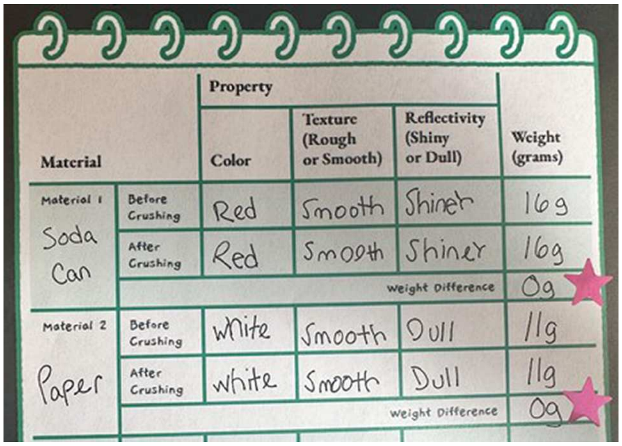
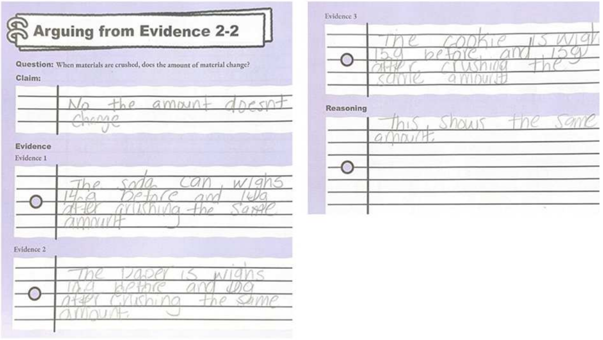


FIGURE 3

Example argument from an ML.



Prioritize Meaning-Making

In the example, Ms. Reid prioritized meaning-making as students constructed their arguments. Instead of beginning the argument process by focusing on structure

FIGURE 4

Self and peer check.

SELF AND PEER CHECK! Arguing From Evidence

Lesson 2-2

Instructions: The purpose of this activity is to help you reflect on and improve your understanding of writing arguments from evidence. Read each question below and answer "Yes" or "No" based on the argument you wrote. Then use the results to revise your argument.

Argument	
Does my argument include a claim, evidence, and reasoning?	☐ Yes ☐ No
Claim	
Does my claim answer the investigation question?	☐ Yes ☐ No
Evidence	
Does my evidence include specific data from the investigation?	☐ Yes ☐ No
Does my evidence identify a pattern in the data about more than one garbage material (soda can, cup, paper, cookie)?	☐ Yes ☐ No
Does my evidence include a comparison of the weight of the garbage materials before and after crushing?	☐ Yes ☐ No
Reasoning	
Does my reasoning describe how my evidence supports my claim?	☐ Yes ☐ No

Identify one area for improvement to keep in mind the next time you write an argument in science class.

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(e.g., defining claim, evidence, and reasoning), Ms. Reid gave students space to make sense of their observations from the investigation. She began by asking students to think about their answer to an investigation question and write down how they knew that was the answer. Then, Ms. Reid pointed out that the answer to the question was their claim and how they knew was their evidence. Later in the argument process, Ms. Reid had students place stickers on their investigation handout to indicate data that would provide evidence to support their claim. Students discussed their claims and evidence in groups. In this way, Ms. Reid took an asset-oriented approach that built on what students already could do and then added structure to their thinking. This was especially helpful for MLs, as a premature focus on argument structure might have constrained these students' meaning-making.

Scaffold the Argument Process Through Varied Interactions

Ms. Reid scaffolded the argument process by having students engage in multiple interactions as they constructed their arguments. She began by having students,

FIGURE 5

Teacher rubric for summative assessment.

	Claim	Evidence	Reasoning
0	Claim is incorrect, irrelevant, or missing. Examples: • *(None)* • *Yes, when materials are crushed, the amount of material changes.*	Evidence is incorrect, irrelevant, or missing. Examples: • *(None)* • *The paper is 11 inches long.* • *The weight of the soda can changed, but the weight of the paper did not change.*	Reasoning is incorrect, irrelevant, or missing. Examples: • *(None)* • *Since the crushed material was smaller, the weight must have gotten smaller.*
1	Claim is correct and answers the investigation question. Example: • *No, when materials are crushed, the amount of material does not change.*	Evidence supports claim using specific data from at least one material. Examples: • *The soda can weighed 16 g before and after crushing.* *OR* • *The paper weighed 11 g before and after crushing. The cookie stayed the same.*	Reasoning is correct and links the evidence to the claim. Example: • *Since the weight tells us if the same amount of material is there, and there was no change in the weight of any material, crushing a material does not change the amount of material.*
2		Evidence supports claim using specific data from at least two materials. Example: • *The soda can weighed 16 g before and after crushing. The paper weighed 11 g before and after crushing.* • *The cookie weighed 8 g before and after crushing. The cup weighed 5 g before and after crushing.*	

TOTAL: _____ out of 4

individually, write down their initial answer to the investigation question and how they knew, which became their claim and evidence. Then, students worked as a whole class to revise the sticky notes. Students answered the second investigation question in small groups, discussing their claims and evidence with their peers. Finally, students completed the argument with a partner. This approach afforded students meaningful opportunities to develop their ideas using both oral and written language. Additionally, the careful sequencing of the interactions from more support (whole-class and small-group work) to less support (partner and individual work) scaffolded students' argument writing, which was especially beneficial for MLs.

Make Visible What "Counts" as a Strong Argument in Science

Ms. Reid provided multiple examples throughout the argument process. As students wrote evidence on sticky notes, Ms. Reid used students' contributions to identify strong and weak evidence, referring to the evaluation criteria for evidence that the class had derived from the examples. As a class, students revised weak examples of evidence, which Ms. Reid shared orally with the class and displayed written on the chart paper. Ms. Reid concluded by modeling how to write the full argument. Examples of strong evidence as well as an example of how to write a full argument provided mentor texts that all students, especially MLs, could benefit from referencing in subsequent arguments.

In the next class period, Ms. Reid had students complete a self-assessment of their arguments (Figure 4). This checklist highlighted elements of a strong argument (e.g., Does my claim answer the investigation question? Does my evidence include specific data from the investigation?). Engaging in this self-assessment helped make visible for MLs what "counts" as a strong argument in science.

Conclusion

On the one hand, we can think about the practice of arguing from evidence as being difficult for students, especially MLs. On the other hand, we hope to capitalize on the opportunities this language intensive practice brings to the science classroom. As we continue rethinking how to engage all students in arguing from evidence, our approach calls for prioritizing meaning-making, scaffolding the argument process through varied interactions, and making visible what "counts" as a strong argument in science. When we implemented this approach, our MLs were able to argue from evidence in powerful ways to explain phenomena.

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