Cultivating a next-generation classroom culture

by Christina Krist, Lisa Brody, Michael Novak, and Keetra Tipton

You have a curriculum designed to align with the *Next Generation Science Standards* (*NGSS*) (NGSS Lead States 2013). Your units are organized around driving phenomena that you are excited to have students explain by engaging in scientific practices (NRC 2012; Krajcik, Czerniak, and Berger 2002). You are working to shift the social norms in your classroom toward ones that support the kinds of interaction and discourse that effectively engage students in collaborative knowledge building (Brown and Campione 1996; Engle and Conant 2002; Michaels, O'Connor, and Resnick 2008). You have some prompts for productive discussions posted in your classroom (Michaels and O'Connor 2012). You are working to turn over some intellectual authority to your students by having *them* be the ones to collaboratively and reflectively address those prompts. You are excited to see students meaningfully engaged in science knowledge–building practices, such as constructing explanations and engaging in argument from evidence (NGSS Lead States 2013, Appendix F), that give you a window into their creative and insightful ways of thinking.

But—inevitably—these strategies do not work as you hoped. Instead of eagerly sharing their ideas for why a can of regular Coke sinks, but a can of Diet Coke floats, some students only tentatively offer answers, trying to gauge your reaction to see if they are right or wrong. Some students talk frequently but do so only to gain attention or to derail the conversation. Some students already "know" the right answer and shut down other students' ideas. You feel miles away from the kind of productive argumentation and knowledge building you are hoping for. How do you respond to these challenges in a way that teaches students how to engage productively in scientific practices in order to move your classroom toward a student-led learning community?

In this article, we identify four key challenges that classroom communities will encounter when trying to engage students in *NGSS*-aligned instruction (see Figure 1). We present them in a progression, indicating that you will likely encounter the earlier challenges before encountering the later ones. However, we do not mean to imply that once you encounter a later challenge, you will never experience earlier ones again. Students will need continuous instructor feedback if they are to engage in this new kind of science learning. A careful curricular design and the development of a classroom culture that provides a safe, intellectual space for students to offer, tinker with, and produce ideas that everyone eventually owns are also essential for success.

We discuss each challenge in the context of examples from sixth- through eighth-grade science classrooms in which students are working to explain driving questions. For the sake of simplicity, we situate the examples in one of two contexts: working to construct a model of air to explain how an odor travels around a room and working to build a model of the Earth's tectonic plates to explain earthquakes, volcanoes, and various geographic features (both units are from the IQWST curriculum; Krajcik et al. 2013). These examples represent situations we have frequently observed and encountered, even after many years of experience in rich, discussion-based classrooms. Our strategy recommendations are based on the theoretical recommendations of the science-education literature regarding the development of knowledge-building communities (e.g., Engle and Conant 2002) and from Lisa Brody, Michael Novak, and Keetra Tipton's 30 plus years of collective teaching experience as early adopters, developers, and pilot-testers of curriculum materials aligned with *A Framework for K–12 Science Education* (NRC 2012) and the *NGSS*.

Challenge 1: My students won't "go public" with their ideas

You show some very engaging videos of a volcano erupting in Japan and an earthquake occurring in Chile. You ask students to predict where they think they will find patterns of earthquakes and volcanoes, and you see them all writing down interesting predictions in their notebooks: Volcanoes will be located near water, in tropical areas; earthquakes occur near volcanoes because volcanoes cause earthquakes. You ask students to share some of their predictions, and—crickets. No one says a word. You ask a student who had at least three ideas written down to share one. She shyly reads, "I think volcanoes will be by water." "Great!" you respond. "Why do you think that?" She mumbles, "I don't know…" and looks around nervously. You know this student is popular and outgoing. What is going on?

Teacher strategies

1. Celebrate ideas. You need to build the understanding that all ideas (or at least all ideas relevant to the topic) are good ideas and are useful and welcomed in your classroom. Although you may be tempted to probe for elaboration or reasoning beneath students' ideas, they are not yet ready to do that. Instead, make this classroom activity feel like an "idea show-and-tell": Everyone's idea is fascinating, and the more we hear, the better!
2. Align reading strategies to further enforce idea generation and sharing. Many classrooms use the RAHA reading strategy, which asks students to "Read, Answer questions in the text, Highlight, and Annotate." Instead, we use RAHQ, meaning that the only kind of annotations we ask students to make are Questions. This exercise allows students to write down what they have thought about on their own so they are ready to share with the class. It also reinforces the idea that it's not knowing right answers that we value but rather the investigation and exploration of ideas.
3. Probe for elaboration, but selectively. Only probe students who have voluntarily "gone public" several times before and are more comfortable being put on the spot. You can also take the risk of digging in if an idea is going to be fruitful later on, either because it is a correct answer that needs unpacking (e.g., volcanoes are at plate edges) or

FIGURE 1 Summary of challenges and strategies

Challenge	Strategies
1. My students won't "go public" with their ideas.	• Celebrate ideas • Align reading strategies to further reinforce idea generation and sharing • Probe for elaboration, but selectively • Use reflective discussion sheets (Figure 2)
2. Students are dismissing other students' ideas.	• Probe for confirmation and elaboration • Turn a "know-it-all" student's idea over to the classroom community—and if it's not taken up, let it die, even if it's right • Police behavior, not ideas
3. Students are sharing and elaborating on their ideas, but they are not building on each other's ideas. They seem to be talking to me instead of each other.	• Affirm basic talk moves • Resist the urge to jump in and respond to every idea • Have students call on each other • Reposition yourself strategically so students have to talk loudly enough for the whole class to hear • Use your forgetfulness to your advantage
4. Students have great talk moves, but they are afraid to critique.	• Point out logical discrepancies and let students work them out • Set up "camps" calling attention to two different ideas

FIGURE 2 Student worksheet for self-assessment in whole-class discussions

Speaking & Listening: Self-Assessment in Discussions

1. What was the main idea or question we talked about?

2. What was **one** new idea or question that someone else shared?

3. What was a **second** new idea or question that someone else shared?

4. Did you track the speakers during the discussion most or all of the time?
5. Did you raise your hand to share your ideas during the discussion?
6a. If you were called on, what talk move did you try to use?

6b. If you raised your hand, but were not called on, what did you intend to share?

6c. If you did not raise your hand how can the class and your teacher encourage contributions from you in the future?

because it is a competing idea that will need to be rejected (e.g., volcanoes clump in tropical areas, mainly on islands).

4. Use reflective discussion sheets (Figure 2). Give students a chance to reflect on why participating is hard for them and what you as a teacher can do to help. Some students will say, "Just call on me—I'm not good at raising my hand." Suggestions such as this can give you insights on what is okay and not okay from their perspective. As more students begin to "go public," there will still be some who never participate. These sheets give those students a chance to write down their ideas and reflect on what others are saying, which demonstrates that they are actively listening and participating in the class discussion, even though they are not talking. For students who are especially shy, are English-language learners, or have other causes for anxiety about speaking in public, these discussion sheets can give them time to prepare to share. For students who have difficulty writing, try pairing them with another student who can "scribe" their ideas.

Challenge 2: Students are dismissing other students' ideas

This can happen when one individual student "knows it all" (K-I-A), always offers the scientifically correct answer, and scoffs at any alternative ideas or explanations. As a result, students who offered other ideas may suddenly and unexpectedly drop their idea and change their mind to agree with the K-I-A student. For example, Kyra states that she thinks that in between air particles, there are infinitely more and more air particles. Samir, the K-I-A student, scoffs and mutters under his breath, "No! There's nothing in between! Why don't you understand that?"

Alternatively, this sort of dismissal can also happen in a small group of students who are "too cool" for your class and laugh under their breath any time a student (or perhaps a particular student) shares an idea, especially if the ideas don't sound "scientific." These students might also participate, but only for the attention. For example, Devin says he thinks the volcanoes in the Horn of Africa formed "because of the plate." When asked which plate he means, he says with a goofy grin, "The ocean," which elicits giggles.

Teacher strategies

1. Probe for confirmation and elaboration (Figure 3). Demonstrate genuine interest in students' ideas and "revoice" them to give them credibility, even if they don't sound like science knowledge (O'Connor and Michaels 1993). For example, revoicing Devin's idea by saying, "You think an oceanic plate is involved with the volcanoes in the Horn of Africa?" demonstrates to others that he has ideas worth making sense of, and it also

FIGURE 3 **Confirmation and elaboration talk moves (excerpted from *Talk Science Primer* [Michaels and O'Connor 2012])**

Confirmation

- What I heard you say is…
- So, would an example of that be…

Elaboration

- What do you mean by that?
- I am trying to picture it. Can you draw me a model of how that works?
- Does anybody want to respond to/add on to/link in to this idea?

demonstrates to him that anything he says will be taken seriously and he will be held accountable to it. Asking other students to "link in" can also reinforce that a student is not alone in what they think and that the ideas voiced are useful ones for the whole class to engage with. For example, asking how many other students think that there are more air particles between other air particles shows Kyra (and maybe Samir) that she's not alone in her thinking. If a particularly interesting idea is mentioned, have students spend two minutes with a partner discussing *that student's* idea, such as Devin's idea about oceanic plate involvement. Have students try to work out an explanation using this idea. If they still disagree or scoff at the idea, ask them to explain *why* they don't find it compelling and give Devin a chance to respond to their comments. This models the kind of serious engagement you expect with *all* ideas, even ones that might sound silly or wrong at first blush (or because they were intentionally delivered that way).

Begin this serious probing for confirmation and elaboration while students are working in small groups. Get down at their level. Listen to their discussion for a few minutes without interrupting. If they seem to be "off task," chatting about their personal lives or not engaging deeply in the thinking task at hand, ask a student what he means by "plates." As in, a dinner plate? Can I see them if I look on the ground? What do you think it looks like when two plates collide together? Can you draw a picture? Then ask other students in the group if that was what they meant when they said plates. As soon as there is space for interesting discussion—Devin thinks plates crumple up when they collide, while Michon thinks one goes up and one goes down—encourage them to continue explaining why they each thought it might be that way, and move on to another group. Then, when you come back together for class discussion, be sure to acknowledge the interesting conversation that group had and ask them to share their ideas and insights with the class.

2. Turn the K-I-A student's idea over to the classroom community—and if it's not taken up, let it die, even if it's right. If Kyra changes her mind to accept Samir's idea about nothingness between particles simply because he said it, or if other students in the class then refuse to offer other ideas or agree with Kyra after Samir speaks, ask Kyra or other students to explain why they changed their mind or what Samir actually said or means. Reiterate that the class can't just accept an idea; students also need to understand why they would accept it. Everyone needs to understand an idea if the class is going to accept it as a community, so if someone doesn't understand an idea, he or she should ask for clarification. For Samir, reinforce that if everyone doesn't agree, then he hasn't done his job of communicating to everyone in a way that they understand.

   When you ask the class what they think about Samir's idea of nothingness, there may be no uptake. Often "correct science" answers are very counterintuitive—they won't make sense to most students when they actually think about them. If other students in the class do not respond to or accept the idea—even though it is right and is the key conceptual idea you want students to develop—don't try to change students' minds. Ensuing activities and investigations will support them in building that conceptual idea in a way that makes sense to them, from evidence and from wrestling through ideas, not because you or a smart student told them to think that way.

3. Police behavior—not ideas. Adjust your grading system so that it reflects the importance of pro-

ductive participation in class discussions. Give daily participation grades that actually make an impact on students' overall grades, where behavior such as Samir's receives a zero for the day. We weight discussion points equally with homework-completion points. Similar to a homework check at the beginning of the class period, we do a "discussion check" at the end, especially early in the school year. We ask students who didn't speak up in class if they participated in their small group; if their group says yes, they get points for the day. Remind everyone for the first few weeks that participation is important, not only for their grades but also because it's how they will learn. Use the discussion-reflection sheets on a weekly basis or after a few discussion-heavy days, so that students get credit for raising their hands, writing down questions, and recording others' interesting ideas, and not only for talking. These reflection sheets count for a few days' worth of discussion points.

In addition, adjust your role so that instead of policing *ideas* by deciding which ones are right or wrong, switch to policing behavior in order to protect ideas—all ideas. Remind a student similar to Samir of the "figure it out" goal of the classroom, and let him know that his behavior is disrespectful of other students' ideas and prevents the class from making progress in figuring out how odors travel. If a student is being particularly disruptive—even by something as small as scoffing under his or her breath or intentionally ignoring or dismissing a question another student asks him or her—remove that student from the community. Let them know they have lost the right to participate today because they are interfering with community learning. If you have behavior-reflection sheets for other, more serious forms of infractions (e.g., fights, swearing, damaging property, bullying) or academic issues (e.g., forgetting homework, failing a test), adapt them for community participation as well. In other words, instead of policing or redirecting students' ideas toward the correct answer, position yourself primarily as a protector of the ideas put forth in the community. These ideas should undergo rigorous scrutiny but not disrespect.

Challenge 3: Students are sharing and elaborating on their ideas, but they are not building on each other's ideas and seem to be talking to me instead of to each other

Everyone seems to have an idea about what air looks like and how the scent of fresh-baked cookies travels around a room, and students are eager to share. That's great! You love hearing all of their ideas, especially the reasoning behind why Jasmine thinks an odor particle "latches on" to an air particle and travels around like a tick and why Kyle thinks the odor puffs out like a cloud from an explosion. Soon, however, you start to realize that the discussions are feeling a little bit like "idea show-and-tell." Although this was an important kind of discussion to have early on to build trust, you need students to do more than just share their own individual ideas if you want them to engage meaningfully in scientific knowledge–building practices, such as modeling,

FIGURE 4 Teacher repositioning away from the student speaker

argumentation, and explanation (NGSS Lead States 2013, Appendix F). How can you get students to begin listening and responding to each other?

Teacher strategies

1. Resist the urge to jump in and respond to every idea—you might be getting in the way. Instead of evaluating a student's idea or asking a probing follow-up question, ask, "What do others think?" and return the floor to students. Remind them that it is their responsibility to figure this out and to monitor their own understanding: If they did not hear or understand what a student said, you can ask that student to repeat it. If they are unsure of how to respond to a student's idea, point out the talk moves or discussion starters again.
2. Have students call on each other. If Alma shares an idea, then she gets to call on a student to respond to her idea. This way, several turns of talk can happen without you doing or saying a thing. You, too, should raise your hand and wait to be called on if you would like to respond to a student idea. Otherwise, your main role is managing the conversational norms: reminding Alma she gets to call on someone or ensuring that the person she calls on connects what he or she is saying to Alma's idea.
3. Reposition yourself strategically so students have to talk loudly enough for the whole class to hear. Instead of moving toward the student who is talking, move away, across the room (Figure 4). Because the student is likely talking "to" you, this forces the student to speak loudly and face the rest of the class. Subtly, this reminds students that you are not their audience; the entire classroom community is their audience.
4. Use your forgetfulness to your advantage. Keeping track of ideas is hard work. Undoubtedly, you will forget where an idea came from, whose turn it is to be talking, or why students are talking about a certain topic. If you have forgotten, someone else in the class probably has as well. Frequently ask questions such as, "Whose question are you responding to again?" or "How is this helping us figure something out again?" or "Who had the floor?" This *metatalk*, making your own thinking explicit while trying to follow the conversation, also helps students learn how to listen actively to the discussion as well.

Challenge 4: Students have great talk moves, but they are afraid to critique

1. Point out discrepancies or things that don't make sense, then let students work it out. Even when listening carefully, it's more socially acceptable to agree and build than it is to challenge, critique, or disagree. Instead of relying only on students' statements of agreement or disagreement, point out logical inconsistencies: "But wait, if Josh is saying Iceland is on a transform boundary and Danny is saying it's a hotspot, now I'm confused." "Wait, Maria and Sam are both saying that the air is expanding when we remove some pressure, but they each said something really different about what happens to the particles. Maria and Sam, can you each tell us what you said about the

FIGURE 5 A student "camp" working out the "particles each expand like balloons" model

particles again?" Importantly, give the responsibility to students to work out these inconsistencies. They might just need to work through the justification for their explanations logically, they might decide that both ideas could work but in different circumstances, or they might need to gather more evidence to figure out which idea best explains the phenomenon.

2. Set up "camps" calling attention to two different possible ideas (Figure 5). In the case of the lesson on air, there are often two ideas that both make sense, given most of the evidence, but they are logically incompatible: Maria thinks that "air expanding" means individual particles moving further away from each other, creating more empty space in between, while Sam thinks that each individual particle is expanding like a tiny balloon. Without making it a game or a competition, have students work together in their "teams" to really flesh out their own model and, every so often, share their updated ideas. Instead of becoming a competition, the goal is still about sense-making: taking seriously the interpretations of evidence and putting pieces together. Students are researching or gathering evidence with a particular audience and sense-making goal in mind (Berland and Reiser 2008; Engle and Conant 2002), creating a perfect context for rich engagement in argumentation.

Conclusion

In this article, we identify four key challenges that classroom communities will encounter when trying to engage students in *NGSS*-aligned instruction and present some strategies for addressing those challenges from our own teacher "toolkits." Along with careful curricular design, these strategies offer some of the unspoken tips and tricks for developing a classroom culture that provides a safe, intellectual space for students to offer, tinker with, and produce ideas that everyone eventually owns. This kind of intellectual work is not only the goal of recent reforms such as the *NGSS* but also the image of meaningful teaching and learning that we want all students to experience. ■

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