

Adapting Existing Curriculum for Equitable Learning Experiences



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Despite the increased availability of curricular resources intended to support teachers to engage in equitable instruction as expected by the *Next Generation Science Standards* (NGSS Lead States 2013), teachers are still left wondering how to use those generic resources in local classroom contexts that have unique challenges. There is growing consensus among researchers that promoting equity requires teachers to adapt the existing curriculum,

tailoring it to the needs of their students in a local context, instead of simply using a generic curriculum “as is” (Kang et al. 2016; Penuel et al. 2007). In this article, we—a team of science teachers and a university researcher—present the processes of adapting existing curricular resources to promote equitable learning experiences for diverse learners. Using a middle school ecology unit as an example, we illustrate what the modification process looks like in two key elements of designing NGSS-aligned science instruction: (a) making phenomena matter with the consideration of student identities and (b) leveraging students’ diverse ideas and questions to drive instruction.

Making phenomenon matter

For the teachers who are familiar with the standards that advocate engaging students in active sensemaking of phenomena (National Research Council 2012; Schwarz, Passmore, and Reiser 2017), phenomena-based science instruction is not a new idea. We have learned, however, that not all phenomena motivate student learning the same way. For example, we have seen several instructional materials that use wildfire as an anchoring phenomenon (e.g., “Why is it hard to extinguish wildfire?” or “How does an ecosystem respond to wildfire?”). We noticed that although students enjoy investigations related to fire, many did not show interest beyond the school activities, nor could they explain why the learning mattered to them. In fact, “wildfire” is a generic event. Without specifying a particular aspect of this observable event that can be explained using core disciplinary ideas, it is difficult to facilitate students’ deep sensemaking with this generic event. The other challenge that we encountered was students’ struggles to connect the focus of the investigations with themselves. Why should they care beyond receiving grades? For many of our students who experienced adversity or trauma during the pandemic, grade was not a strong motivator. Decades of research on science learning and equity has taught us that students, in particular students of color, multilingual students, and/or students from socioeconomically disadvantaged

communities, are more likely to engage in science meaningfully when they feel that what they do in classrooms matters, whether to them or to the people they care about (Birmingham et al. 2017; Calabrese Barton and Tan 2010). Cultivating a sense of mattering involves “establishing a personal connection and seeing a real impact of their work on the condition of students’ lives and their communities, either in the present or in the future” (Kang and Nation, under review). Different from other motivational constructs, such as interest or relevance, this sense of mattering is related to altruistic consequentiality. In other words, students think what they do matters if they perceive that their investigation could have a positive influence on the lives of people they care about (Kang and Nation, under review).

With the principle of making phenomena matter in mind, we adapted our existing curriculum in the ecology unit. Specifically, we took two pedagogical actions to facilitate students making personal connections with the learning, therefore generating their sense of mattering. First, we decided to select a local phenomenon that was relevant to our students instead of using the generic phenomena from the curriculum. Many families in our community were recently evacuated due to several wildfires. The fires

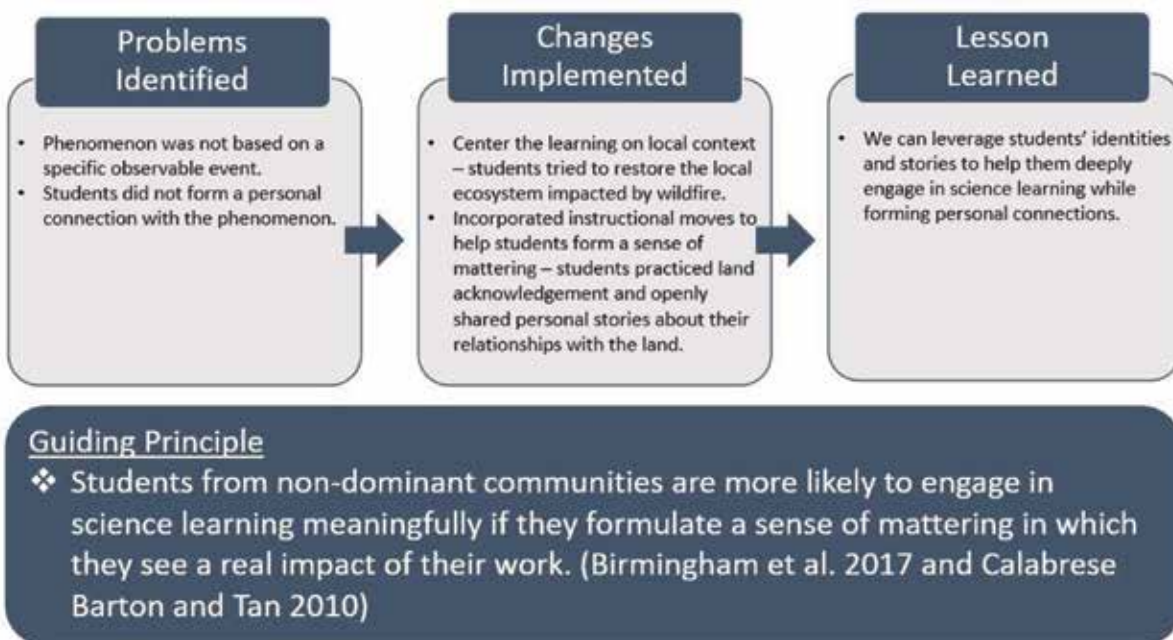


burned part of the city’s preserved open space, a National Natural Landmark that has rich biodiversity and unusual geology (see links to *Irvine Ranch Conservancy* and *Crystal Cove Conservancy* in Online Resources). The area had burned three times in the last 13 years and was populated by nonnative plants. This phenomenon had a specific observable event that students could connect with, explore, and make sense of. Restoring the burnt area also had a crucial impact on the lives of people in the community now and in the future. Our modified anchoring phenomenon was “frequent intense fires have altered the native ecosystem in our community” (MS-LS2-4 on disruption in ecosystem). The driving question that guided students’ investigation was, “How are our local ecosystems impacted by wildfires and how can we preserve our ecosystem while keeping our community safe?” As students wrestled with this question, they realized it represented a complex problem for the community. Students were challenged to come up with a solution: Should we again restore the land that had recently burned? If so, then how (MS-LS2-5 on biodiversity and designing solutions)? Students explored both how and why frequent wildfires impacted our local ecosystem and then designed a

solution (see *Fire Ecology: Restoration Plan Presentation* in Supplemental Materials).

The other intentional work we did was facilitating students to share their stories and relationship to the land in order to build a personal connection to the topic and with each other. On Day 1 of the unit, we practiced land acknowledgment as a class. This is a practice that acknowledges whose ancestral homelands we are in (see link to *Native Land Digital* in Online Resources). Through this practice, we recognize the history of the place, show respect to the ancestors who had lived on this land, and acknowledge the enduring relationship indigenous people have to this area. Students then reflected on why they should care about this land by sharing their personal stories. They posted their stories on a discussion board and responded to each other. This activity created a space for students from diverse backgrounds to see and connect with their classmates in a new way. Whether they were White students or students of color, native born, or immigrants, the students learned that they all shared this sense of place and called it their “home.” The issue of restoring the burnt local land came to matter to students as they publicly shared their stories. When

FIGURE 1: Making phenomenon matter by considering students’ identities.



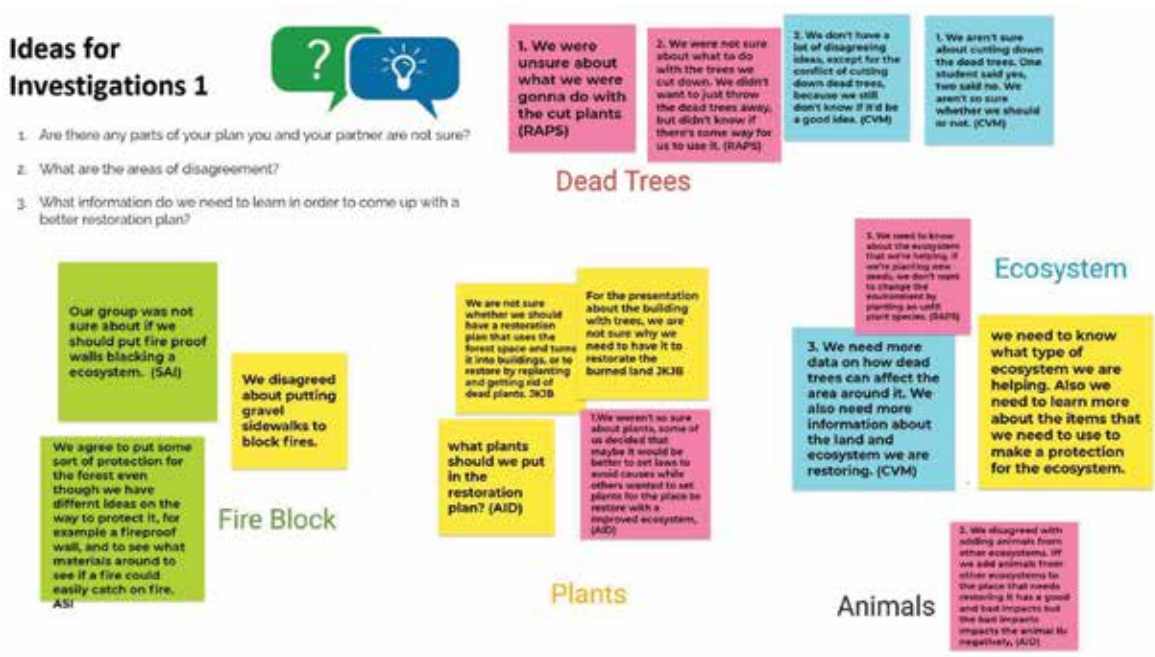


students presented their designs toward the end of the unit, they explained why the place was important to them and their families, and expressed the legacy they wanted to leave behind. By leveraging students’ identities and stories, we intend to help students—particularly those who are “invisible” or “quiet” in science classrooms—to deeply engage in and connect with science learning (Council of State Science Supervisors 2018; see Figure 1).

Creating a student-driven storyline

The next challenge was to develop a coherent unit storyline based on the phenomenon. For the most part, the series of activities in the curriculum made sense to the teachers, but we were unsure if the proposed sequence was logical for the students. Our first trial implementing the modified unit illustrated this challenge. On Day 1 of our unit, students were excited

FIGURE 2: Students compare similarities and differences in restoration plan and identify ideas for investigations.



about the phenomenon, asked lots of questions, and developed an initial restoration plan. This was followed by direct instruction on Day 2, during which the teacher introduced different types of biomes. The intention was to help students learn that the Mediterranean biome in Southern California is special and needs to be protected. However, we noticed that students were passively receiving information instead of actively engaging in something they wanted to know. The students did not know *why* learning about biomes mattered. This made it clear that the presence of a compelling phenomenon or problem was insufficient to support the learning if students' ideas were not valued and if they were not positioned as sense-makers throughout the learning process.

As we sought to re-engage learners, we realized students brought rich ideas into their initial restoration plans. We could leverage these funds of knowledge and use them to drive the learning. As noted by many researchers, a key element of equitable learning involves creating an environment where all students' ideas are valued. This requires that "teachers support students as they explicate their ideas, make their thinking public and accessible to the group, use

evidence, coordinate claims and evidence, and build on and critique one another's ideas" (National Academies of Sciences, Engineering, and Medicine 2018, p. 141). With this guidance in mind, we decided to engage students in science discourse where they shared their restoration plan in small groups. We knew some students would not feel comfortable sharing different ideas, so we paid particular attention to establishing classroom norms to ensure safe and equitable participation. Sentence stems were provided to help students respectfully disagree. This protocol also helps language learners develop academic language (Windschitl, Thompson, and Braaten 2018; see link to *Tools for Ambitious Science Teaching* in Online Resources). Students identified areas of uncertainty and disagreement, as well as possible ideas for investigations as a result of these discussions. For example, one major difference among student restoration plans was whether to let nature recover by itself or to remove the dead plants from the burnt area (see Figure 2). This disagreement created a need for students to figure out the ecological role of dead organisms. Understanding how matter cycled through an ecosystem came to be essential for students as they tried to resolve their

FIGURE 3: Students engaged in another round of science talk to share their revision and discuss new questions and ideas for investigations.

Engage in Science Talk - Share your Restoration Project

- You will share your project idea in groups of 3 using the Science Talk Protocol
 - Talk & Listen
 - Revise & Ask
 - Clarify & Respond
- Use the sentence frames to help you engage in productive and respectful conversation
- Complete [Assessment](#)

Ideas for Investigations 2

- New ideas:** How did you change your thinking? What new ideas did you add?
- More questions:** What are the areas of disagreement?
- What information do we need to learn in order to come up with a better restoration plan?
- Reflect on our [Science Agreements](#)

New Ideas

- Our thinking changed from cleaning all the dead plants and start new, to not cleaning the dead plants hence they can support the wildlife since they contain nutrients in them.(AN, SP)
- Our thinking has changed. Now, we all agree that we should leave the decomposers and add a water source. We also think that we should add some trails to bring in money and supporters. We need
- 1. We should leave the dead plant and bark in the area. The decomposers will break down the dead materials and turn them into nutrients for the producer/plants. (LT, MP, KO)
- during our discussion we all agreed that we should support the native plants in the area, we also agree that we should clear the trash and unnatural material from the ecosystem that was blown in by wind or left by
- We wanted to remove all the dead plants at first, but now we will use the plants as nutrients for the new plants. The decomposers will provide nutrients for the new plants, using the dead plants - VD

New Wonder

- We disagreed about how we were gonna water the plants long term. Some of us thought that it would be too expensive to have irrigation systems and to have farmers. -AS, NL, 3Z
- I think we need to learn what specific types and varieties of native plants we need to use. -NB
- We added more depth into our explanation of watering or plants and leaving the dead trees. Two areas are whether the plants need continuous watering and whether a lake is sustainable. In order to solve these mysteries, we must
- Should we add a man-made water source to support the native plants? Would that disturb the environment? (LT, KO, MP)
- 1. I am going to keep dead organisms for a while 2. Can removing some dead organisms affect the area in a really bad way? 3. Do the plants need greenhouses? 4. it was fun
- One question my group came up with was how the plants get their water, or how the non-native plants get their water since they are not adapted to their environment.(AN, SP)

disagreements. Students engaged in various scientific practices, such as developing and using models and analyzing data to understand the process of matter cycling. Through these activities, students reached the consensus that they should leave the dead plants in place to decompose in order to provide nutrients for the ecosystem. After students revised their restoration plan accordingly, they engaged in another round of science talk to discuss their revision. New questions emerged among students about whether to add a lake as a source of water for plants and animals (see Figure 3). This led students to learn about the importance of native plants. In each iteration of their exploration, students' diverse ideas prompted them to engage in rich conversations, which in turn generated new wonderings and led to the next investigation. Throughout this inquiry process, the storyline was driven by students' curiosity, so we rearranged the activities that were presented in the instructional materials. This required teachers to be flexible and responsive to students' needs. As students saw how their collective questions helped advance the class's inquiry, they could explain why they were doing the investigations

and articulate the goal of the learning.

An important lesson that emerged from our efforts to generate a coherent storyline from students' perspectives was the role of a rich open task that enabled us to elicit multiple solutions. The existing curriculum had a similar engineering project at the end of the unit as an application of knowledge. We modified it by making it the anchor problem of the unit to drive the learning. Students came up with different restoration plans supported by evidence (see example in Figure 4). The emphasis on multiple solutions moves their focus from "getting the right answer" to collectively "figuring it out." It is worth noting that this was one of the few assignments that all students submitted while hybrid learning during the pandemic, even students who historically struggled in science. When teachers purposefully solicited students' diverse ideas, especially from students whose voices are not often heard, they became more engaged in the learning while connecting with their peers (see Figure 5). This helped create an equitable learning environment because all students were positioned as developing experts and sensemakers.

FIGURE 4: Example of students' restoration plans [see final infographic at <https://bit.ly/3lc0Wu7>].

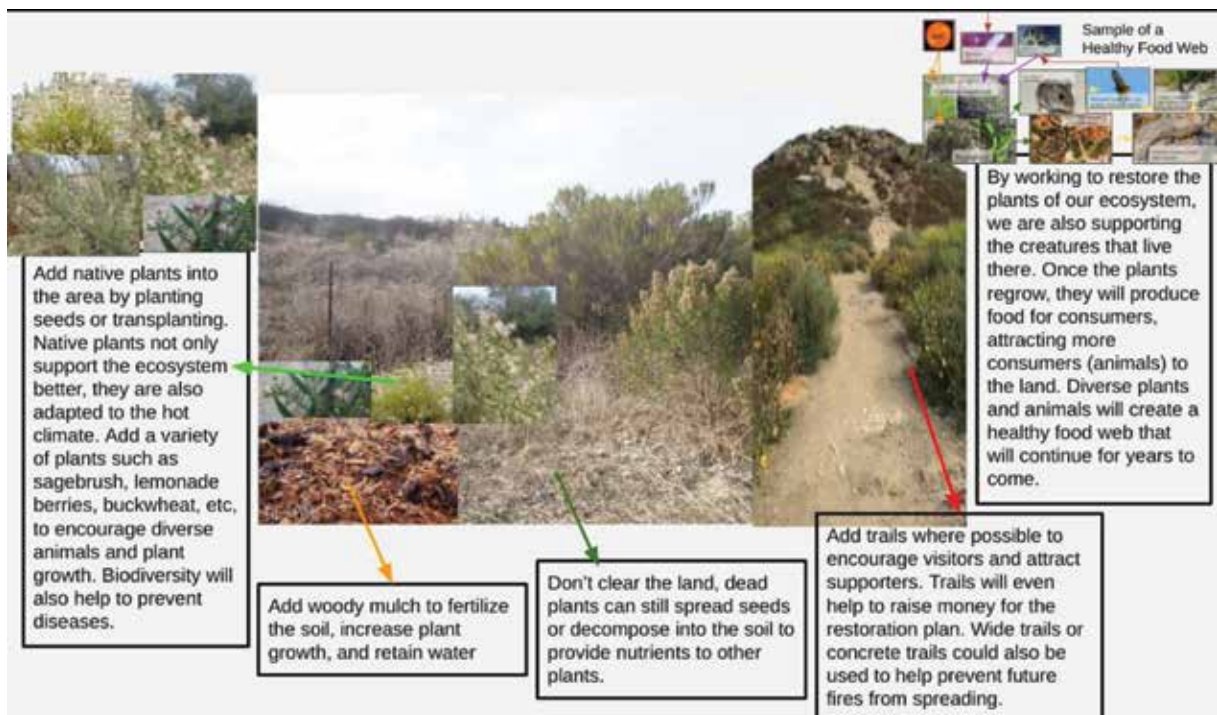


FIGURE 5: Using students’ diverse ideas to develop a student-driven storyline.

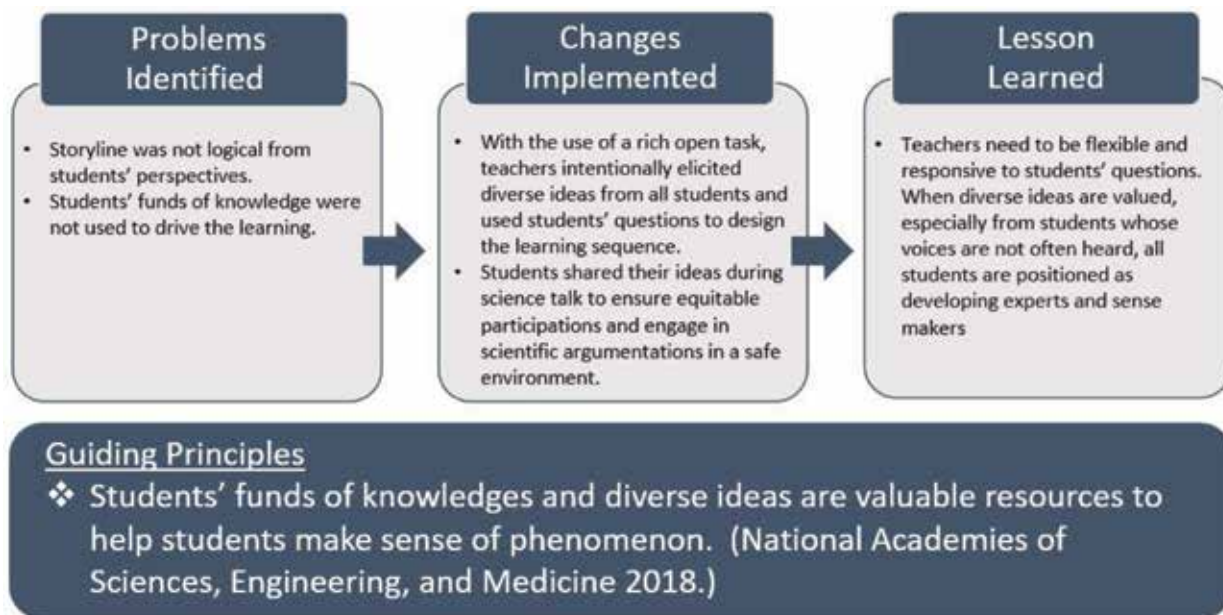


FIGURE 6: Guiding questions for modifying curriculum toward equitable instruction.

Making phenomenon matter by considering students’ identities

- Is the phenomenon based on an observable event contextualized in a specific time and place?
- Who might feel the phenomenon matters to themselves, and who might not? How might the collective investigation into the phenomenon’s problem improve the lives of people in the community?
- How can the teacher facilitate students to form a sense of mattering through classroom interactions?
- Is student identity considered to further develop a sense of mattering?
- [If applicable] What community resources are available to support place-based learning?

Using students’ diverse ideas to develop a student-driven storyline

- Is there a rich open task that can elicit diverse ideas, questions, and/or multiple solutions?
- How can we make students’ *disagreement* visible?
- How is the daily essential question formulated? Does a daily essential question reflect students’ questions, wondering, or disagreements?
- What norms are in place to support a safe learning environment?
- How do teachers validate students’ diverse ideas, including scientifically inaccurate ones, without judging it as ‘right’ or ‘wrong’?

Implications in your classroom

A key takeaway from our collective effort to adapt the curriculum toward equitable instruction is that equity is not a strategy checklist; it is a fundamental shift of mindset. It requires principled, ongoing, and intentional pedagogical actions to reorganize students' experiences in a way of honoring students' identities, voices, and ideas. As illustrated in the previous examples, equity should come through every pedagogical decision to help students connect science learning with people in their classroom. Some guiding questions are provided in Figure 6 as a starting place to reflect on how to move toward more equitable instruction. It is important for teachers to learn how to modify instructional resources in the context of their own local classrooms. Doing so will advance educators toward the NGSS vision of offering equitable learning for all students. ●

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SUPPLEMENTAL MATERIALS

Fire Ecology: Restoration Plan Presentation—[<https://bit.ly/3juXXTI>]

ONLINE RESOURCES

Crystal Cove Conservancy, Virtual Project Crystal Code—<https://bit.ly/3tPpPxE>

Irvine Ranch Conservancy—<https://bit.ly/3pQg76d>

Native Land Digital—<https://native-land.ca/>

Tools for Ambitious Science Teaching—<https://bit.ly/3vTwIK2>

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