ARTICLE

Biology Experiences in the Summer: Keeping the Faucet Flowing for All Students

NABT BioClub RECOMMENDATION

JEFFREY J. ROZELLE,
ANN HALEY MACKENZIE

Abstract

In a time when electronic devices dominate students' free time, students often stop learning in the summer and instead focus on sedentary indoor activities, like video games and television programs. Sociologists have documented that, for some students, summers result in little learning and contribute to an achievement gap. To help combat "summer learning loss," teachers should implement a summer biology project to provide students with hands-on, inquiry experiences promoting science learning. Assigning long-term activities to be completed during the summer months compels students to explore the outdoors, the learning-loss flow is slowed, and students are better prepared for the start of the next school term.

Key Words: *Biology education; science education; homework; summer learning loss; disadvantaged students; summer vacation; nature activities.*

> *We can no longer afford an academic calendar designed for when America was a nation of farmers who needed their children at home plowing the land at the end of each day. That calendar may have once made sense, but today it puts us at a competitive disadvantage … Now, I know longer school days and school years are not wildly popular ideas. Not with Malia and Sasha – not in my family, and probably not in yours.*
>
> President Barack Obama, March 10, 2009

A recent TIME magazine cover story lamented the loss of "the romance of summer" – the idea that blissful, adventurous, playful summers are an important component of American childhood. Instead, they report, even if that once was true, summer for many children is now

> a season of boredom, inactivity and isolation. Kids can't go exploring if their neighborhoods aren't safe. It's hard to play without toys or playgrounds or open spaces. And Tom Sawyer wasn't expected to care for his siblings while Aunt Polly worked for minimum wage. (Von Drehle, 2010: p. 37)

Furthermore, summer vacation is an important cause of the United States' lack of international competitiveness in educational achievement against countries whose students spend more days and more hours per day in school. Policymakers like President Obama and Secretary of Education Duncan have sounded the call for longer school days and years as well as a serious rethinking of the academic calendar.

The uglier truth, however, is that the downside of summer vacation is not equally felt by all students. Scholars have documented the phenomenon they call "summer learning loss," in which all students learn while schools are in session, but students of lower socioeconomic status (SES) lose ground to their higher-SES counterparts during the summer months. Entwisle et al. (2001: p. 12) explain it this way:

> We think a "faucet theory" makes sense of these seasonal patterns. That is, when school was in session, the resource faucet was turned on for all children, and all gained equally; when school was not in session, the school resource faucet was turned off. In summers, poor families could not make up for the resources the school had been providing, and so their children's achievement reached a plateau or even fell back. Middle-class families could make up for the school's resources to a considerable extent so their children's growth continued, though at a slower pace.

The uglier truth, however, is that the downside of summer vacation is not equally felt by all students.

Surprisingly, a substantial body of research (see Cooper et al., 1996, for a thorough review) argues that the majority of the achievement gap between urban and suburban schools is attributable to different achievement levels as students begin kindergarten and to summer learning loss. In other words, when schools are in session, all students learn about the same; summer widens the gap.

But what are teachers or schools to do about this problem? Decisions about whether to expand school days or school years are outside of teachers' domain. And let's face it, most teachers we know are understandably a lot like Malia and Sasha – less than crazy about losing summer vacations, which they use for professional development, long-term planning, and, of course, relaxation and rejuvenation. In this article, we describe

The American Biology Teacher, Vol. 73, No. 8, pages 449–452. ISSN 0002-7685, electronic ISSN 1938-4211.
DOI: 10.1525/abt.2011.73.8.5

our efforts with one urban high school to tackle summer learning loss through hands-on science in the summer. We describe the summer homework we created, our rationale for its design, its implementation, and parent and student reactions to it that suggest it accomplished its purposes.

○ Designing the Assignment

We created a biology summer homework assignment by first recognizing that the students in our school (here called "Howard High") matched the demographic profile of those students most affected by summer learning loss; our students lived within an urban core and close to 70% qualified for federal free or reduced lunch support. Keeping the research on summer learning loss and science education in mind, we had three guiding principles for creating the assignment. First, the assignment should involve students in activities that have been found to correlate with summer learning gains – the use of books and libraries (Entwisle et al., 1997) and visits to zoos, museums, and other cultural institutions (Burkam et al., 2004). Although, to our knowledge, science-specific summer homework had not been tried as an intervention, interventions designed to promote learning activities in the summer have been successful in other subject areas. For example, White and Kim (2008) describe a series of experiments in which children in grades 3–5 were scaffolded in their voluntary reading over the summer. Experimental groups were provided with books, the students were taught to complete assignments about their readings (reported to their teachers using postcards), and their parents received some instructions for how they might read with their students. Students made significant gains in the summer (+1.3 months of learning) in the experimental groups, and this improvement was largest for Black (+3.3 months) and Hispanic (+2.1 months) students. In our summer homework project, we sought to create a similar situation to the experiment described above in that we would have students engage in summer activities while providing them the scaffolding necessary to be able to complete it on their own. Second, the assignment should create learning opportunities that encourage students to explore the natural world in ways they might not if left to their own devices – to get outside, away from TVs, video games, and the Internet. Third, the assignment should engage students in hands-on, inquiry science that captures the intent of the *National Science Education Standards* (National Research Council, 1996).

The assignment employed a menu approach. Part I of the assignment required students to read, summarize, and answer reflection questions about a number of biology articles from popular magazines like *TIME, Discover, Newsweek*, and *Scientific American*. We chose articles that highlight the ways in which biology and biologists are important parts of culture and society. For example, students could read an article that described recent discoveries that lent insight into human ancestry (e.g., "Lucy" or the discovery of fossil "Hobbits") or stories that detailed recent advances in our understanding of human senses. Part II provided 13 different hands-on biology activities that students chose to complete over the summer (see Table 1 for a sample of activities). A minimum number of activities from Part I and Part II were required to earn a C and "pass" the summer homework; students could complete more from each section to earn higher grades. This method gave students a significant amount of choice about how to structure their assignment, while also providing them with the necessary structure they might not have if left on their own for the summer.

We also recognized some clear hurdles we had to overcome, particularly with the hands-on biology portion of the assignment. Students would be outside of our control and unable to ask us questions easily about the assignment; as a consequence, the activities needed to be easy to understand, with simple, short directions, while still being sophisticated enough to be worthwhile. In our case, we limited our directions to three or four short sentences. In addition, because we would not be with our students as they conducted the activity, we would need more concrete evidence of students' work than we might were we next to them in our classroom. Each activity listed one or two pieces of evidence that would be challenging (though not impossible) for a student to fake (e.g., a receipt from the zoo or pictures of a log rotting over 15 days). While we intended that students would begin work on the assignment shortly after the summer began, we also knew that some would be more likely to wait until the last minute, so we included some activities that were longer-term and some that could be done in a shorter time frame.

○ Implementation

In our case, assigning summer homework was a school-wide commitment supported by the administration. Like many urban schools, Howard High faced pressure to raise the achievement scores of its students, and the administration recognized the summer as one place where gains might be made. In schools where administrators might be less supportive, we suggest introducing them to the extensive literature on summer learning loss; most administrators we know care deeply about achievement score gains, and this literature documents how important summer months are to student achievement. Science teachers were initially resistant, particularly because preparing large review packets (as initially suggested) seemed to be drudgery both for teachers and for students. However, the idea of including hands-on science during the summer months excited the science faculty because they viewed it as something students would find more interesting and would thus propel the students to engage readily in their fall science courses. We think this feature – that the activities are interesting and novel – is a key motivator in getting everyone (teachers, students, and parents) on board. The language arts, mathematics, and social studies departments also designed assignments. Language arts and social studies assigned novels and a related essay while math assigned a variety of practice problems. These assignments were used for all students entering 9th and 10th grades in the fall. For incoming 10th graders, assignments were distributed and explained during the last week of school (when they were still 9th graders). Teachers conveyed that all students were receiving the homework and that the assignment would be due on the first day of school. Students signed a release form indicating that they received the homework assignment. All five biology teachers at Howard High used the assignment described here, and over 250 students completed the assignment.

○ Results

We cannot pretend that the assigning of summer homework, even work that incorporated hands-on biology, was universally popular with students. Many students would voice disappointment, again echoing Malia and Sasha that "summers are our time" and that teachers were clearly infringing on something they viewed as sacred. However, after several years of implementation, students came to accept the homework as simply a part of what it meant to be a Howard High student. At orientations for middle school students who might attend Howard High, teachers discussed summer homework as part of conveying a message that high expectations and interesting work were part of what attending Howard entailed.

By the end of the summer, however, many students seemed to regard their projects proudly, particularly those that produced an artifact like most of the activities in Table 1. Students completing some of the "grosser" activities like "Bury it" or "Decaying Food" would compare stories of what they had witnessed, while more artistic activities like "Finding Color in Nature" allowed students to express a more creative side. Many biology teachers began their year with students sharing and comparing their results for each of the activities, whereas others integrated activities into later units. For example, those students who completed the Chicken Bone Reconstruction could contribute to discussion of homologous structures during the unit on evidence for evolution. Some students, of course, chose not to do the homework, and the

Table 1. Sample summer biology experiences.

Directions: Choose from the following list of biology summer homework experiences. You must complete at least one to pass the homework. The more you complete the better your grade. In order to get credit for the assignment, you must follow the directions and submit the evidence that is required.	
1.	**DISCOVER COLOR IN NATURE.**
	Go to any store that sells paint and collect a sample paint strip (or strips) with at least a total of seven paint swatches of various natural colors. For each color, go outdoors to a natural area and find something in nature that is exactly the same color hue. Cut the color swatch from the store out and glue or tape it along with the color from nature to a small piece of white poster board. Try to identify the object. Write an essay or reflection (1 page or less) about what conclusions you can reach about "color in nature" as a result of engaging in this experience. ***Required Evidence: (1) Poster board with seven color swatches and colored objects from nature taped together. (2) Attempted identification of the natural objects. (3) A one-page reflection or essay.***
2.	**OBSERVE A ROTTING LOG FOR A PERIOD OF 14 DAYS.**
	Find a rotting log to observe for a period of at least 14 days. Visit it each day. Make five quantitative (measurements, length, etc.) and qualitative (feels like, looks like, colors) observations and record them in your notebook. Use colored pencils to sketch the log each day or, if you prefer, take a picture of it each day. Finally, record observations about any living creatures (insects, plants, etc.) you see on the log. ***Required Evidence: (1) Pages from notebook with five observations each day, a daily sketch or photograph, and observations about living things around the log. (2) A 250-word summary of what happened and the implications of those changes.***
3.	**BURY IT.**
	Take an athletic sock and fill it with various forms of garbage (soft drink can, banana peel, paper, etc.). Record in a data table some descriptive observations of the things you put in the sock. Some time between June 1 and June 7, go outside and bury it approximately 2 feet deep. On the day before school starts, dig up the sock and examine the objects inside. In the same data table, record your descriptive observations of the objects. Write a 250-word summary of the results and compare the sock to what you think happens in landfills where our trash is taken. ***Required Evidence: (1) A data table with descriptions of trash before and after burying including illustrations or pictures. (2) A 250-word summary of what happened and comparison to landfills.***
4.	**CHICKEN-BONE RECONSTRUCTION.**
	Purchase a whole chicken at a grocery store. Once you've had a wonderful dinner, boil the bones in a large pot with 3 Tablespoons of hydrogen peroxide added to bleach the bones. Separate the bones. Carefully observe the bones, especially noting the appearance of the inside structure of the bone marrow. Now, reconstruct the bird's skeleton using wire, glue, or any other materials you find that work. Compare and contrast the bird's anatomy with your own. How is it similar? How is it different? Write a 250-word essay comparing and contrasting the bird anatomy with mammalian (YOU!) anatomy. ***Required Evidence: (1) Your bird's skeleton (be careful bringing it to school! Maybe you could put it inside a shoebox). (2) An essay comparing and contrasting the bird's anatomy to yours.***
5.	**ANTHILL INVESTIGATION.**
	Locate an anthill. Make some ant food by mixing a spoonful of sugar with a small amount of water. Pour the mix 6 inches away from the anthill. Make observations at the anthill for 1 week for 15 minutes each day. Create a data table where you collect data about the ant behavior. Use these questions to help you observe: What activity do you see? What changes are happening over time? What reactions do you see to the stimulus (sugar)? Do not do anything to harm the anthill or to interfere with it beyond providing the food source. Prepare a 250-word conclusion summarizing your results and discussing what you've learned along with the data tables. ***Required Evidence: (1) Data tables for 1 week, recording your observations. (2) A 250-word conclusion.***
6.	**DECAYING FOODS.**
	Prepare three paper or plastic plates, each with a slice of bread and a piece of cheese. Place one of the plates in the refrigerator, the second plate in a dark, cool area of the house (a closet, for example), and the third plate in a well-lit windowsill. Observe the food every day for 14 days. Keep a notebook of observations. Try to make five different observations or measurements daily. Focus on which of the plates of food are showing signs of decay the most quickly or most slowly. Sketch the plates of food in your notebook daily using colored pencils. At the end of the 14 days, write a 250-word summary of what you have observed. What overall trends did you see in food decay or mold growth? ***Required Evidence: (1) Data notebook for 14 days, including observations and sketches. (2) A 250-word conclusion summarizing what you found.***

7.	**WHAT PROBLEMS DOES SALTING OF ROADS CAUSE? OBSERVE NAILS RUSTING OVER 14 DAYS.**
	Fill four small paper cups with tap water and label then with numbers between 0 and 3. In cup #3, put three tablespoons of salt. In cup #2, put two tablespoons of salt. In cup #1, put one tablespoon of salt. In cup #0, do not put any salt. Put an iron or steel nail into each cup. Each day, for 14 days, make observations about each nail. Use these questions to guide your data collection: What color changes have occurred? How much rust is present? Which nails seem the most rusty? Finally, write a conclusion that summarizes the data that you have found. Focus on these questions: How does salt in the water seem to affect the rustiness of the nails? How might salting roads in the winter cause problems for people? ***Required Evidence: (1) Data log for 14 days. (2) A 250-word conclusion summarizing what you found and discussing the practical implications related to salting roads. (3) Your four nails in small plastic bags. Make sure the nails are labeled with the cup number or the amount of salt added.***
8.	**ENVIRONMENTAL SCIENCE ZOO LAB.**
	An animal's habitat is an environment that provides the food and shelter required for the animal to make its home. Take a trip to the Hillsdale Zoo (or another zoo if you are visiting out-of-town). Make sure you get a receipt. Choose five animals. For each animal, visit the exhibit and observe the habitat created by the zoo and read about the natural habitat. Write a description of the habitat that they live in naturally. What adaptations have the animals made to survive in their environments? Each habitat description should be at least 150 words. ***Required Evidence: (1) A receipt showing zoo admission. (2) Five different 150-word descriptions and illustrations of an animal's habitat. Make sure you discuss how the animal has adapted to its environment.***
9.	**PICTORIAL 2-WEEK NATURE STUDY.**
	Use a digital camera or disposable camera and find a tree, shrub, insect activity, or nearby park. For 2 weeks, take a photo each day of this one thing in nature. Print the photos and create a timeline of changes and observations made during the 2-week period. ***Required Evidence: (1) A series of 14 photos in chronological order. (2) Two-sentence observations about each day. (3) A 250-word reflection about the changes you observed during the 2 weeks.***
10.	**DESIGN AN INVESTIGATION ABOUT NATURE.**
	Design an investigation around a question you have about something in nature (e.g., What seeds do cardinals prefer?). Determine a method to investigate your question. Collect data (both numerical and observational). Prepare your results with at least two graphs or charts. Write a conclusion about your investigation (must be at least 250-words). ***Required Evidence: (1) A lab report with the hypothesis, methods, results (including at least two graphs or charts) and a 250-word conclusion that includes questions for further research.***

school adopted policies that required students to complete the work in the cafeteria, or an acceptable substitute, before returning to class.

Parents were also quite receptive to the biology homework. Parents often told us how they appreciated that the assignment got students out of the house and away from more electronic pursuits. One parent told us that he appreciated the assignments because "they remind [him] of the kinds of things that [he] used to do as a kid, but that kids these days don't seem to do anymore" – exploring anthills, rummaging around in the woods, and interacting with nature. Another parent described fondly her experience working with her daughter to reassemble a cooked chicken's skeleton – her daughter's experience became a family puzzle that both mother and daughter seemed to enjoy, even if they couldn't figure out exactly how the wings needed to be reattached.

These stories of success encouraged the faculty of Howard High to make these hands-on biology experiences a consistent part of their work. The assignment described here went through several iterations but was used in some form for 4 years by over 1000 students at Howard High. By requiring students to complete science experiences in the summer, Howard High attempts to keep the faucet on by requiring, even coercing, students to avail themselves of the kinds of experiences that have been shown to promote learning during the summer months and, in doing so, reduce the effects of summer learning loss.

References

Burkam, D.T., Ready, D.D., Lee, V.E. & LoGerfo, L.F. (2004). Social-class differences in summer learning between kindergarten and first-grade: model specification and estimation. *Sociology of Education*, 77, 1–31.

Cooper, H., Nye, B., Charlton, K., Lindsay, J. & Greathouse, S. (1996). The effects of summer vacation on achievement test scores: a narrative and meta-analytic review. *Review of Educational Research*, *66*, 227–268.

Entwisle, D.R., Alexander, K.L. & Olson, L.S. (1997). *Children, Schools, and Inequality.* Boulder, CO: Westview Press.

Entwisle, D.R., Alexander, K.L. & Olson, L.S. (2001). Keep the faucet flowing: summer learning and home environment. *American Educator*, *25*(3), 10–15, 47.

National Research Council. (1996). *National Science Education Standards.* Washington, D.C.: National Academy Press.

Von Drehle, D. (2010). The case against summer vacation. *TIME*, 2 August, 36–42.

White, T.G. & Kim, J.S. (2008). Teacher and parent scaffolding of voluntary summer reading. *Reading Teacher*, *62*(2), 116–125.

JEFFREY J. ROZELLE is Assistant Professor of Science Education at Syracuse University, 105 Heroy Geology Lab, Syracuse, NY 13244; e-mail: jrozelle@syr.edu. ANN HALEY MACKENZIE is Associate Professor of Teacher Education at Miami University, 01-D McGuffey Hall, Oxford, OH 45056; e-mail: mackenah@muohio.edu.