# MARINE MYSTERY ORGANISMS

## LEARNING MARINE ECOLOGY WITH WHALES, NOT FLASHCARDS

By Rebecca Freeman


My college introductory oceanography students—mostly non-science majors—think scientists sit around making up new terms. Despite my teasing warnings that I want to ban flashcards (and online versions such as Quizlet) from my classroom, my students enthusiastically embrace the cards as a study method for learning all those new words. And indeed, we must learn the definitions of words before we can use them. But memorizing definitions is a lowest-level activity in Bloom's influential taxonomy of learning (Bloom et al., 1956), updated by Anderson et al. (2001). My students don't aspire to be scientists, but I aspire for them to learn at a higher level. I don't just want "remembering," I want "comprehending," "applying," and maybe even a touch of "analyzing." I want them to practice as they learn, a point emphasized over and over again in my class.

Despite teaching a large class in an auditorium-style classroom with no lab facilities, I also want my students to "actively learn," a teaching style that leads to better learning outcomes (e.g., Freeman et al., 2013). I want them to think of science as something you do, not something you learn. Plus, it's more fun for everyone when I don't just drone on.

Many of my students take introductory oceanography because they have watched oceanography documentaries and were mesmerized by marine life. They expect "charismatic megafauna" to be regularly featured in class. I expect they want Sir David Attenborough, rather than a soft-spoken Southerner, as well. Unfortunately, mine is a physical oceanography class, not a marine biology class, and when we do cover marine biology, we are more focused on the interactions between life, the ocean, and the atmosphere than we are on learning to identify different kinds of whales. I warn them about this on the first day of class, but when I first started teaching this class, my teaching evaluations were mostly filled with complaints about the lack of whales in my class. My whale-free oceanography class became something of a joke among my colleagues.

By the time we've covered ocean physiography, plate tectonics, seafloor sediments, tides, waves, ocean water chemistry, and coastal landforms, the students are more than ready for some marine ecology, preferably with whales. "Phytoplankton are possibly the most important organisms on Earth," I say as they sigh and wish their professor seemed more interested in dolphins. Learning about marine ecology is term-heavy. What is the difference between phytoplankton and zooplankton? Plankton versus nekton versus benthos? Autotrophy versus heterotrophy? Chemoautotrophy versus photoautotrophy? I imagine them reaching for their flashcards, matching words and definitions, ever more disappointed in the course's subject matter. I've made a video that tries to explain these terms in as interesting a way as possible (available as online supplementary materials along with a PowerPoint), but I'm still introducing a lot of new terms for my students to learn.

They want dolphins, and I want to talk about plankton. They want to memorize definitions, and I want higher learning. Can we meet in the middle? Can I capitalize on the many hours of oceanography documentaries they may have watched? Well, let's play a game of "Marine Mystery Organisms" (worksheet and PowerPoint available in the online supplementary materials). I give the students a description of an organism: *This organism is 4 or*

*5 meters in length and swims around the Arctic Ocean. One of its teeth is elongated into an odd tusk that makes it look like a swimming unicorn. It does not use its tusk in eating however, as it preys on fish by getting close to them, then vigorously sucking them into its mouth.* I also give them a list of words we've learned:

» pelagic
» benthic
» prokaryote
» eukaryote
» autotroph
» heterotroph
» photoautotroph
» chemoautotroph
» phytoplankton
» zooplankton
» bacterioplankton
» nekton
» benthos

Which words apply? I want them to apply their knowledge, but for them the fun is in figuring out what the organism is. The students huddle together with their cell phones to try to figure this out, and barely notice that they are learning what these terms mean on a much deeper level than the flashcard method of study allows. As they discuss the identity of the mystery organisms among themselves, I hear them using the words that we are trying to learn in their arguments.

It doesn't take long for the students to figure out that this first "mystery organism" is a narwhal. Students in my previous semesters of this class alerted me to the viral earworm video "Narwhal, Narwhal Swimming in the Ocean," and I play a bit of it now for a moment of levity. It's not just a narwhal, though. It's an excellent example of a pelagic eukaryotic heterotrophic member of the nekton.

We move on to other organisms. I try to mix the charismatic (Seahorses! Sharks! Brittle stars!) with the less well known (usually my personal favorites) to cover all the terms. Although everyone loves a narwhal, the students throw themselves into trying to identify these less-familiar organisms. As often as possible I attempt to use a video as a "reveal." Why not watch a narwhal "swimming in the ocean, causing a commotion, because they are so awesome"? Of course, my video footage of a stromatolite is considerably less exciting, but the students indulge me as I explain how awesome cyanobacteria are, also.

And on the exam, no surprise! My multiple-choice questions do not ask the students to regurgitate definitions but ask them to apply terms to a description of an organism. Although identifying the actual organism is not part of the exam, several students sidle up to me on the way out of the classroom after turning in their exam paper. "Was it an orca?"

Many studies have demonstrated the "test-taking effect" on student learning. Testing noticeably enhances learning (review in Roediger and Kapicke, 2006). The act of trying to retrieve and apply information already learned somehow enhances a student's ability to perform on future tests. This effect is even stronger when feedback is given, even if the test is not graded (Butler and Roediger, 2008), and even when the testing is open book (Agarwal et al., 2008). Expecting students to learn material and then be tested on it a single time, for a high-stakes grade, deprives them of the opportunity to really learn the material. Yet, no one enjoys taking an exam. And even though I have emphasized the importance of practice, my students would roll their eyes if I told them what the marine mystery organism exercise in fact is: formative assessment. It is designed to allow them to apply their knowledge and test their comprehension before a high-stakes summative assessment, an upcoming exam. It allows them to identify gaps in their understanding and fill those gaps in a way that seems painless. Putting similar questions on the exam allows the students to see that what we do in class matters, even if disguised as a fun game. Preparing students to take exams that incorporate high-level learning on Bloom's taxonomy improves learning at the lower levels as well (Jensen et al., 2014). While trying to solve the identity of the mystery organism, my students solidified their understanding of the meanings of many terms.

And, at the end of the semester I smile with satisfaction as a student writes on the teacher-course evaluation how much they enjoyed learning about whales. We really learned about marine ecology, but they never noticed.

## SUPPLEMENTARY MATERIALS

The supplementary materials are available online at https://doi.org/10.5670/oceanog.2021.304 and include:

» Instructor Guide
» Lesson in PPT
» Lesson Video
» Sample Worksheet
» Answer Key for Sample Worksheet
» Exercise and Answer Reveal in PPT
» IMS QTI file

## REFERENCES


Agarwal, P.J., J.D. Karpicke, S.H.K. Kang, H.L. Roediger III, and K.B. McDermott. 2008. Examining the testing effect with open- and closed-book tests. *Applied Cognitive Psychology* 22:861–876, https://doi.org/10.1002/acp.1391.

Anderson, L.W., D.R. Krathwohl, P.W. Airasian, K.A. Cruikshank, R.E. Mayer, P.R. Pintrich, J. Raths, and M.C. Wittrock. 2001. *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*. Longman, New York, 336 pp.

Bloom, B.S., M.D. Engelhart, E.J. Furst, W.H. Hill, and D.R. Krathwohl. 1956. *Taxonomy of Educational Objectives: The Classification of Educational Goals: Handbook 1. Cognitive Domain*. David McKay Company Inc., New York, 216 pp.

Butler, A.C., and H.L. Roediger III. 2008. Feedback enhances the positive effects and reduces the negative effects of multiple-choice testing. *Memory and Cognition* 36(3):604–616, https://doi.org/10.3758/MC.36.3.604.

Freeman, S., S.L. Eddy, M. McDonough, M.K. Smith, N. Okoroafor, H. Jordt, and M.P. Wenderoth. 2013. Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of the Sciences of the United States of America* 11(23):8,410–8,415, https://doi.org/10.1073/pnas.1319030111.

Jensen, J.L., M.A. McDaniel, S.M. Woodward, and T.A. Kummer. 2014. Teaching to the test...or testing to teach: Exams requiring higher order thinking skills encourage greater conceptual understanding. *Educational Psychology Review* 26:307–329, https://doi.org/10.1007/s10648-013-9248-9.

Roediger, H.L., and J.D. Karpicke. 2006. The power of testing memory: Basic research and implications for educational practice. *Perspectives on Psychological Science* 1:181–210, https://doi.org/10.1111/j.1745-6916.2006.00012.x.


## AUTHOR


**Rebecca Freeman** (rebecca.freeman@uky.edu) is Associate Professor, Department of Earth and Environmental Sciences, University of Kentucky, Lexington, KY, USA.