How Clean Is My Water?

A Culturally Responsive, Project-Based Interdisciplinary Summer Camp

Alma D. Stevenson and Shelli L. Casler-Failing

During recent decades, educational reform in the U.S. has favored standards-driven curricula with the purpose of improving education. However, national assessments have not demonstrated significant improvements in educational outcomes, especially among economically disadvantaged and minoritized populations (Hussar & Bailey, 2017).

To mitigate these outcomes, youth-serving organizations provide children from these populations with out-of-school time programs to enhance their academic and social skills (see Hirsch, 2011; Springer & Diffily, 2012). Many such organizations have focused on learning opportunities in STEM to support "youth in their intellectual, social, and emotional development" (National Research Council, 2015, p. 11).

As professors who believe in partnering with nonprofit organizations that offer quality afterschool programs, and in keeping with our university's commitment to community outreach, we contacted the directors of our local Boys & Girls Club to discuss how we could collaborate to meet their academic goals. We wanted both to cultivate connections with the club and to develop opportunities to provide

ALMA D. STEVENSON, PhD, is a professor of literacy at Georgia Southern University. Her research explores home languages and cultures to support positive identity formation and sociocultural and critical approaches to literacy to construct culturally responsive and sustaining curricula.

SHELLI L. CASLER-FAILING, PhD, is an associate professor of middle grades and secondary mathematics education at Georgia Southern University. Her research focuses on mathematics teacher education and the integration of robotics technology in mathematics curricula.

afterschool instruction that embodied culturally responsive, project-based teaching. After listening to the directors' views of the club's needs, we decided to design and implement a one-week summer science camp for students entering grades 4–7. We created an instructional unit that integrated literacy and mathematics into a science unit focused on water quality and related environmental issues; we also planned to explore student outcomes. The interdisciplinary project-based instructional unit we designed focused on culturally responsive practices. For example, the readings included individuals from diverse backgrounds, the water samples used in lab experiments were gathered from students' neighborhoods, and discussions about water preservation helped students empathize with the struggles of other young people around the world. Through these practices, students developed awareness of environmental issues and increased their understanding and use of scientific vocabulary related to water quality.

Framing the Program

Minoritized populations are underrepresented in STEM fields (National Science Foundation, 2017). The National Research Council (2012) has framed science education as a cultural endeavor in which interaction and collaboration are highly regarded. This approach favors inclusive instructional strategies and curricula that focus on students' sociocultural and experiential backgrounds (Gay, 2018; Ladson-Billings, 2014). In our culturally responsive, project-based interdisciplinary unit, students investigated real-world questions relevant to their community. We used pedagogical approaches grounded in social constructivism, culturally responsive pedagogy, project-based learning, critical literacy, and multimodality.

Based on Vygotskian (1978) social constructivism, in which learning is seen as a social process, we enabled students to learn through interaction and to use language to enhance their academic cognition. Students had multiple opportunities to work collaboratively during science labs and paired projects.

A culturally responsive instructional approach that placed their cultures and experiences at the center of the curriculum (Gay, 2018) gave students equitable opportunities to learn. This pedagogical approach followed Ladson-Billings' (1995) tenets for culturally relevant instruction: focusing on the students' academic success while preserving their culture and developing their critical consciousness. The project placed students "at the center of the learning orbit and turn[ed] their personal interests and strengths into opportunities for academic success," following the principles of culturally responsive teaching (Gay, 2018, p. 61).

Culturally responsive teaching is aligned with project-based learning, which "is sensitive to the varied needs of diverse students with respect to culture, race, and gender" (Krajcik & Czerniak, 2014, p. 5). Project-based learning promotes a culture of belonging and a sense of identity when students engage in common activities that seek responses to a mutual problem (Penuel et al., 1999). The approach incorporated small-group interactions, collaborative learning, interesting tasks, group discussions, and daily reflections. The multidimensional curriculum incorporated high but obtainable expectations, which students achieved by using their experiences and cultural resources to advance their knowledge and skills, following Gay's (2018) principles.

Culturally responsive pedagogy is interconnected with critical literacy based on Freire's (1970/2000) perspective of literacy for empowerment. Pedagogical approaches based on critical literacy promote students' critical thinking skills, develop their awareness of their socioeconomic context, enable them to question relations of power or social inequality, and support them in becoming agents of social change (Freire, 1970/2000). The students in our summer camp participated in activities that challenged their literacy and critical thinking skills in a nonthreatening way. For example, they were not critiqued on inaccuracies but instead were praised for their contributions and were encouraged through purposeful questioning to write more and think more deeply.

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Because students were at different grade levels and had different cultural backgrounds, we offered them multimodal opportunities to demonstrate their understanding, following the recommendation of

Kress (2010). Students could communicate and make meaning using various modes—speaking, writing, body language, audio recordings, and visual images or recordings—based on their experiential and cultural background, as recommended by Gay (2018) and Ladson-Billings (2014).

Program Context

The culturally responsive, project-based interdisciplinary science camp we designed and implemented at our local Boys & Girls Club focused on testing local surface and groundwater samples and on researching water pollution. Our purpose was to develop students' interest in their environment and to nurture positive attitudes toward science learning. The unit's guiding research question was, "How does the water quality compare in different parts of town?" That question had two sub-questions: "How does surface water quality differ in various communities within our town?" and "How does tap/groundwater from different suppliers in our town compare?"

The program was conducted four hours a day for five days during one week in summer 2019. The curriculum included culturally relevant picture books and a graphic novel about water, science lab experiments on local surface and groundwater samples, math activities based on the findings from the labs, and whole-group discussions. Various types of journal writing, including freewriting and framed paragraphs, encouraged students to reflect on their learning and practice new vocabulary. Students worked collaboratively to research water quality, design posters on preventing water pollution, and create bar graphs to display the results of their lab tests. At the end of the unit, student pairs created and videotaped a newscast reporting on one of the local water sources to demonstrate their learning and apply their new vocabulary.

We made the project culturally relevant by applying the content to places and situations with which the students were familiar. They all knew the locations of the ponds and creek that supplied the surface water samples. They learned that at least three different entities supply tap water in their town. Furthermore, relevant readings offered our diverse students opportunities to see themselves represented in the texts and learn about other people's cultures and lives (Bishop, 1990). Students also engaged in daily discussions in which they expressed their opinions and developed their critical literacy skills and agency as citizens concerned about water quality. See the box on this page for a list of culturally responsive practices embedded in the week-long instructional unit.

Culturally Responsive Practices in the Summer Camp

To connect program content with students' interests and cultures, we:

- Identified students' strengths and cultural backgrounds
- Set high expectations with challenging but attainable activities
- Reviewed material from previous days and previewed each day's agenda
- Used multimodal instructional practices to make concepts accessible to all students
- Used writing and drawing prompts based on personal experiences and prior knowledge; focused on content rather than execution
- Selected readings that reflected children's experiences and provided avenues into others' experiences
- Asked purposeful questions to connect the readings and lesson concepts to personal experiences
- Provided scaffolding and opportunities for student collaboration
- Cultivated students' awareness of their surroundings and resources as a way to promote critical thinking
- Connected readings and discussion topics to students' personal experiences and to issues affecting them and their communities
- Designed lab experiments around water samples from students' own neighborhoods
- Developed students' self-awareness and motivation to become agents of change
- Facilitated a culminating task in which students applied their personal experiences and expressed their opinions and concerns

Participants

This study was conducted in a rural southeastern U.S. town at a local Boys & Girls Club. The ten student participants in the weeklong summer camp program were rising fourth to seventh graders, ages 8 to 14. Six students, four male and two female, were African American; four students, all male, were Caucasian. All attended schools in the same public school district. The club unit director, using convenience sampling, selected the participants from among children who were scheduled to attend the club during the entire week of the camp. All students signed research assent forms, and parents also consented.

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Conducting the Program

As university researchers specializing in literacy and mathematics, we designed and implemented the summer science camp and evaluated its outcomes. Together, we have 16 years of experience as elementary and middle school teachers. We have created and implemented extracurricular programs and summer camps that incorporate culturally responsive literacy pedagogical approaches in science, mathematics, and multicultural literature to advance minoritized students' reading and writing skills. In this section, we describe the program as we implemented it, day by day.

Day 1: Background Knowledge

On Day 1, after introductions, we explained the objectives and content of the unit to the students and outlined the week's activities. To build the students' academic competence, based on their strengths, we had them fill out an anticipation guide and a brief vocabulary pre-test. The anticipation guide asked students to agree or disagree with statements such as "The amount of water on Earth has not changed since before the dinosaurs lived" and "All tap water, regardless of the source, is the same"; they then had to explain their reasoning. This document, together with the vocabulary test, helped us understand what the students knew and needed to learn about water.

Next, we asked students to freewrite about water for three minutes. This activity prompted a discussion about the origins of water, what constitutes drinking water, and sources of water in different parts of town. We introduced the first vocabulary words, *groundwater* (equivalent to *tap water*) and *surface water.* Then a facilitator read aloud to the class *One Well: The Story of Water on Earth* (Strauss & Woods, 2007). This picture book explains the origins of water, the water cycle, and the amount of water needed by living things. It encourages readers to conserve water by showing how everything on Earth is interconnected. The book's illustrations of farmland created a connection with students in this rural town. The next activities made more connections with the book: Students drew maps depicting local water sources and answered questions such as "What surprised you about this book?" and "Why did you visit the body of water that you drew a map of in your journal?"

Then students participated in a brief experiment in which they tasted three samples of drinking water: tap water, purified water, and bottled spring water. They completed a chart to summarize their tasting experiment and wrote a reflection in response to guiding questions. Before the end of the session, we gave the students empty water bottles and asked them to bring a sample of surface water from a location near their home for the next day's activities. This task made the project even more relevant and helped to activate students' curiosity.

Day 2: Pollution and Surface Water Testing

On Day 2, after asking students for their questions from the previous day, we introduced the day's topic, water pollution. We started with vocabulary: *bacteria, contaminants, dissolved oxygen, pH,* and so on. Having made sure students understood the vocabulary, we conducted an interactive read-aloud using *Water, Water, Everywhere! Stop Pollution, Save Our Oceans* (Pfiffikus, 2016). This age-appropriate book presents research-based information about the importance of water on Earth and describes the causes and prevention of pollution. Although the book does not have characters

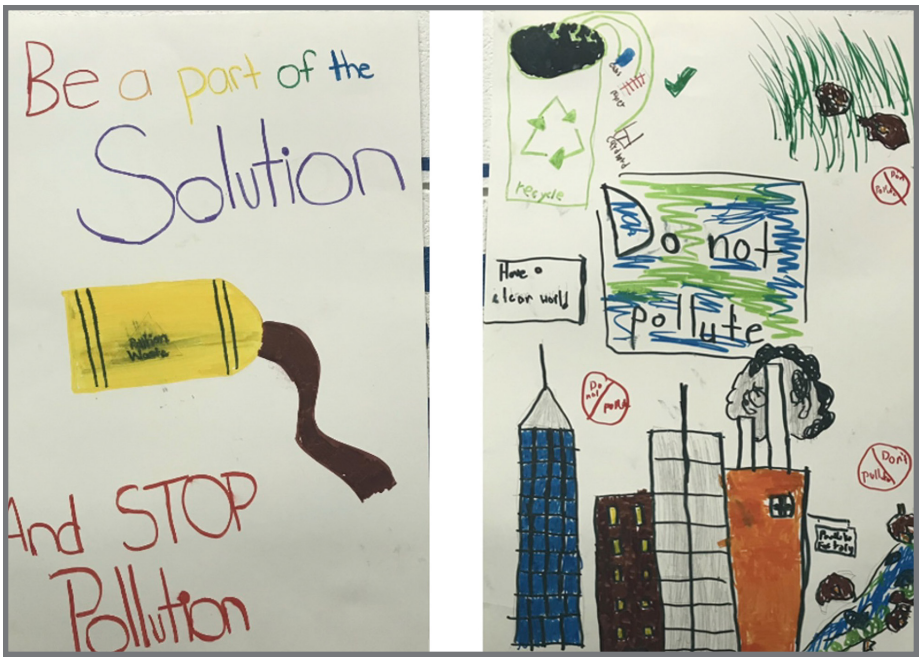

Figure 1. Two Pollution Posters Created by Students

Figure 2. Students Testing the Water During a Lab Experiment

with whom students can connect, the illustrations showed sights they might see around town, such as culverts, waterways, and roadsides littered with garbage. To develop students' critical thinking skills and awareness of the importance of stopping pollution, we asked questions that connected the reading with their personal experiences: "Have you ever noticed any garbage on the ground when you were walking down the street or riding in a car? Is the garbage you saw a form of pollution? How can it affect our water?"

After the reading and discussion, we had students write in their journals for about five minutes in response to guiding questions: "What did you learn about pollution? What are some ways that you can prevent pollution? What will you do on a day-to-day basis to minimize how much you pollute?" Then students worked in pairs to design a poster about pollution; two sample posters are in Figure 1. These activities helped students engage with new vocabulary before applying it in the day's lab, in which they began to test the surface water samples they had collected; see Figure 2. Because the students collected the water samples themselves from their own communities, the activity had relevance and purpose. The day ended with a brief group recap.

Day 3: Water Testing and Internet Research

After answering students' questions from the previous day, we introduced the Day 3 focus, researching surface and tap water. Students started the day by continuing the lab activity, testing the surface water samples they had brought from five different locations in town. Once all samples were tested, we divided the students into five pairs to generate bar graphs of the lab results. Each pair graphed the results of one test—turbidity, dissolved oxygen, phosphates, pH, or nitrates. Students read one another's graphs and then, as a whole group, compared the five surface water samples. They identified possible reasons for the dissimilarities among the samples in a conversation that sparked their awareness of the differences in the neighborhoods of their town.

Next was a group reading of the graphic novel *The Surprising World of Bacteria with Max Axiom, Super Scientist* (Timmons et al., 2013). Max Axiom, a Black scientist with superpowers, is committed to making learning science fun and accessible for all children. He presents a positive role model for all students, but especially for students of color. His scientist colleagues represent diverse populations. The students expressed

interest in this graphic novel because it is like a comic book, a genre that appeals to many tweens and teens. The illustrations facilitated students' understanding of the story's content.

We finished the day by pairing students to do internet research, using a list of websites we provided, on one of two topics: our state's surface water or our town's drinking water. Figure 3 shows one student doing this research. After they finished researching and taking notes, students completed a paired writing activity connecting their observations, the lab results, the day's reading, and their own experiences. We encouraged students to use the day's vocabulary words in their explanations.

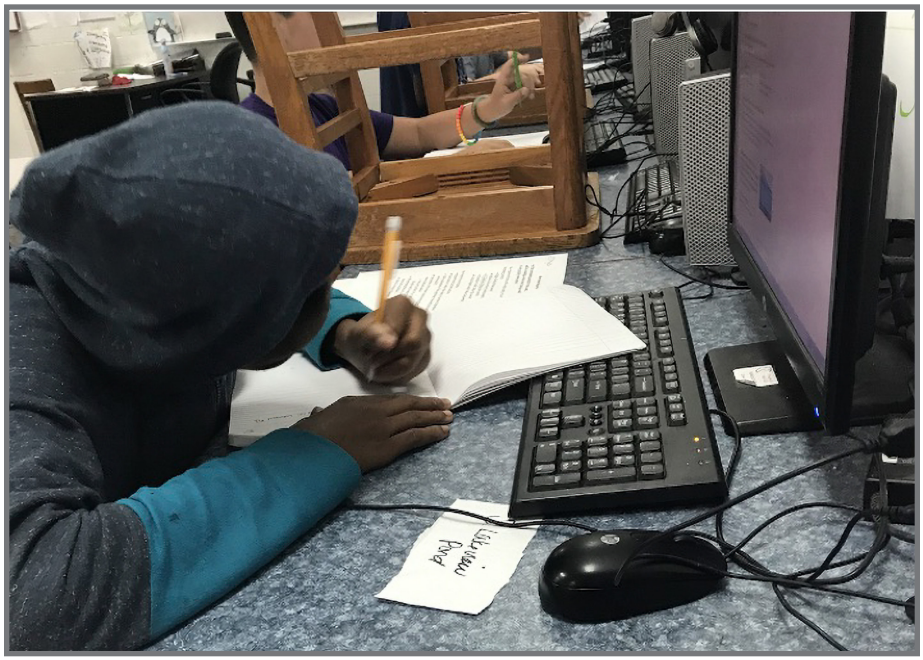

Figure 3. A Student Conducting Internet Research on Local Water Quality

Day 4: Groundwater Testing and Putting it All Together

As we did each day, we began Day 4 by asking for questions from the previous lessons; this practice was one of the ways we supported students to achieve success. Then we introduced students to the day's topic: testing groundwater. Students performed the same lab tests they did on the surface water samples with tap water from three water suppliers in town: the municipal water supply and two wells managed by different water companies. Once again, using water samples from the students' communities created a personal connection to the learning. We made clear to the students that tap water in our town is obtained from groundwater resources.

Once the students finished the lab tests, they completed a data sheet that required the same information as for the surface water samples. They then compared their surface water and tap water results, making informed comparisons as they responded to questions such as "Which sample(s) would you prefer to drink? Explain." Later, they looked at surface and tap water samples under a microscope. Then they wrote in their journals their conclusions about levels of contamination in the surface and tap water samples and which sources would be more likely to contain bacteria and so be less safe to drink. One writing prompt required them to make a personal connection: "What did you learn about today that can affect the water in our community?" Once they finished writing, the students shared their thoughts with the whole group.

Finally, the students watched two videos—a news report about drought in our state and a video about local pollution—and read aloud *The Water Princess* (Verde & Reynolds, 2017). This book, based on the childhood of African model Georgie Badiel, illustrates the hardships she endured as a young girl in order to get fresh water. The videos and book prompted a discussion about water preservation and helped the students develop awareness of and empathy toward the struggles of young people their age from another part of the world. Students verbalized the need to conserve water because water is necessary for all people around the world. We ended the day by talking about the final project. We asked the students to write a comprehensive reflection putting together what they had learned in the four days so they could develop ideas for the newscast they would create the next day.

Day 5: Final Project and Wrap-Up

On the last day of the camp, students completed the anticipation guide they had started on the first day of the camp. We found that some of their answers had changed; for example, more students now disagreed that "All tap water…is the same." We also administered a vocabulary post-test.

Immediately thereafter, we paired students to write scripts for their final project: a video newscast. We provided clear guidelines; for example, the newscasts were to focus on one of the surface or tap water sources, needed to be at least 90 seconds long, and had to feature appearances by both partners. The students took turns going to a room to record their newscasts. As they waited their turn, the remaining students wrote in their journals about their experiences during the camp. After all the students finished their newscasts, we conducted a final group interview in which students shared their thoughts about the program. Then we celebrated with snacks and juice as students shared their news reports.

Program Outcomes

For this qualitative study, we analyzed, classified, and recursively coded the data we collected during the program using a naturalistic, interpretive approach (Denzin & Lincoln, 2005). Data were drawn from the anticipation guides, students' journal writings, student artifacts, and transcribed recordings of the whole-group discussions and final group interview. Data were reviewed independently by each researcher to determine emergent themes. Then correlations across the data were highlighted and further analyzed to expand upon emergent themes.

Quantitative data derived from the pre- and post-vocabulary assessments were analyzed to determine the accuracy of students' responses, which would provide evidence of students' understanding of the scientific definitions of the water quality terms. Three overarching themes emerged from the data: emergent awareness of environmental issues, engagement with program content, and vocabulary and concept learning.

Emergent Awareness of Environmental Issues

The students' interest in their environment, and specifically in water conservation, became evident during our Day 4 discussion of *The Water Princess* (Verde & Reynolds, 2017), in which the protagonist describes the hurdles she faced to obtain water for everyday use in a location in Africa. The students were shocked to learn that the protagonist was allowed to drink only a limited amount of water each day, even when the weather was hot. To help students connect to their own lives and to earlier readings, in keeping with research on culturally responsive learning (Gay, 2018; Ladson-Billings, 2014), we asked about the weather in our community. Thinking of the difficulties the Water Princess faced to obtain safe, clean drinking water, a student asked, "They boiled the water?" Students responded, "Yes, because she had to drink it." This conversation led to a discussion about contamination, pollution, and the water cycle in which students' understanding of water was connected to the Day 1 reading, *One Well: The Story of Water on Earth* (Strauss & Woods, 2007):

> *Facilitator:* We tested all these water samples, right? We found that surface water has contamination; it's polluted, OK? Does the contamination affect somewhere else or just here [in our town]?
> *Student 1:* That affects everywhere.
> *Facilitator:* Why?
> *Student 1:* Because all water comes from the same place.
> *Students, in unison:* The ocean.

One of our goals, guided by Freire's (1970/2000) concept of critical literacy, was to build students' critical awareness of the need to preserve water and stop contamination. Their critical awareness became evident in the discussion of pollution and was further reinforced when they watched the news report about drought in our state.

> *Student 2:* I know this person in our neighborhood who has the best grass … and he has all these sprinklers … and he even has water fertilizer, and that's bad.…
> *Student 3:* You can always take trash out of the water, clean the water.
> *Student 2:* I can tell the guy [with the best lawn] to stop using fertilizer.
> *Student 4:* You can make posters, too, in science, to convince people to stop putting fertilizer on the grass and stop putting trash in the water.
> *Student 5:* Stop pollution.
> *Student 6:* Turn off the faucet when you brush your teeth.

Students also demonstrated their awareness in the posters they created on Day 2. As they developed an interest in their environment, they acted as emergent agents of change (Freire, 1970/2000).

Engagement with Program Content

Throughout the program, students were enthusiastic and engaged during readings, group discussions, and science laboratory activities. In the final group interview, the students shared positive opinions about the week's activities. The collaborative work, which we based on Vygotsky's (1978) model, was particularly popular; the students said that they enjoyed the lab experiments: "Because they showed us a deeper explanation," said one student. Other students said, "I really like the experiments because they gave me knowledge of why the water on Earth is bad," and "I like when we did the experiments because I learned a lot." The students also said they liked creating the posters and graphs. They appeared to appreciate learning by doing. As one student said, "At school we just talk about it, and here we are actually getting into it."

The students expressed surprise at the amount of writing they did during the week. They said they felt proud that they knew what they were writing about. Of the readings, they favored the graphic novel, *The Surprising World of Bacteria with Max Axiom* (Timmons et al., 2013). They said that they would tell their teachers that graphic novels are "fun for kids to read!" as several students expressed.

Vocabulary and Concept Learning

During all activities, we encouraged and supported students to use the new content vocabulary so that they could become comfortable with and deepen their understanding of the terms. Thus, the program's instructional strategies not only developed the students' awareness of their environment, but also increased their scientific vocabulary. The average score on the vocabulary pre-test was 1.4 out of 10 words; on the post-test the average score was 6 words. Only one student mastered all 10 words, but all students scored better on the post-test than on the pre-test. Similarly, their responses to the anticipation guide demonstrated changes in their knowledge about water origins and preservation.

Benefits of Culturally Responsive Project-Based Learning

The findings of this study corroborate the benefits of using culturally responsive, project-based interdisciplinary instructional approaches. These approaches were successful in our summer camp because students were able to interact and explore in a nonthreatening environment while looking to answer questions that were relevant to their lives and communities, as recommended by educational theorists (e.g., Gay, 2018; Ladson-Billings, 2014; Penuel et al., 1999). The instructional approaches we used appear to have been effective in developing students' awareness of their environment and of their responsibilities as citizens in their communities. These approaches were also effective in developing scientific vocabulary.

The instructional approaches we used appear to have been effective in developing students' awareness of their environment and of their responsibilities as citizens in their communities. These approaches were also effective in developing scientific vocabulary.

Furthermore, the students showed enthusiasm when reflecting on their experiences during the final group interview. When asked what they liked best about the week, students' responses included almost all the activities, particularly the experiments, posters, graphs, journal writing, and graphic novel. In other words, students enjoyed the hands-on aspect of this camp. One noted that, in school, students "normally read books and don't do much, like with microscopes and hands-on stuff—and this is really fun."

Creating opportunities for students to collaborate in meaningful, real-world activities through project-based learning that incorporates culturally responsive pedagogy is crucial to the development of a deep understanding of concepts. Such approaches make learning relevant for diverse student populations. When the students were asked to describe the camp in three words, they used such words as *unique, extraordinary, awesome, fun, exciting, educational,* and *adventurous*. Ideally, students should use these adjectives to describe all their educational experiences. Culturally responsive teaching practices should be embedded in all instructional approaches.

This study highlights the significance of programs offered by nonprofit organizations like the Boys & Girls Clubs and the need to establish partnerships with universities like ours to foster systematic collaboration.

We challenge higher education and PK–12 faculty to connect with local afterschool organizations to find avenues for implementing culturally responsive, project-based interdisciplinary programs to support student learning and develop students as agents of change for their communities.

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References

Bishop, R. S. (1990). Mirrors, windows, and sliding glass doors. *Perspectives: Choosing and Using Books for the Classroom, 6*(3), ix–xi.

Denzin, N. K., & Lincoln, Y. S. (2005). *The Sage handbook of qualitative research* (3rd ed.). Sage.

Freire, P. (1970/2000). *Pedagogy of the oppressed: 30th anniversary edition*. Bloomsbury Publishing.

Gay, G. (2018). *Culturally responsive teaching: Theory, research, and practice* (3rd ed.). Teachers College Press.

Hirsch, B. (2011). Learning and development in after-school programs. *Kappan, 92*(5), 66–69.

Hussar, W. J., & Bailey, T. M. (2017). Projections of education statistics to 2025. NCES 2017-019. National Center for Education Statistics. https://nces.ed.gov/pubs2017/2017019.pdf

Krajcik, J. S., & Czerniak, C. M. (2014). *Teaching science in elementary and middle school: A project-based approach*. Routledge.

Kress, G. (2010). *Multimodality: A social semiotic approach to contemporary communication*. Routledge.

Ladson-Billings, G. (1995). But that's just good teaching! The case for culturally relevant pedagogy. *Theory into Practice, 34*(3), 159–165.

Ladson-Billings, G. (2014). Culturally relevant pedagogy 2.0: aka the remix. *Harvard Educational Review*, *84*(1), 74–84. https://doi.org/10.17763/haer.84.1.p2rj131485484751

National Research Council (2012). *Committee on conceptual framework for the new K–12 science education standards*. National Academies Press.

National Research Council. (2015). *Identifying and supporting productive STEM programs in out-of-school settings*. National Academies Press. https://doi.org/10.17226/21740

National Science Foundation, National Center for Science and Engineering Statistics. (2017). *Women, minorities, and persons with disabilities in science and engineering: 2017*. Special Report NSF 17-310. http://www.nsf.gov/statistics/wmpd/

Penuel, W. R., Korbak, C., Cole, K. A., & Jump, O. (1999, December). Imagination, production, and collaboration in project-based learning using multimedia. *Proceedings of the 1999 Conference on Computer Support for Collaborative Learning,* 55.

Pfiffikus. (2016). *Water, water, everywhere! Stop pollution, save our oceans*. Pfiffikus.

Springer, K., & Diffily, D. (2012). The relationship between intensity and breadth of after-school program participation and academic achievement: Evidence from a short-term longitudinal study. *Journal of Community Psychology, 40*(7), 785–798. https://doi.org/10.1002/jcop.21478

Strauss, R., & Woods, R. (2007). *One well: The story of water on Earth*. Kids Can Press.

Timmons, A., Webb, M., Smith, T., Ward, K., & Biskup, A. (2013). *The surprising world of bacteria with Max Axiom, super scientist*. Capstone Publishers.

Verde, S., & Reynolds, P. (2017). *The water princess*. G.P. Putnam's Sons Books for Young Readers.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.