Kaleidoscope

Educator Voices and Perspectives

Knowles TEACHER INITIATIVE

Transforming Mathematics & Science Education

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ABOUT *KALEIDOSCOPE: EDUCATOR VOICES AND PERSPECTIVES*

In December 2014, the Knowles Teacher Initiative published the inaugural issue of its new journal—*Kaleidoscope: Educator Voices and Perspectives*. Through *Kaleidoscope*, Knowles shares stories from teachers about teaching, leading and learning.

Kaleidoscope strives to provide readers and writers a public space for discourse and dialogue about the knowledge and expertise of teachers and the complexity of our profession. We believe that teachers are well-positioned to improve education in their classrooms and beyond, and we know the power that storytelling and knowledge sharing can hold in the process of transforming educational outcomes for students.

Two issues of *Kaleidoscope: Educator Voices and Perspectives* are published each academic year (Spring and Fall).

KALEIDOSCOPE

EDUCATOR VOICES AND PERSPECTIVES

Call For Submissions

The *Kaleidoscope* editorial staff accepts submissions on a rolling basis. We publish in a variety of formats, including print, podcast and video.

If you are interested in writing, or already have a piece in mind, contact **kaleidoscope@knowlesteachers.org** at any time for feedback, information, or guidance. Every submission, from idea to fully-developed piece, is assigned a peer advisor to help develop, build, and edit the piece before submission.

On our webpage, **www.knowlesteachers.org/kaleidoscope**, you can find other resources to help you develop your ideas, including

- a non-exhaustive list of the genres of stories we publish, including examples of pieces from *Kaleidoscope* and elsewhere;
- the rubric used for the final review of submissions; and
- past issues of *Kaleidoscope* to see what others have shared.

We look forward to learning your story!

Subscriptions

Print and digital subscriptions of *Kaleidoscope* are available at **https://knowlesteachers.org/subscribe**; digital subscriptions are complimentary while print subscriptions are available for purchase. If you are a member of the Knowles Teacher Initiative community, please let us know when you contact us, so we can ensure that your subscription is properly processed.

In This Issue

Disclaimer

From the Editors' Desk:

Teaching Means More than Teachers will Ever Know

A letter from a student changes one teacher's perception of the power of community.

Remember that sign in the comic strip "Peanuts" that Lucy hangs above her advice booth? "The Doctor Is In—Way In!" Sometimes, my once-weekly homeroom feels like that, with high schoolers asking serious questions in small groups about adolescence and the world, their teacher trying to help and coach the best she can.

Cady (not her real name) spent all four of her high school years in my homeroom. She was a quiet, seemingly confident athlete and student, happy to dye the bottoms of her curls in school colors when her teams went to sectionals. She was a part of some of those small groups, but she never shared problems or concerns or asked for help.

On the last day of school, Cady brought a basket and shyly handed it to me. In that basket was a beautiful, functional water bottle (in sharp contrast to my beat-up, leaky travel mug) and a letter. "When I came into your classroom as a freshman," the letter began, "I . . . had been sheltered within the walls of a small private school for the first twelve years of [my] schooling career. I was so scared of being in a new . . . school that, during the summer before starting [high school], I would have panic attacks to the point where my mom would have to take me to the ER.

"Being placed into your homeroom on the very first day of school, walking into your class and seeing you smiling and excited to have all of us, really made a large impact on the way the rest of those first weeks went by. I didn't feel so alone because I knew that there was at least one teacher who cared [about me] in the school.

"Even though I've never been open about it, I've experienced loads of anxiety and waves of depression that have lasted for months. I always looked forward to coming into your class every Monday and hearing you help others deal with their problems because it helped me determine how to deal with mine . . . You have taught me, by helping others, that it is okay to not be okay sometimes. It's okay to have things that you're struggling with . . . Thank you for being a teacher I can always count on for support, even if I'm not open about my struggles."

We hear all the time that the impact of teachers on students is immeasurable, that you might never know how you helped people as an educator. But this is the first time I realized that some students are helped indirectly by the strong relationships you build with others. Without Cady's letter, I never would have known her struggles, nor guessed that she felt supported by the conversations others were having in those weekly 45-minute check-ins.

I love teaching science to high schoolers because I think the lens of science is a useful way to view the world. Cady's bravery in writing me leaves me equally convinced, however, that the lens of relationships is what builds learning spaces for students. I know that relationships are what build learning spaces for me as an adult.

In this issue of *Kaleidoscope*, you'll hear career changers talk about what brought them to teaching and learn about the teaching of two incredible science teachers. You'll also travel with a thoughtful educator through her inquiry into language use in her classroom, and experience both collaboration and loss through the

narrative of another. The *Kaleidoscope* staff is excited to bring these teachers' voices to you, and we hope that you'll think about helping us tell stories about teaching and learning, too—because we know that, like teaching, those stories mean more than you might ever know.

Citation

Milks, K. (2020). From the editors' desk: Teaching means more than teachers will ever know. *Kaleidoscope: Educator Voices and Perspectives*, *6*(2), 1–2.

Kirstin Milks,
a Knowles Senior Fellow, is an editor-in-chief at Kaleidoscope. Reach Kirstin at kirstin.milks@knowlesteachers.org.

Call and Response:

What is Your Teacher Superpower?

We asked teachers in the Knowles community to reply to this prompt: ***"We know that what the non-teaching world thinks of as teacher superpowers are not the superpowers we teachers know to be effective in the classroom. So, we want to know: What is your teacher superpower?"*** *Here are their responses.*

I've been thinking about this one for a while, and I finally think I've identified my teaching superpower: the ability to read that which is illegible! I've even been asked to translate for other teachers or other students (when working in a group).

Justin Ragland, 2019 Teaching Fellow

My teaching superpower is learning all my students' names on day one. There is nothing more powerful than being able to greet them by name on day two (and also call them out as needed: "Knock it off, Dillon!").

Michelle Vanhala, Senior Fellow

I actually thought this past year that I DID have a superpower: the power to build strong relationships with students. I think this is the strongest superpower any teacher can have, and I am lucky to possess it. I care, no, love students unconditionally. From that love, I lower my boundaries and act like my authentic self around students, which may slowly get students to lower their walls and notice my heart's affection for them. I then begin to talk and joke with students, make sure they feel included and like their presence matters. It's not enough to just give them attention; you have to ostentatiously show them they are the most important people in the world to you. Finally, there is a mutual priority-making between both students and myself that continually strengthens our relationship; there is a mutual respect and care for each other's spaces, an inclusion in decision-making, and sharing of thoughts.

Anthony Tedaldi, 2015 Teaching Fellow

I would say that my superpower is being able to find a way to connect almost any topic to how it can help us live more sustainably on the planet.

Ryan Morra, 2019 Teaching Fellow

I'm Elastigirl, definitely. Flexibility is absolutely key in teaching. Sometimes it's because there's a surprise fire drill, but more often it's because a lesson doesn't go the way you expect. It takes quick thinking and adaptation on-the-fly to figure out where your students are and how you can help them move forward, even if it's not along the path you originally planned or expected.

Emily Kennedy, Senior Fellow

My teacher superpower has been an ability to stay open to fresh perspectives. When I try to look at my students, curriculum, learning environment, and more from a different angle, I often see them in fresh light. I see

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>
> *- Heather Buskirk, Senior Fellow*

new opportunities and options and better understand new layers to the challenges I face. This very special superpower requires me to stay connected with my colleagues (especially ones working in vastly different contexts from mine), students, families, and the greater community. I can't flex this power alone.

Heather Buskirk, Senior Fellow

My teacher super power is the ability to find the power in any student's thinking. Instead of thinking about, "What is your misconception?", I can, on the fly, figure out, "What question did you answer instead?"

Shira Helft, Senior Fellow

My teacher superpower is my infectious energy. My students have told me that my 'level of intensity' pushes them to try in mathematics, even when they historically haven't experienced success. I know when to push students and when to give them space to wrestle with their understanding.

Dwaina Sookhoo, Senior Fellow

> *My students have told me that my 'level of intensity' pushes them to try in mathematics, even when they historically haven't experienced success."*
>
> *- Dwaina Sookhoo, Senior Fellow*

Citation

Ragland, J., Vanhala, M., Tedaldi, A., Morra, R., Kennedy, E., Buskirk, H., . . . Sookhoo, D. (2020). Call and response: What is your teacher superpower? *Kaleidoscope: Educator Voices and Perspectives, 6*(2), 3–4.

An ongoing feature in *Kaleidoscope*, Call and Response features short responses to a writing prompt. Do you have an idea for a storytelling prompt? Contact us at **kaleidoscope@knowlesteachers.org**.

Now on Teacher Voice

Changing Careers

In this episode of ***Teacher Voice: The Podcast***, we talk with teachers who have come to teaching after having a different career. What was it that drew these career changers to the teaching profession?

> *"Although I loved math and was a math teacher, I wasn't in the math business teaching students—I was in the student business teaching math."*
>
> *- Rick Barlow*

In this episode of *Teacher Voice*, hosts Kirstin Milks and Rick Barlow, both career changers, talk with other teachers who have also joined the teaching profession after another career.

Listen to the podcast to hear Diarra Gueye talk about what caused her to leave a fast-moving career on Wall Street for the classroom. Hear how Valentina Bumbu sought out the human connections that were missing from her work as a chemist for Sigma Aldrich. What about the clout of studying biochemistry looking for a cure for cancer? It wasn't enough for Kirstin Milks. And hear how a piece of wisdom from the corporate world provides the guiding light for Rick Barlow's classroom pedagogy.

> *"This was not in my career plans . . . but this is the happiest thing I've done forever."*
>
> *- Diarra Gueye*

To hear more about these teachers' journeys to the classroom, listen to the podcast on our website.

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Teaching Climate Science and Resilience with Computer Simulations

Jon Darkow

Computer simulations are a powerful method for students to explore and understand how their actions can help mitigate the effects of climate change.

As my biology class approached the school library recently, one student asked, “Mr. Darkow, do you know of any books about the environment that are not depressing?”

Another student quipped, “Those would be in the fiction section.”

The whole class broke out laughing, me included.

I’ve enjoyed teaching about the environment ever since I started in the classroom 16 years ago, but I didn’t consider myself a climate activist. That slowly changed when letters to the editor from my former students—letters making political arguments based on misconceptions of climate data—began appearing in our local newspaper.

As letter after letter was published, I realized that my curricula weren’t preparing students sufficiently for understanding the origins of scientific data on climate and why these data matter. As a result, I began to restructure my biology courses to focus more intently on how we know what we know about climate change and its effects in the biological world. I’ve learned that teaching climate science to impressionable and innocent adolescents can sometimes feel risky or arduous, but it also presents an exciting challenge for educators to grow their and their students’ understanding of the science and policy of climate change.

“Teaching climate science to impressionable and innocent adolescents can sometimes feel risky or arduous, but it also presents an exciting challenge for educators to grow their and their students’ understanding of the science and policy of climate change."

We do, indeed, have powerful and uplifting stories of ecological visionaries and political will, stories where ecosystems have been restored: Rachel Carson and the regulation of pesticides, Joe Farman and the global ban of chlorofluorocarbons, Gregory Carr and the philanthropic restoration of Mozambique's Gorongosa National Park, and others. We need to share and celebrate these examples of positive work for the greater good.

At the same time, science teachers are in a unique position to minimize climate change's impact on people, other species, and ecosystems by showing how changes in our current behavior could hold catastrophic climate change at bay (Intergovernmental Panel on Climate Change, Working Group III, 2014). To do so, we first need to build students' knowledge and skills in understanding the ways we know that our global climates are changing, as well as in understanding the often-stark ways ecosystems have already changed as a result of climate change.

Equally importantly, we need to help students see the exciting, hopeful power that humans hold with respect to environmental and climate issues. Sometimes, that power has been used to degrade ecosystems and our atmosphere, but it's also the key to stopping climate change.

The way I've approached both the problem of addressing large ecosystem impacts from human activities and how students can visualize real, incremental solutions in my classroom is through building computer models that they can use to run simulations. Designing and working with computer simulations allows learners to authentically practice scientific skills woven into the Next Generation Science Standards (NGSS) and Advanced Placement (AP) Biology standards, and the work also lets their thinking parallel the modeling that many scientists do to understand climate change.

> *Students can see it is possible to have a positive effect on endangered species by intervening in the current conditions."*

Computer models are powerful in climate research for three reasons. First, they let scientists try to understand what parameters are driving changes we're already seeing in natural systems. Second, while models of all sorts have limitations, they can be extremely useful tools to understand systems that you wouldn't want to destroy. After all, we can't run randomized controlled experiments on the emissions threshold needed for runaway global greenhouse gas effects or catastrophic changes to ecosystems. Simulations allow us to probe those ideas in a humane way. Third, computer models allow scientists (and students) to understand possible solutions to environmental changes and to learn what actions can be done to positively affect change to our environment.

Sometimes, the connection between climate change and the traditional content of biology class can feel overwhelming. One of the NGSS standards for high-school biology is HS-LS2-7: "Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity" ("HS-LS2-7 Ecosystems: Interactions, Energy, and Dynamics," n.d.). Simulations are a powerful way to allow students to explore and use data from complex, dynamic systems in a more targeted and simpler framework. To help students accomplish the goal of this and other NGSS standards, I built two computer models that allow students to adjust initial conditions and run simulations based on those conditions, giving them opportunities to experiment and explore these complex systems in a manageable way. Both models run online in web browsers and are free to use.

One of the simulations I've created gives students the opportunity to test the effects of climate change on the phenology, or life cycle timing, of the Karner blue butterfly (available online at https://sites.google.com/site/biologydarkow/phenology-of-the-endangered-karner-blue-butterfly). This simulation allows students to see how adjusting the mean global temperature affects the emergence of the Karner blue butterfly, an endangered butterfly found throughout the Northeast and northern Midwest. Students run the simulation in order to record how a population of eggs, larva, and butterflies change over the course of a year. Students can adjust the temperature, clutch size, the number of eggs, and the habitat size. Students then can run

simulations in which they adjust these initial conditions (see Figure 1).

In the simulation, an increase in temperature causes the larva to emerge earlier in the springtime. However, their food source (the wild lupine) does not shift at the same rate. This results in the caterpillars emerging without their food source. This asynchrony caused by a changing climate is having an effect on the butterfly populations in the real world, as the animals are starving without their food source. Students can see that increasing habitat size, increasing food source, and minimizing the mean global temperature all can positively affect the butterfly population and reduce the impacts of climate change on the Karner blue. This allows students to see that it is possible to have a positive effect on endangered species by intervening in the current conditions. For example, students might decide to cultivate native plant butterfly gardens at home or in green spaces to increase the size of the butterfly habitat in their communities, or call on their representatives to enact policies that seriously mitigate their communities' carbon footprints.

Another computer model that I have my students use to explore how humans are affecting ecosystems is called "Algal Blooms and Trophic Dynamics in Aquatic Ecosystems" (available online at https://sites.google.com/site/biologydarkow/ecology/catastrophic-regime-change-in-aquatic-ecosystems). Using this model, my students investigate how different biotic factors, environmental variables, and population parameters affect the community interactions in a freshwater ecosystem like Lake Erie. The simulation runs show

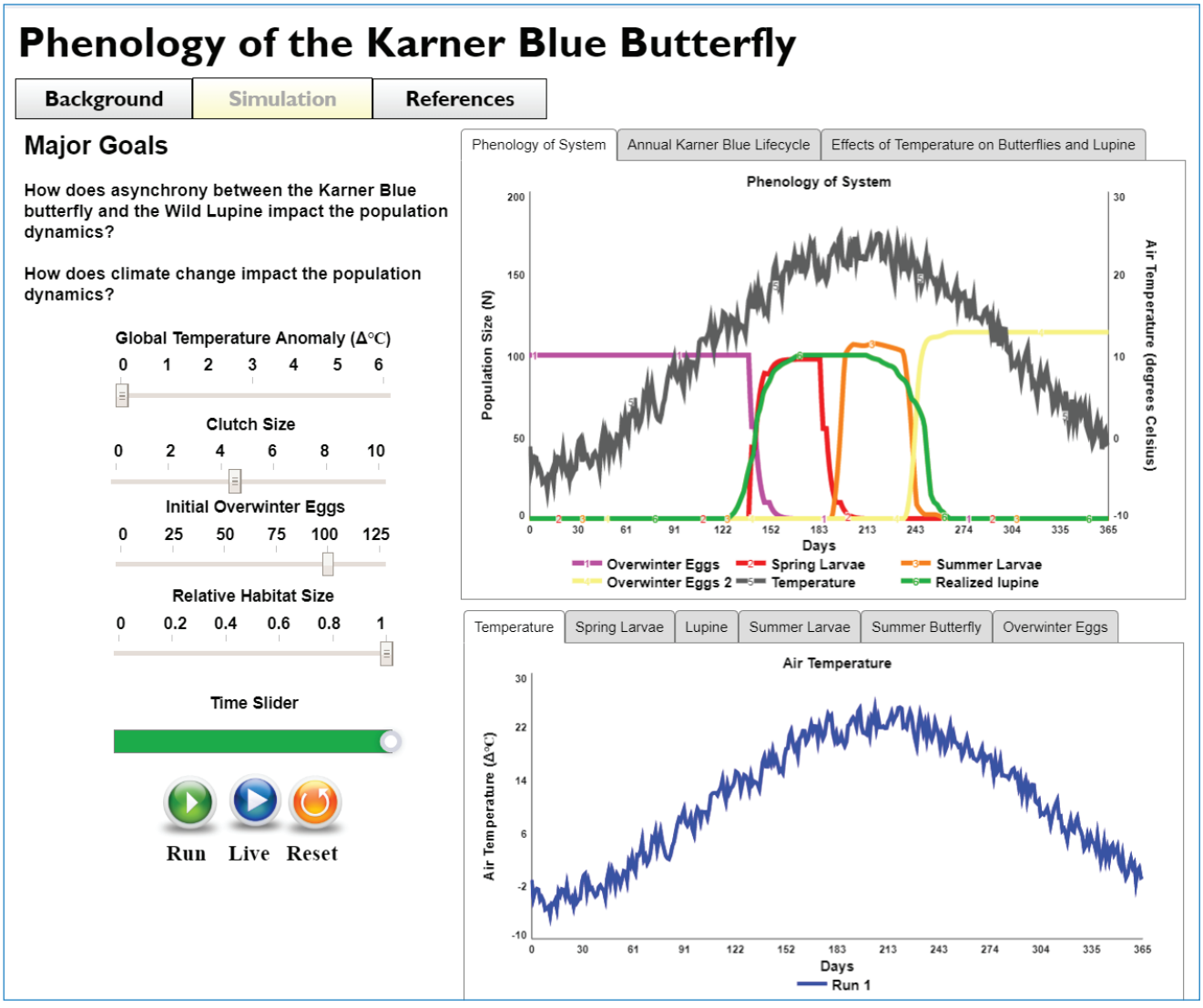

Figure 1. Interface of the Karner blue butterfly simulation, a web-based tool available free to teachers and students at https://sites.google.com/site/biologydarkow/phenology-of-the-endangered-karner-blue-butterfly

how diatoms (a type of green algae), zooplankton, fish, cyanobacteria (blue-green algae), and decomposers can change over time in response to environmental conditions (See Figure 2).

NGSS standard HS-LS2-6 asks students to "Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem" ("HS-LS2-6 Ecosystems: Interactions, Energy, and Dynamics," n.d.). By running the aquatic ecosystem simulation, students discover that increases in both nitrates and average temperature do not have a large effect on the ecosystem, but the system is less resilient to increases in phosphates. They also notice that temperatures above a certain threshold cause the ecosystem to change from a diverse ecosystem to an ecosystem comprised mostly of cyanobacteria and decomposers. Just as in this simulation, there are thresholds in all our real-world ecosystems, and once those thresholds are passed, catastrophic changes can result.

Here is where resilience emerges powerfully from this work. Students can see that minimizing the number of nitrates and phosphates can positively affect the biodiversity and relative concentrations of abiotic factors in the aquatic ecosystem. Students can also see that small increases in the mean temperature won't cause the ecosystem to collapse, but more dramatic increases can. In my classroom, students use simulation data to build an argument that we can conserve the biodiversity of aquatic ecosystems by minimizing temperature, nitrates, and/or phosphates. I've not yet found a more powerful way for students to see that people (including themselves) can be agents of positive change for environmental resilience.

Every year on the National AP Biology Teachers Facebook group, teachers from around the country claim that they will be having students learn ecology over the summer via a summer assignment. This is a mistake. The catastrophic effects to our ecosystems should not be taught as a summer assignment. When teachers deprioritize ecology, they communicate

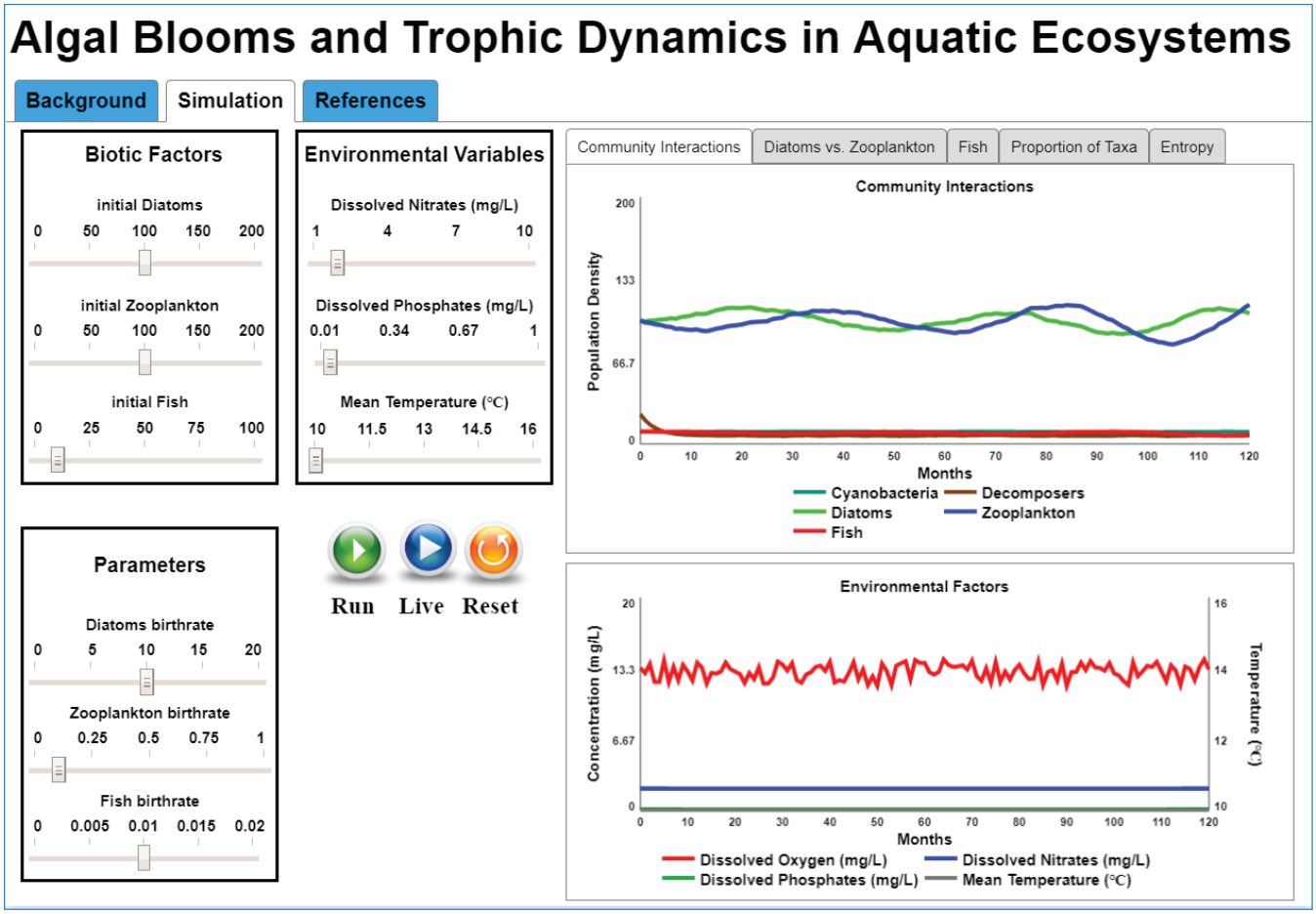

Figure 2. Interface of the algal blooms simulation, a web-based tool available free to teachers and students at https://sites.google.com/site/biologydarkow/ecology/catastrophic-regime-change-in-aquatic-ecosystems

to students that our interdependence with our environment is trivial.

We are living during a human-centered time, the Anthropocene. Our ability to address climate change and widespread biodiversity loss will require people taking these issues seriously. Therefore, one of the most important gifts a biology teacher can give their students is the understanding that humans live interdependently with their ecosystems. Concepts like feedback loops, thresholds, and interdependent behaviors are not intuitive, but with a great deal of support and scaffolding, students will learn that by leveraging Earth's systems (e.g., habitat size, mean temperature, and the number of nutrients in our lakes), humans can mitigate damaging ecosystem changes. Our students—and our future—deserve our best science teaching.

References

HS-LS2-6 Ecosystems: Interactions, Energy, and Dynamics. (n.d.). In *Next Generation Science Standards*. Retrieved from https://www.nextgenscience.org/pe/hs-ls2-6-ecosystems-interactions-energy-and-dynamics

HS-LS2-7 Ecosystems: Interactions, Energy, and Dynamics. (n.d.). In *Next Generation Science Standards*. Retrieved from https://www.nextgenscience.org/pe/hs-ls2-7-ecosystems-interactions-energy-and-dynamics

Intergovernmental Panel on Climate Change, Working Group III. (2014). *Climate change 2014: Mitigation of climate change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge: Cambridge University Press.

Citation

Darkow, J. (2020). Teaching climate science and resilience with computer simulations. *Kaleidoscope: Educator Voices and Perspectives*, *6*(2), 6–10.

Jon Darkow

(@jondarkow) has taught a variety of biology courses at the high school and college level for the past 16 years at Seneca East High School and through Bowling Green State University, both in Ohio. Jon was the 2016 recipient of the Outstanding Biology Teacher Award from the National Association of Biology Teachers and he has received numerous grants for projects that integrate computational modeling and simulations with authentic data collection experiences for students. Reach Jon at jdarkow@se-tigers.com.

The Team, The Team, The Team

Michelle Vanhala

One teacher reflects on how a shared space impacted her team's work together.

Beginnings

Our principal locked himself in classroom 205 with his wife and twin toddlers for a day over the summer. As each member of our newly-formed interdisciplinary freshman teaching team prepped our own rooms, we made excuses to walk by the middle classroom, surreptitiously trying to peek past the covered door window to the source of the hammering we could hear from within. Later that day, my science teaching partner Lynn[1] texted me—"WAIT UNTIL YOU SEE IT."

Just weeks before, a tense team meeting ended in tears when Lynn and I had advocated for traditional teacher desk spaces in our own classrooms. We had pushed back when our principal articulated his expectation that our team would complete all of our prep work together in this shared space rather than at desks in our separate rooms—citing the drab off-white walls and anticipating the chaos that would inevitably emerge with nine teachers trying to work alongside each other.

Amidst a bevy of structural and curricular changes that included new classrooms for all of us and the implementation of project-based learning integrated across subjects, Lynn and I grasped at something we felt like we could control—this shared physical space and how it was to be used—as we challenged our principal's vision. TJ, a math teacher on our team, finally interrupted our protests and effectively silenced our arguments; "It's no big deal," he said with an easy-going shrug. "I can work wherever."

Resigned to giving it a try, we continued to prep our classrooms and procrastinated the work we knew we needed to put into our shared team room until that summer day when our principal surprised us. Walking in, I failed to hold back tears as I saw the former French classroom transformed by bright cerulean paint. On one wall where faded, torn posters from the 90's had once resolutely hung there was now a new sign: "Our Happy Place."

In the center, nine brand new black rolling office chairs were situated around six tables pushed together around laptop charging stations, with a collection of pencils, erasers, and post-it notes set out for each of us. A basket of candy—the good stuff—sat on a chalkboard-painted shelf which was pushed against the opposite wall that read "Enjoy!" at the top. Over the next few days, each member of our team claimed their spot in the team room, settling in with pictures of family members, piles of papers, and towers of books.

Lynn and I got there first. "We should make sure we get seats next to each other so that we can plan together," she reasoned. Her profile to my left quickly became a familiar, comfortable thing; her spot was strewn with pictures of her two kids and husband, healthy snacks and empty bags of chips—clutter that contrasted with

[1] Names have been changed to protect privacy.

her incredibly detail-oriented mindset and organized, composed nature.

Andrea used to sit at the far end of the table, but relocated to the opposite side of the table in October, next to Lynn. It happened suddenly, with little fanfare, after a quiet conversation between her and Lynn one lunch period—she piled up her towers of books and wheeled her tall shelf of papers over.

Her abandoned spot was next to Janet's seat, which sat empty most of the year. Janet could usually be found in her room, where her computer was always hooked up because of the technical issues she experienced regularly. Janet's rare presence in the room was usually marked by a notable hush—we were afraid to be honest around her because she was known for cornering administrators to discuss her concerns about our team's direction.

The only one of us whose voice would subdue Janet's predictable protests was Tom, whose meticulously clean table was on my right. A confident, experienced social studies teacher who moved from teaching Advanced Placement courses to juniors and seniors in order to work with our freshmen, he said that our work together transformed how he views education. Tom liked to get close and whisper intently in a way that made you feel heard. He recently shared an adage with me: "I'd rather teach something new every year for 30 years than teach the same thing over and over for 30 years."

Megan and John sat directly across from us. At Megan's desk, everything had its place. Disney-themed scissors and office supplies were placed into an organizer on day one and were artfully arranged each afternoon before she packed up to leave. Megan was known within our team for being the one to say, "Yes, and . . .". I looked across to her when I needed calm support.

Next to her, John's seat was often empty, as he was out and about running around from classroom to classroom to support his special education students. Between his and TJ's spot was a table-top basketball hoop toy that John's oldest daughter put together for them. "I figured you guys might need a stress reliever some days," she explained when she dropped it off, with a glance towards Janet's empty seat and a knowing smile.

And indeed John and TJ were often seen pinging the mini-basketballs-on-strings from their catapults into the attached hoops. Expletives regularly came from that side of the table as the two close friends laughed and aimed to outshoot each other. TJ, whose friendship with John went back to their high school days, rarely was seen sitting down—more often he was pacing in circles around our table to rack up even more steps on his Fitbit, which probably had already recorded thousands of steps from his morning 6-mile run. As the school's award-winning head wrestling coach, it wasn't unusual for TJ to initiate a friendly wrestling match in the room's corner when one of his wrestlers would pop in with a quick question. TJ was always good for a one-liner and was known for his smirk, which effectively grounded any anxiety in our collaboration as he reminded us not to take life too seriously and go with the flow. From my vantage point, I could see a post-it note on the back of one of his photo frames: "Lighten up, for f***'s sake," it said next to a smiley face.

Zach's seat was to TJ's right. A big, football-player kind of guy, he was usually quiet and looking down at his computer, except when he spoke up passionately in a way that surprised everyone who didn't realize that he was listening intently the whole time. Zach didn't say much—but what he did say was always meaningful and positive. Zach had shared that he viewed his role on our team as that of a servant-leader; his answer was a reliable "yes" when asked to do anything.

By the spring, our team had settled into predictable roles, our personalities (mostly) balancing each other out to form a cohesive unit that saw a goal, formulated steps, and moved forward to meet the needs of our students. We used our shared space to plan within and across disciplines, to meet formally utilizing protocols, and to eat the food we brought in for each other. "How is Susie doing in your class?" was a common informal conversation topic, often followed up with collectively-

Our team had settled into predictable roles, our personalities (mostly) balancing each other out to form a cohesive unit that saw a goal, formulated steps, and moved forward to meet the needs of our students."

drafted emails home as we identified concerning patterns and talked across the table to suggest solutions. We used the white boards around the room to sketch out plans for each interdisciplinary unit, mapping out project timelines and visualizing how each subject's classwork would support the unit's shared project-based learning theme. This was a place where we could develop and refine our common grading practices—"Can you look at this? What would you say would take this student's response from a level 3 up to a level 4?"—but also a space to solidify our after school plans to meet up at the local brewery. We weren't perfect by any means, but we saw how we could be better, and we looked forward to starting and ending our day together in our blue team room.

Endings

The walls are still blue, and the desks are still circled around the megatable at the center of our converted French classroom. A list of dates on the front whiteboard count down the days until the end of the school year. There are handwritten notes in distinctly different colors annotating the makeshift calendar with our various thoughts and questions about each day's plans.

Messier with boxes and final papers, our team room is also notably quieter than it was in April. Janet is in the room because she needs help with end-of-the-year technology. Andrea has more books than ever at her spot—she will be moving classrooms this summer to take over what was my room, and the team room is her temporary holding space for piles of young adult novels and knick-knacks.

My space is the cleanest it has ever been—I am packing up and sending a student out to my car with a box of classroom materials each day because I am moving schools in the fall. My decision came after our newly elected school board fired our superintendent, hired someone with no educational background, voiced their opposition to project-based learning, voted to return to traditional grading in the middle of the year, and decided that we would not have a structure to support collaborative, interdisciplinary teaming in the next school year (see Figure 1).

Lynn is also leaving the district—but she has not cleaned her space yet, and there are still chip bags and pictures of her two children lining her desk. On my other side, Tom's space is meticulous as ever, and across from us are cupcakes that Zach brought in for the team from the local bakery.

Megan is working on grading—she has taken over half of the grading for TJ's classes—so she is stressed out with completing everything before grades are due. Next to her, John's spot is almost empty, except for the tissue container between him and Megan.

John doesn't come into our team room anymore since TJ's accident—not because he is busy running around supporting his special education students, but because the room reminds him too much of his friend. When I saw him quickly walk in to grab his laptop out from underneath their mini-basketball court toy, there were tears in his eyes.

TJ's spot sits empty now. His table knick-knacks and pictures were removed by his wife for his memorial ceremony, but there is one orange, student-designed shirt that is folded on top of his desk. It features a picture of him with his familiar smirk holding a sign that reads "Why I teach: To be the difference" and the dates January 31, 1983–May 19, 2019.

January 25, 2019: Newly-elected school board cuts ties with Tecumseh superintendent

March 26, 2019: Tecumseh's new superintendent on leave amid allegations of 'harassment, intimidation'

March 28, 2019: Tensions high as Tecumseh school district looks to hire 3rd superintendent in 2 months

April 8, 2019: Tecumseh Schools paying 3 superintendents after hiring new interim

April 28, 2019: Emails show parents' frustrations with Tecumseh schools

May 16, 2019: Tecumseh Schools hires fifth superintendent in five months

May 20, 2019: Tecumseh Schools mourns teacher, coach killed in pedestrian crash

May 30, 2019: Tecumseh Schools pumps brakes on reconfiguring district buildings

June 7, 2019: Tecumseh superintendent on leave says board president ordered him to 'target and terminate' employees

June 13, 2019: Tecumseh superintendent under investigation resigns, calls for state to take over

Figure 1. Tecumseh School District news headlines. The headlines included here were reported on the news website MLive.com from January through June 2019.

> *Seeds have been planted—seeds of constructivism, seeds of innovation, seeds of teamwork, and seeds of collaboration."*

As I pack one of my last boxes, Tom pulls me aside for one last fervent whispered conversation: "Keep doing what you do, okay? Don't change because you know these students and you know what they need. A new school? Doesn't matter. A new city? Doesn't matter. Doesn't change who you are and what you know. Keep doing that because you're going to do amazing things for those kids there." Tom isn't a hugger, so with a quick nod, he throws his bag over his shoulder and walks out of the room.

Megan, Andrea, Lynn and I leave together, each carrying a box to my car. I am leaving this room with just a few boxes, but I am also leaving with the fast friendship of these three ladies. I am leaving with the strength demonstrated by John and the passion exemplified by Tom. I am leaving with perseverance and patience cultivated through challenging conversations with Janet, and I am leaving inspired by Zach's steadfast positivity. I am leaving with the memory of TJ's energy: "Go out and kick the world's a** today, everybody." he once told us in a 5 am video sent via a group chat on his morning run.

Our team may be broken and our blue team room's future uncertain, but seeds have been planted—seeds of constructivism, seeds of innovation, seeds of teamwork, and seeds of collaboration. Wherever we are in our separate spaces in the fall, we are leaving with lessons learned in our year of teaming together. We are leaving having witnessed the successes of an interdisciplinary, project-based learning curriculum for students who were more engaged than ever. We are leaving with the drive to continue to push the envelope, to challenge traditional, outdated practices, and, most importantly, to support those around us who share our views of transformative education for our students.

Citation

Vanhala, M. (2020). The team, the team, the team. *Kaleidoscope: Educator Voices and Perspectives*, *6*(2), 11–14.

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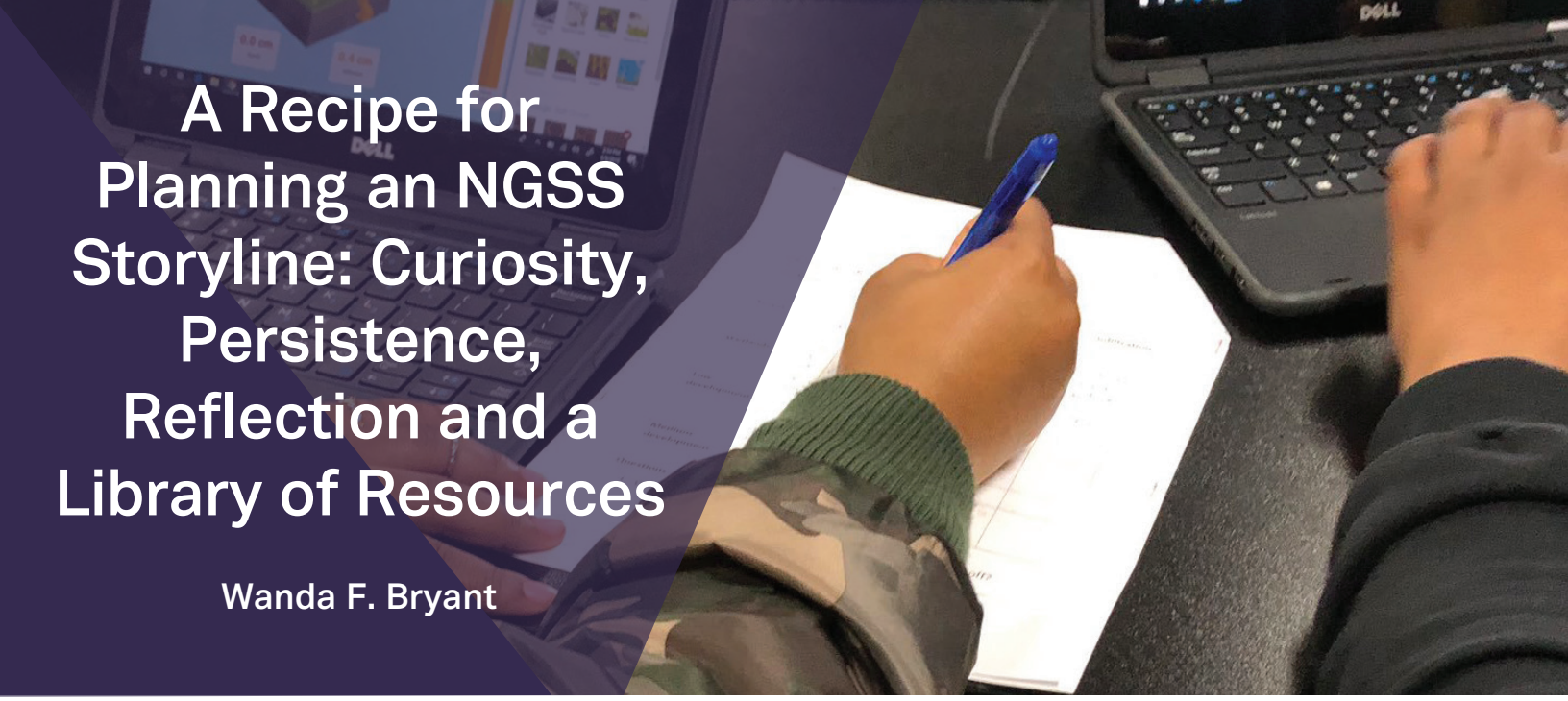
A Recipe for Planning an NGSS Storyline: Curiosity, Persistence, Reflection and a Library of Resources

Wanda F. Bryant



Creating culturally-relevant, place-based learning opportunities to support equity and develop science skills.

According to the Institute for Science + Math Education, barriers to implementing Next Generation Science Standards (NGSS) in classrooms include the limited availability of curriculum resources and the cost to districts in teachers' time and funding to develop them (Institute for Science + Math Education, n.d.-a). The good news is that curriculum adaptation, the act of customizing universally applicable lesson plans and materials for use in one's classroom, is proving to be an effective strategy to help teachers learn about NGSS while also fostering the ground-up development of an entire scope and sequence of K–12, peer-reviewed, NGSS-aligned units and instructional materials (Institute for Science + Math Education, n.d.-a).

As a middle school science teacher, I have found myself in the same bind many other science teachers face: I need to engage my students in NGSS-aligned lessons that are relevant to their lives and where they live. I wondered, "How can I create a low-cost, place-based, NGSS-aligned unit using activities from multiple curricula?" Last year, as a participant in a professional development program for Detroit-area teachers (Creating Great Lakes Stewards to Promote Clean Water and Healthy Watersheds, sponsored by Michigan Technological University), I set out to answer this question and to discover how to integrate resources from multiple curricula into a coherent storyline.

Introducing the unit

In my Detroit middle school science classroom, the last unit of the year is focused on water chemistry. I was uncertain how to weave resources from the district and the professional development program together until I reviewed a district resource titled "15 Recent Water Quality Issues, Threats in Michigan" and located an August 2014 Detroit flood videoclip (MLive, 2014). From these resources, I learned that the 2014 Detroit flood produced five inches of rain in one hour and resulted in 4.5 billion gallons of raw sewage! I decided to use the 2014 Detroit flood as an anchor phenomenon—a real-world event my students and I would use to focus and direct our learning.

Previously, in my work on a research project with Professor Brian Reiser of Northwestern University, I piloted an NGSS unit storyline about sound that I anchored using a video about how the sound from speakers can cause windows across the street to shake (Bryant, 2018). The video captivated my students' attention, and I hoped the video of the Detroit flood would have a similar positive effect on student engagement.

I started the watershed unit with a pretest from the Michigan Science Teaching and Assessment Reform Curriculum (MI-STAR), with the goal of activating and assessing students' prior knowledge. As I prepared the unit, I realized my initial driving question for the storyline, "How does rainfall cause streets to flood?", was incorrectly framed; there were many interactions involved in explaining the flood phenomenon that the question would not capture. I reframed the question as

"How do interactions between air, land, water, and living things relate to flood events?" and shared it with my students.

With the question in mind, students watched the video and completed a notice-think-wonder protocol designed to help them distinguish between their observations and interpretations. These were some student responses:

1. I noticed it was raining hard.
2. I think the sewer will be clogged so when it rained, the rain had nowhere to go.
3. I wonder how much it rained and how the sewers were unclogged.

I planned to incorporate instructional strategies that supported students in planning and carrying out an investigation using their own questions. To accomplish this, I knew I had to shift the focus of my teaching from me asking questions to my students asking questions. I reached out to other science teachers during an NGSS chat on Twitter (#NGSSchat). Another science teacher suggested question formulation technique (QFT), a strategy in which students generate questions, categorize and improve them, and then select their top three questions to develop a driving questions board (See Figure 1).

Question Formulation Technique

- Introduce a stimulus for jumpstarting questions
- Students generate as many of their own questions as they can in four minutes.
- Students categorize their questions into "open" and "closed" groups and then practice changing one open question to closed and vice-versa.
- Students prioritize three questions that when answered will help them understand the phenomenon.
- Together, students plan next steps and develop a "driving questions board" to represent the questions they want to answer in the unit.
- Students reflect on ways QFT affected them.
  1. Why is learning to ask your own questions important? (cognitive change)
  2. How do you feel about asking questions now? (affective change)
  3. How can you use what you learned about asking questions? (behavioral change)

Figure 1. The steps for Question Formulation Technique. Adapted from "Steps of QFT" by The Right Question Institute, n.d. Retrieved from https://rightquestion.org/what-is-the-qft/

Next, students drew initial models to capture their understanding of the beginning, middle, and end of the flood phenomenon and added "zoom in" bubbles between sun, rain, and land to capture unobservable features. Then, we had a class discussion about our models, decided the components we would keep, and added question marks for ideas about which we were unsure (see Figure 2).

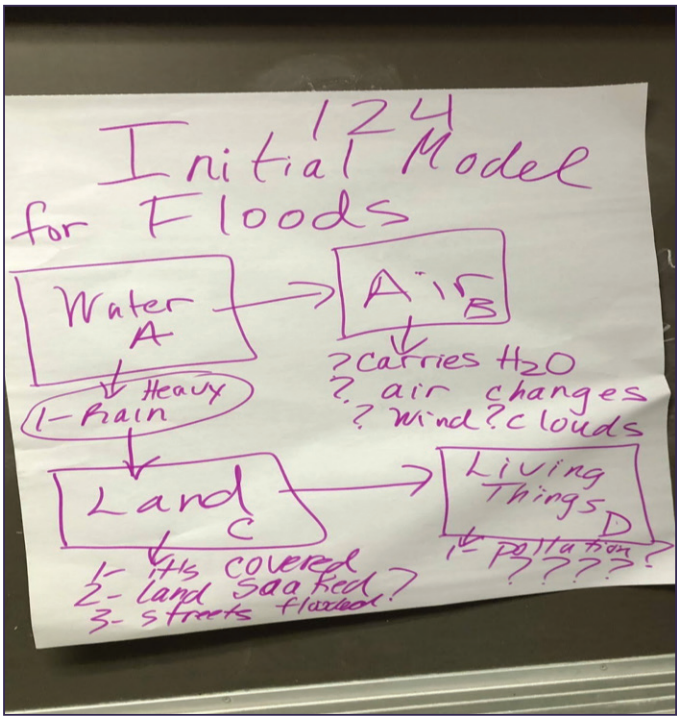


Figure 2. Our class consensus model.

Refining the model through an investigation

In this unit, my students were working toward mastering five NGSS standards (Next Generation Science Standards, n.d.):

- MS-PS1.1—Develop models to describe the atomic composition of simple molecules and extended structures.
- MS-PS1.4—Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.
- MS-ESS2.4—Develop a model to describe the cycling of water through earth's system driven by energy from the sun and the force of gravity.
- MS-ESS3.2—Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.
- MS-ESS3.3—Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

Using the Model Based Inquiry Unit template as a guide (Model-based inquiry - MBI template, n.d.), I identified performance expectations for each part of our model and the investigations that would ground the unit, including examining where flood water goes, the behavior of water itself, and what causes it to rain.

Lessons were framed by guiding questions which, when answered, would complete a bit of the flood phenomenon puzzle. For example, I asked my students, "Is water sticky?" When most students answered "No!" with emphasis, I decided to challenge their preconceptions with a demo involving immersing two dry pieces of paper towel in water and putting them together to make them stick. This simple demonstration of a phenomenon piqued student interest and gave them a reason to read articles and complete graphic organizers to learn more about the structure and properties of water.

Students further investigated the properties of water when they engaged in the Project Wet Water Olympics activity to predict and observe the interactions of water with different materials (Project WET, 2011). When I used this activity with students in the past, my objective was for students to learn facts about water. However, in the context of my NGSS storyline, I used the activity to build students' conceptual understanding. As the unit progressed, I realized the activity also helped students develop background information they could retrieve later to understand absorption/infiltration of different land cover types. We also used a physical model of water to visualize stickiness and a graphic organizer on scale, proportion, and quantity to record observations of the macroscopic patterns to atomic-level structure. However, I missed opportunities to incorporate math concepts such as ratios (in molecular formulas) and large-scale calculations using exponents (number of molecules in a drop of water)—something I will improve on the next time I teach this unit.

After a few days of instruction, students returned to their initial models to make revisions. They used three sticky notes to record what they would add to the model, what they would take away, and what new questions they had (see Figure 3). We then added their new questions to the driving questions board.

Incorporating multiple models and tools

The next question we considered was, "How does heat affect the particle arrangement and motion in solids, liquids, and gases?" We used a virtual simulation, States of Matter (PhET, n.d.), and a worksheet from a unit by MI-STAR, "Water on the Move: The Water Cycle" (Michigan Science Teaching and Assessment Reform, n.d.), to support students to use their prior knowledge to deepen their understanding of the flood phenomenon. To further

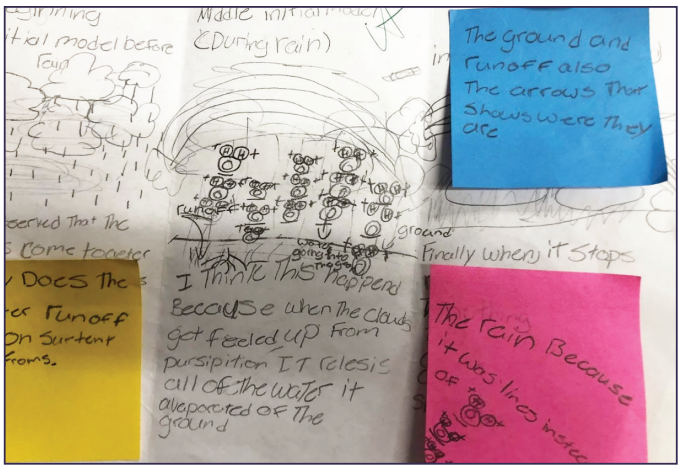


Figure 3. Example of a student-revised initial model.

assist with sense making, students used a bead model with a pre/post-talk writing support tool following the simulation (Institute for Science + Math Education, n.d.-b). Using this combination of models provided students with opportunities to discuss the advantages and limitations of each.

I also accessed resources from the Michigan Environmental Education Curriculum Support and the Concord Consortium to demonstrate ways to improve their watershed models by implementing appropriate conservation practices. My students used "Water Moving Around the Earth," "Energy Balance and Atmosphere," "Radiant Energy," and "What Affects Your Watershed?" from Innovative Technology in Science Inquiry (ITSI) for this lesson because along with engaging students in modeling, computational thinking, and real-time data acquisition, these resources also invited them to consider STEM careers (Concord Consortium, 2016–17 a–d). I found that projecting these ITSI models on a screen allowed us to note the strengths and weaknesses of models as a class. To further deepen students' understanding, when I use this resource again next year, I plan to ask students to construct additional partner models and write explanations about other related phenomena following the simulation.

Six weeks into the unit, students worked with partners to create an updated model including new evidence (see Figure 4). I then used the pretest assessment as a post-test to gauge the impact of instruction on students' learning about parts A, B, and C of our classroom consensus model (see Figure 2). Although I sensed that students were near the point where they could transfer and apply their knowledge, I realized they struggled when trying to explain their thinking on an embedded assessment. My Twitter professional learning network

recommended that next time, before I assess students' understanding, I should use the Discussion Diamond writing scaffold provided by STEM Teaching Tools to help students clarify what must be true about all solids, liquids, and gases based on the various models they explored. The Discussion Diamond has triangular corners with a diamond in the middle. Each student has three minutes to think and respond to a question prompt in each corner. After they discuss their individual answers, they come to a consensus and write their response inside the diamond. I am looking forward to implementing this structured discussion tool with my students during my next enactment of this unit to see if it improves their performance on the embedded assessment.

Closing the unit

To answer the question, "How does elevation combined with the force of gravity influence the flow of water?", students constructed 3D watershed models, wrote explanations, and used interactive mapping software (ESRI, n.d.). Students were excited to type in their home addresses and observe changing elevation within their neighborhood.

As a final challenge to improve their watershed models, students used a runoff simulation to answer the question, "How does a 24-hour storm event affect the watershed?" (Stroud Water Research Center, 2019). The interactive runoff simulation allowed students to investigate how changing land cover, amount of rainfall, and soil texture affects where water goes when it rains. As they worked, students created a t-chart noting land uses that minimize

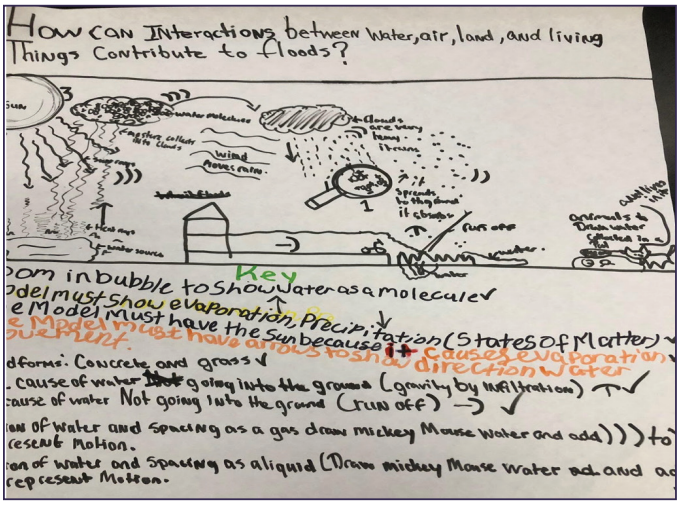


Figure 4. An updated model. Students worked with a partner to update their models to describe interactions between Earth's spheres—A–water, B–air, and C–land. Notice the magnifying glass has been added to zoom into water structure and semi circles are used to represent particle speed and state of matter.

> *NGSS units are complex and require a variety of resources, collaboration, and pedagogical strategies."*

water runoff and pollution, to help them decide which land cover they would pick for their watershed based on their results.

Next steps

At the beginning of the unit, my students generated a list of related phenomena, including tornadoes, snow storms, tsunamis, hurricanes, hail storms, and earthquakes. Time constraints prevented us from circling back to these student ideas, but they could be used as stimuli to create scenarios for summative tasks. In the next iteration of this unit, it will be important to address why the sewers were clogged and how the problem was solved. I have already identified Project Wet activities to illustrate how demands on some treatment plants cause sewer overflows. I would also like students to consider more deeply how wetlands aid in flood prevention. In addition, I will modify the directions of the pre/post test, as many students did not represent states of matter using semicircles, nor water as a molecule. Next time, I will explicitly ask them to do so.

NGSS units are complex and require a variety of resources, collaboration, and pedagogical strategies. Although my watershed unit did not satisfy every formal descriptor of an NGSS storyline unit, and there is much I want to improve in the future, my students were engaged in building and critiquing models of scientific phenomenon and they did make progress on mastering the disciplinary core ideas and cross-cutting concepts.

Before teachers attempt to build their own NGSS unit from scratch, I recommend spending time engaging with existing vetted NGSS curricula. Access to quality professional learning experiences, like the Learning While Teaching project, curiosity, extensive reading, and ongoing reflection are critical for teachers to create and sequence high quality three-dimensional NGSS units. Encouraged by my initial attempt at using an available collection of free or low-cost resources, I am exploring

options to create additional place-based units and hope readers of this article will consider doing the same.

Resources Discussed in this Article

Discussion Diamond available at http://stemteachingtools.org/assets/landscapes/Protocolsv2_08.pdf

Model-based Inquiry Template available at https://sites.google.com/view/modelbasedinquiry/template/mbi-template?authuser=0

Water Kit by 3D Molecular Designs available at https://www.3dmoleculardesigns.com/Education-Products/Water-Kit.htm

Suggested Reading

Fink, S. & Baek, J. (2017, February). Supporting student understanding of watersheds by using multiple models to explore elevation. *Science Scope, 40*(6), 24–32.

Marcum-Dietrich, N., Kerlin, S., Staudt, C., & Daniels, M. (2018, February 1). Our watershed: Students use data and models to make a difference in their own school yard. *The Science Teacher, 85*(2), 39–46.

Michigan Environmental Education Curriculum Support. (2019). Lesson four: How does land use affect water quality? In *Water Quality Overview* [PDF]. Retrieved from https://www.michigan.gov/documents/deq/deq-exe-outreach-meecs-water-Intro_310329_7.pdf

Windschitl, M., Thompson, J.J., & Braaten, M.L. (2018). *Ambitious science teaching*. Massachusetts: Harvard Education Publishing Group.

References

Bryant, W. (2018). Implementing the shifts in Michigan Science Standards: Professional development that puts the pieces together. In *MSTA Newsletter* [PDF]. Retrieved from https://cdn.ymaws.com/www.msta-mich.org/resource/resmgr/newsletter_pdfs/msta_fall_newsletter-online.pdf

Concord Consortium. (2016–17a). Energy balance and atmosphere [Computer simulation]. Retrieved from https://authoring.concord.org/activities/1094/single_page/9f86d7a5-e3b3-411b-ab03-05b3ba9b724e

Concord Consortium. (2016–17b). Radiant energy [Computer simulation]. Retrieved from https://authoring.concord.org/activities/1093/single_page/b7c8b6e6-da1a-46e3-9a97-91f45dfd40b8

Concord Consortium. (2016–17c). Water moving around the earth [Computer simulation]. Retrieved from https://authoring.concord.org/activities/1110/single_page/ca70a618-b1fc-4dab-a355-b1ca3f3c7cac

Concord Consortium. (2016–17d). What affects your watershed? [Computer simulation]. Retrieved from https://authoring.concord.org/activities/2762/single_page/b407704f-3e73-4e61-b38a-8c31cabafdca

ESRI. (n.d.). Elevation profile maker [Mobile application software]. Retrieved from http://www.arcgis.com/apps/Profile/index.html?appid=fb052ab397f045ea999525f6b57e702e

Institute for Science + Math Education. (n.d.-a). Using curriculum adaptation as a strategy to help teachers learn about NGSS and developing aligned instructional materials. Retrieved from http://stemteachingtools.org/brief/5

Institute for Science + Math Education. (n.d.-b). Talk resource tools: pre- and post-talk writing supports. Retrieved from http://stemteachingtools.org/sp/talk-resource-tools-pre-and-post-talk-writing-supports

Michigan Science Teaching and Assessment Reform. (n.d.). Unit 6.1: Water on the Move: The Water Cycle. Retrieved from https://mi-star.mtu.edu/pages/unit-61-overview/

MLive. (2014, August 11). *Detroit flooding, Aug. 11, 2014* [Video file]. Retrieved from https://www.youtube.com/watch?v=Qqv1EjRmWEM&feature=youtu.be

Model-based inquiry - MBI template. (n.d.). Retrieved from https://sites.google.com/view/modelbasedinquiry/template/mbi-template?authuser=0

Next Generation Science Standards. (n.d.). MS-ESS2-4 Earth's systems. Retrieved from https://www.nextgenscience.org/pe/ms-ess2-4-earths-systems

Next Generation Science Standards. (n.d.). MS-ESS3.2 Earth and human activity. Retrieved from https://www.nextgenscience.org/pe/ms-ess3-2-earth-and-human-activity

Next Generation Science Standards. (n.d.). MS-ESS3.3 Earth and human activity. Retrieved from https://www.nextgenscience.org/pe/ms-ess3-3-earth-and-human-activity

Next Generation Science Standards. (n.d.). MS-PS1.1 Matter and its interactions. Retrieved from https://www.nextgenscience.org/pe/ms-ps1-1-matter-and-its-interactions

Next Generation Science Standards. (n.d.). MS-PS1.4 Matter and its interactions. Retrieved from https://www.nextgenscience.org/pe/ms-ps1-4-matter-and-its-interactions

PhET. (n.d.). States of matter [Computer simulation]. Retrieved from https://phet.colorado.edu/en/simulation/states-of-matter

Project WET Foundation. (2011). H2Olympics directions cards [Microsoft Word file]. Retrieved from http://portal.projectwet.org

Right Question Institute. (n.d.). Steps of QFT. Retrieved from https://rightquestion.org/what-is-the-qft/

Stroud Water Research Center. (2019). Model my watershed—runoff simulation. Retrieved from https://wikiwatershed.org/model/

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teaches middle school science and serves as a mentor at Henderson Academy in the Detroit Public Schools Community District. She's had opportunities to learn about effective pedagogy and NGSS implementation from vertical teams, district professional learning networks, the National Science Teaching Association, the Michigan Science Teachers Association, Twitter (@wandabryant), the NGSNavigators podcast, and professional reading. Reach Wanda at wanda.bryant54@gmail.com.

Lessons in Language

Kristin Berry

A look at language use in my science classroom through an inquiry lens.

Science is billed as a straightforward way of knowing. You design a test to answer a question, isolate variables, look at data gathered with authenticity, and draw conclusions that are supported with evidence. In teaching, we use a similar model to gain knowledge, with the key differences being that your experimental design is always flawed; it is impossible to truly isolate variables, and the data we gather and analyze is intensely nuanced. I've lived all of these experiences through learning about language use in my science classroom.

Learning is language

My year-long volunteer experience at El Centro del Muchacho Trabajador (The Working Boys' Center) in Quito, Ecuador helped me come to value language as a tool for human connection. Lack of shared language resulted in barriers, whereas developing my language skills in Spanish or the English skills of my 6 year-old or 60 year-old students resulted in bridges.

For example, one of the classes I taught was "nivelación," which basically means "leveling." It was part of the special education program and helped students who were only just starting school get caught up to their appropriate grade level. My sole student was a nine-year-old girl named Jocelyn[2]. At the beginning of the school year, she had not had any formal education and did not know the alphabet, let alone how to read. As a result, she was incredibly shy.

Jocelyn and I worked together every morning, first on numbers, letters and sounds, later progressing to basic arithmetic, words and sentences. By the end of the year, she was flying through fluency practice in reading. As her language skills progressed, so did her social skills. Jocelyn came out of her shell and was able to express her silly, caring, and sometimes sassy personality both through writing and speaking.

When I came back to visit the following year, Joceyln was in mainstream class with students her age, and flourishing. She was so proud to show off what she was working on in school and to introduce me to her new friends. Jocelyn's language development helped her connect to the world around her, and being part of her development helped me glimpse the transformative power of education more broadly and language more specifically.

Formalizing my inquiry

Until last year, I taught at a charter network in Denver, Colorado, where our mission was to "transform urban public education by eliminating educational inequity and preparing all students for success in college and the 21st century." In our effort to eliminate educational inequity, we identified a problematic and persistent gap in success between multi-language learner students (MLLs) and non-MLLs. Closing this gap was set as one of our school goals.

[2] Student names are pseudonyms to protect privacy.

> *Jocelyn's language development helped her connect to the world around her, and being part of her development helped me glimpse the transformative power of education more broadly and language more specifically."*

The work was slow at first. Even though I'd been taught to write language objectives in my teacher preparation project, it didn't prepare me to use them on a daily basis in my classroom. After some explicit instruction from Corrie, an administrator at our school with a lot of language expertise, I spent half the year just working on writing language objectives for each day's lesson. Many days, they were not rigorous enough or too vague for students to know if they'd accomplished them. But at least we were thinking about language; it had moved to the forefront of our minds in planning and instruction.

Steps in a circle are still steps

Having worked with the same teaching partner for three years made this possible. Another biology teacher at my school, Gray, and I were engaged in inquiry through our work as Knowles Fellows. Although teacher inquiry looked different for each of us, we both focused on language development and equity in our classrooms. Having already spent a few years refining content in our curriculum, Gray and I were able to pivot toward this specific area of our practice. We would not have made so many adjustments or come to value language support and practice as much if we weren't both committed to the language development of our students and willing to make mistakes along the way.

The simple move of adding a language objective slide to every day's presentation focused our attention and thinking. Sometimes we were able to find the point in the lesson where students would demonstrate a language skill that would help them master the content. For example, a content objective that asks a student to explain a process is likely going to require sequence words. An objective in argumentation is going to require complex structure including evidence and justification. If we weren't able to come up with a language objective that students would need to engage, our lesson needed restructuring.

I was thinking about the language skills students needed to access content and demonstrate understanding, but I hadn't given students nearly enough support and practice in doing so. I was assigning vocabulary practice as homework each week, but not scheduling time in class for them to try out the new words and get feedback. I was asking my students to write and speak more frequently, but not giving a diversity of scaffolds to help all students access those tasks.

In one instance, Gray and I redesigned a writing assignment we'd done the previous year. We wanted to integrate evidence from several activities into a scientific argument for natural selection as a force of evolution. We added sentence stems and word banks, and we did a lesson with a writing workshop. When the assignments were turned in, it was clear that students had not had the opportunity to process each separate activity in writing, and thus compiling them all together was a flop. Meanwhile, the gap in test scores between MLL and non-MLL students still persisted. I had a long way to go in creating equitable access to opportunities to learn in my classroom.

The iterative nature of inquiry

In year two of this work, I was in my fourth year of teaching. I now had the capacity to dedicate even more focus to supporting these students, and more space for inquiry into my own teaching and learning in my classroom. I still wanted to increase student access to opportunities to learn, so I looked at student participation in group work and immediately found that my MLL students were participating at lower rates in both group and class discussions. Knowing that practicing language results in language development, and talking results in making connections and learning, I decided to focus on "fixing" that problem. Here is where things got messy.

Supporting my MLL students in furthering their language development, scientific skills, and feelings of belonging is much more important and urgent to me than tediously identifying which activity, practice, routine, structure, or teacher move is most effective. So Gray and I tried every strategy that was recommended to us, plus some that we invented. We restructured vocabulary instruction by preloading important vocabulary for the day's lesson and giving students practice right away in using it. One

of my favorite tools became the whip-around, where you prompt students, "Which word from this definition do you think is most important in understanding the term?" There is no right answer, just a chance to reflect and share.

Those strategies were just the beginning. Gray and I added more games to class to make vocabulary fun, like QuizletLive and HeadsUp. We added language scaffolds to almost every writing prompt, ranging from fill in the blanks to sentence stems to just bolding keywords. We asked for structured output for turn and talks. Sometimes there was a keyword students should use or an academic phrase that would help narrow their thinking. We started giving MLL students different short answer prompts on assessments that had appropriate scaffolds. These prompts might have pictures or be broken into several smaller questions. I was also still trying to get MLL students to participate more in group work, so I included more roles and sentence stems in tasks.

From school goal to student-focused

Gray and I tried to tackle language use from so many angles that some days I felt I'd tied myself in knots. The other confounding factor is that, fortunately, my students are not test subjects in an experiment; they are humans with goals and emotions and challenges.

Last year, I developed a close relationship with a student named Marina, who only shared two times with the whole class, but with whom I spoke at length every day (in Spanish). Over the course of the year, both her science and writing skills soared. She earned the biology course growth award for Trimester 2, and her final grade was 20% higher than her trimester 1 score. At the end of the school year, she was sharing in English when students turned and talked with partners, consistently producing quality writing, and learning independently. No student took as detailed notes as Marina did.

Marina was clearly seeing success and felt like a powerful learner. I spent 20 minutes interviewing her on her experience with language development both in and out of my class, but at the time, I still could not pinpoint what had been most helpful for her. Was it just that her language had progressed at a normal rate? Did she just like me as a teacher? Was she working particularly hard at her language skills? At the time, I wondered if the things we'd tried in class had really been helpful.

A pivotal moment for Marina took place during this year's Climate Change Summit in class. To prepare for the summit, students worked in groups to read and analyze a variety of articles. Then, during the summit, each student assumed the role of a particular stakeholder and was responsible for conveying their perspective. Marina was a representative of the Center for Disease Control (CDC).

Throughout the year, Marina pleaded with me, with both her eyes and her words, to not call on her in front of the whole class. I knew that speaking in front of that many people brought her anxiety, as her speaking skills were not as strong as her reading, writing, and listening. The other times I'd gotten Marina to share in front of the whole class, she had only put together very short simple responses. I knew she needed more practice speaking than in any other area of language.

However, before the summit, Marina wrote down her prompts and beautifully crafted responses, complete with references. Instead of asking another group member to present for her, as she often did, she confidently and competently presented her claim that increased disease is going to be an effect of climate change, and the world summit should make commitments to mitigate it. It was a quiet victory, but I know it affected both her academic and social confidence. She was beaming afterward. It was probably my proudest moment as a teacher last year.

This was different from my experience with another MLL student named Andres, who had struggled throughout his educational experience. He was not doing well academically at the beginning of the year, so we asked his family for a meeting. In that conversation, his parents shared that he often needed a little extra help moving through tasks, and he explained that because he struggled to build relationships with teachers he often didn't ask for the help he needs. They also shared that Andres had had intervention meetings every year at our school and nothing seemed to "click," both for him and for his teachers.

I worked on getting Andres to open up; we even shared some games of Super Smash Bros on his Nintendo

Fortunately, my students are not test subjects in an experiment; they are humans with goals and emotions and challenges."

Switch. But language development was not his only challenge. He also needed help with soft skills: "What does productive studying look like?", "How do you keep track of assignments?", "Why is consistency important in school?", and "How can you build confidence in your skills and in talking with teachers?"

Andres failed my class (and most of his other classes) the first two trimesters of the year. As a result, Andres was put on an academic contract he designed which, if met, would allow him to pass for the year. Teachers agreed to check in with him during every single class and intentionally celebrate each one of his successes. As of this writing, Andreas has passed our most recent test with an 85% (his highest so far) and told us he's feeling confident and engaged.

Sharing what I've learned

Language development looks different for each student because it is couched in their own identities. Are they a student that always speaks a different language at home? Sometimes? What else is affecting their opportunities to learn?

At this point in my inquiry, I do not have many evidence-based conclusions to share, other than the fact that when I think about and plan for language development my students' opportunities to learn increase. On the last biology final, the gap between MLLs and non-MLLs decreased from about 10% the previous year to only 1%. Although these results are not from a large sample size, and probably not statistically significant, they were certainly significant for those individual students.

What I do know with certainty is that no student is going to learn in my class unless I have a relationship with them. Jocelyn would not have learned to read if she didn't trust me. Marina would not have shared with the whole class if she didn't know how much I believe in her. Andres would not have changed his outcomes in the classroom if he didn't know how much we cared about him. All students have challenges that they bring with them into my classroom, and students who are learning multiple languages usually have previous experiences that make it even more difficult. I will continue to collect data and try to refine my instruction, but forming relationships will always be the heart of my teaching.

A few months ago, Corrie asked Gray and me to run a professional development session for our staff around language practice and supports in our classrooms. We were both a little hesitant because we feel like novices in this work; all we did, we thought, was implement the resources she had given us. But by sharing why we feel language development is important to teaching content and describing how we made it work in our science classes, our colleagues were able to see the potential benefits of making small adjustments to their plans.

Although some days I feel like an imposter confronted by an insurmountable challenge, overall I feel like we are learning how to use language as a tool for making connections, developing content knowledge, and building relationships.

Citation

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