

Biodiversity Show and Tell: An Accessible Activity to Encourage Students to Explore the Tree of Life

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Abstract

An appreciation of organismal diversity is a requirement for understanding evolution and ecology, and can serve as a source of amazement and wonder that inspires students to enjoy biology. However, biodiversity can be a challenging subject to teach: it often turns into a procession of facts to memorize and a disorienting list of Latin names. To help engage students in this topic, we developed an activity in which each student contributes to a class “biodiversity tour” of strange and intriguing species. Students in our large-enrollment introductory biology course use the Internet to find a species that interests them and that they think will interest their peers. They research their species and complete a worksheet to report their findings. Then they meet in discussion sections of ~32 students (in person or online) where each student gives a brief presentation about their species using a slide they have prepared, producing a lively, crowd-sourced, rapid-fire nature documentary. The performance for their peers motivates students to find the strangest species possible. Students overwhelmingly reported that this activity taught them something new about life on Earth and increased their interest in our planet’s species. Many students also reported that this activity caused them to talk to someone about biology outside of the class and increased their personal connection to the natural world, suggesting that it helped them see the relevance of biology to their everyday lives. This simple activity can enrich an introductory biology course of almost any size.

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Author Contributions: ¹Taught the class, conceived the activity, collected and analyzed the data. ²Wrote the first draft of the worksheet and collaborated on refining it; taught the activity in 5 discussion sections and provided insights and feedback.

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Supporting Materials: Supporting Files S1. Biodiversity Show and Tell – Sample Google Slides Presentation; S2. Biodiversity Show and Tell – Instructions for Students; S3. Biodiversity Show and Tell – Worksheet; S4. Biodiversity Show and Tell – Example Student Worksheet; S5. Biodiversity Show and Tell – Instructions for Discussion Leaders; and S6. Biodiversity Show and Tell – Optional Worksheet Supplement.

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Learning Goals

Students will:

- gain a greater appreciation of, and interest in, the diversity of species.
- think of biology as a source of fun discoveries that they can explore and discuss outside of school.
- broaden their knowledge of organismal diversity through exposure to memorable examples of Earth’s species.
- develop a stronger personal connection with biology.
- practice communicating scientific information.
- know essential facts about the ecology and natural history of a species that interests them.
- know how humans affect, and are affected by, a species that interest them.¹
- connect biology to their lives outside of the classroom.

¹This learning goal aligns with the “ability to understand the relationship between science and society” core competency of Vision and Change (1).

Learning Objectives

Students will be able to:

- describe the ecology and natural history of their chosen species.
- describe human effects on their species and its habitat.
- share interesting facts about a wide variety of species with friends and family outside the class.
- stay engaged during readings and whole-class lectures on the topic of organismal diversity.

INTRODUCTION

Many introductory biology courses at the college and high school level include a unit on organismal diversity: a survey of the characteristics of major taxonomic groups of organisms. This is one of the most challenging topics to teach because it often becomes a forced march through facts and nomenclature that students must memorize. It can cause students to disengage from the subject and potentially from the class itself.

There is little literature on more engaging ways to teach biodiversity at the undergraduate level. However, the literature that does exist reveals a consensus: to improve the teaching of biodiversity, we must teach it in an evolutionary/phylogenetic context (2-7) and include natural history (8-12) and/or living specimens (13-15). In addition, we suggest another requirement for teaching the subject well, which has received less attention: instructors need ways to make learning about biodiversity fun. When we can engage students' interest and build their personal connection to a topic, research shows that students become more motivated to learn and perform better in that topic (16-18). In principle, this should be easy; widespread public interest in nature documentaries illustrates the innate appeal of the subject. However, in the more rigorous context of a classroom, many instructors feel compelled to guide students through descriptions of the major taxa, which may feel tedious and remote from the students' lives and interests. In our course, we use a simple activity called Biodiversity Show and Tell to awaken students to the fun and fascination of Earth's biodiversity and invite them to explore the natural history and ecology of species that interest them personally. The activity, which works online or in person, complements our more formal, phylogenetics-based approach to teaching biodiversity in the lecture part of the class. In this article, we describe the activity, which helps spark students' interest in the diverse array of species that they read about in their textbooks and encounter in lecture.

Note: the word "biodiversity" has more than one meaning among biologists. It can refer to a quantitative measure that reflects the number of species and their population sizes in a particular habitat. Alternatively, "biodiversity" can simply indicate the wide array of species that inhabit our planet. In this article, we use the word in the latter sense.

Intended Audience

The intended audience is students in an introductory biology class that covers ecology, evolution, and/or organismal biology at the college or high school level. We use this lesson in a class of up to 400 students at a large research university, and there is no practical limit on the class size for the lesson. However, the lesson requires that students also meet (in person or online) in smaller discussion sections where the presentations take place. We have found that 32 student presentations fit well into one 50-minute discussion section period as long as the discussion leader (in our class, usually an undergraduate instructional assistant) is vigilant about timekeeping. Our class is a mix of biology majors and non-majors and the lesson works well for both groups.

Required Learning Time

The students need 1-2 hours at home to research and complete the worksheet and make the slide. The class presentations take place within one 50-minute discussion section.

Prerequisite Student Knowledge

Knowledge: Students need a basic familiarity with the tree of life so they can correctly place their organism on it for the worksheet. Other than that, the lesson does not require prerequisite knowledge about biodiversity. This is convenient for our course structure, in which I (Stockwell) teach biodiversity in the main class throughout the week while student discussion sections meet separately on different days.

Skills: Students need to be able to browse the Internet and make a slide in the Google Slides presentation that the instructor creates. We have not found these to be obstacles for our students.

Prerequisite Teacher Knowledge

The discussion sections are led by Instructional Assistants (IAs), most of whom are undergraduates. The IAs do not need specialized knowledge or skills other than familiarity with Google Slides, which has not been an obstacle in our experience. IAs who are teaching in person (not online) need a way to project the slides from their laptops, so they are in projector-equipped classrooms and I (Stockwell) make sure they have any needed video adapters at the beginning of the course. If projectors were not available, students could view the class slide presentation on their own laptop, tablet, or phone, sharing with other students as needed. IAs who are teaching online need to know how to host a videoconference and share the slides from their screens.

SCIENTIFIC TEACHING THEMES

Active Learning

The lesson has three components. Each student 1) does Internet research to choose a species, learn about it, and complete a written worksheet; 2) makes a simple slide depicting their species; and 3) gives a short oral presentation about the species to their peers. The first two components happen before class and the third takes place in the discussion section. All three components are active and student-driven. Since each student chooses their species, students have ownership of the project, and many students take the opportunity to follow their personal interests. When students feel a sense of ownership of their project, they tend to be more excited and interested in the topic (19).

Assessment

The primary goal of this activity is to increase students' engagement in the topic of biodiversity and their appreciation of the variety of species on our planet. In keeping with this goal, IAs assess students on completion rather than correctness for the slide and the oral presentation. The IAs also grade the worksheet, giving credit for answers that look credible and are consistent with the IAs' knowledge of biology, since the IAs are not experts on all the different species students choose. (If you wish to be more rigorous, you could institute a peer-review system where students fact-check each other's worksheets.) The worksheet asks students to locate their species on a phylogenetic tree and IAs grade this question on correctness. The knowledge that other students will be watching their presentations provides incentive for students to put extra effort into finding an intriguing species and discovering fun facts about it that will interest their classmates.

In addition, I (Stockwell) used iClicker questions in the whole-class lecture to assess students' experience of the activity and

self-reported progress toward the activity's learning goals (see Figures 1-3).

Inclusive Teaching

After completing their research, worksheets, and slides independently, students come together for a 50-minute discussion section to share the highlights of their species. This discussion is one of the most inclusive moments in the entire course because it brings together the perspectives of over 30 students instead of the perspective of one instructor. Many students choose to share species that interest them personally, so the presentations offer an opportunity for self-expression.

In our experience, the activity appears to foster a sense of community among the students as they learn about each other's interests and have fun together. However, giving the presentation can be intimidating for some students, especially those with anxiety or for whom English is a second language. For that reason, we structured the activity to support those students. When I (Stockwell) give the IAs directions on how to run the in-person version of the discussion section, I emphasize that they should let students present while sitting at their desks if they prefer. Students also have their worksheets in front of them and can read from them if they feel nervous about speaking spontaneously. The IA is in charge of projecting the students' slides so the students do not need to worry about the technology. The presentations are graded only on completion. With all those supports in place, the presentations represent a low-stakes way for students to practice the important skill of speaking in front of a group. If you have students with such severe anxiety that they cannot present even under these circumstances, you could offer them the opportunity to pre-record a presentation, as described in the online version of the activity.

The activity asks students to speak, listen, look, and (in the worksheet) write, thus offering many ways for students to engage their senses and demonstrate what they can do. Students get to hear about biodiversity from over 30 different perspectives, in over 30 different voices, and each student participates equally in the lesson. The result is a multifaceted, inclusive "nature documentary" created collaboratively by and for the students themselves.

LESSON PLAN

Pre-Class Preparation: Instructor

1) Make a Google Slides presentation for each discussion section.

If your institution offers faculty accounts with G Suites for Education, it is simplest to use that account. However, I (Stockwell) have also successfully done this using a private Google Drive account. Make one Google Slides presentation with an example slide (Supporting File S1. Biodiversity Show and Tell – Sample Google Slides Presentation). Then make one copy of the file for each discussion section, editing the title slide to indicate which discussion section it is for, and set the sharing permissions so anyone with the link can edit it.

2) Distribute the links to the slide presentations.

I prefer to post the links to the Google Slides presentations so that each student can only see the link for their own discussion section's presentation. This is not tight security -- nothing prevents

a student in one discussion section from emailing the link to a student in another – but I do it because I want to encourage students to find their own species rather than copying species choices from others.

The instructions below are for Canvas but could easily be adapted for other learning management systems such as Blackboard.

Approach 1: Use Canvas/Google Apps. At our university, Google Apps is integrated into Canvas. In that circumstance, the best approach is to set up a Canvas group for each discussion section (you may well have done this already to simplify grading and other tasks). Then in Canvas, navigate to the Assignments area and do the following for each discussion section (if your browser gives you problems, try Chrome):

- Make a new Canvas assignment. In the text box for the assignment, look for the Google App icon. Use that to link to this discussion section's Google Slides presentation.
- Assign the Canvas assignment to the discussion section it is intended for by selecting the appropriate Course Section in the "Assign to" menu.
- Set the Canvas assignment to "no submission."

Once you have done these steps for all the discussion sections, make a Canvas page that is visible to all students where you link to all of the Canvas assignments you just created. Each student will only see the assignment and link for their own discussion section.

Approach 2 (works for any LMS): Email the students in each discussion section to give them the Google Slides link for their discussion section. I have had good success with this approach as well, though it can take longer than Approach 1 for a large class. If you use the Blackboard LMS, I suggest this approach. Note: I have tried the Wiki feature in the Blackboard LMS and I recommend using Google Slides instead.

Approach 3 (works for any LMS): Decide that you don't care if students copy species choices from other discussion sections. In this case, just post the entire list of Google Slides links in a central location in your LMS.

3) Post the instructions and worksheet for students.

The instructions (see S2. Biodiversity Show and Tell – Instructions for Students) describe the assignment: choose an interesting species, contribute a slide with the species name and photo to the class presentation, and complete the worksheet. The instructions also tell students to check their discussion section's Google Slides presentation to make sure no one else in their discussion section has already chosen their species. We require students to choose unique species in order to increase the taxonomic breadth of the presentations. This requirement also avoids the problem where several students all choose the top hit from a web search on "weird animals;" nobody wants to be the third presenter explaining what an aye-aye is.

The two-page worksheet (see S3. Biodiversity Show and Tell – Worksheet and S4. Biodiversity Show and Tell – Example Student Worksheet) asks students to research the basic natural history and ecology of the species, such as, "What does this species eat? If it does not eat, how does it get energy?" and "Where does this

species live (geography) and what is its natural environment like (habitat)?” It also asks students to find out how humans affect this species and vice versa. The worksheet includes a phylogenetic tree of life and asks the student to circle the location of their chosen species on the tree. Students also report the fun facts about the species that inspired them to choose it.

4) Send instructions to the IAs who run the discussion sections.

The instructions (see S5. Biodiversity Show and Tell – Instructions for Discussion Leaders) explain how to run the discussion section, project the slides, and moderate the student presentations to keep things on schedule.

Discussion Section Activity: Instructional Assistants

During the 50-minute discussion section, which may be held in person or via videoconference, each student gives a one-minute presentation on their chosen species while the IA shows the species slide for the class to see. The IA acts as moderator and timekeeper. Students use their worksheets as notes for their talk. The IA encourages students to focus on the “fun facts” section of the worksheet, which helps limit the presentations to one minute each. For a more detailed guide to how to run the discussion section, see S5. Biodiversity Show and Tell – Instructions for Discussion Leaders.

It encourages students if the IA makes an interested follow-up comment or question after each presentation. If you are concerned about the possibility of students making things up, you could encourage IAs to use their phones to check on particularly outrageous facts or species, but in our experience this has not been a problem.

Students turn in their worksheets before leaving the discussion section.

Assessment

IAs grade the worksheets. Since IAs do not have expertise on all the species, students receive full credit for answers that demonstrate a thoughtful effort to answer the question, are correct as far as the IA can determine based on the IA's knowledge of the relevant taxon/ecology, and cite sources. IAs also give students points for completing the slides and giving the presentations.

Once all students have done the Biodiversity Show and Tell activity, I ask them to self-assess their learning and their experience of the activity via iClicker questions in lecture or via a brief online survey. See the Teaching Discussion section for sample results of this assessment.

TEACHING DISCUSSION

Assessment of the Learning Goals

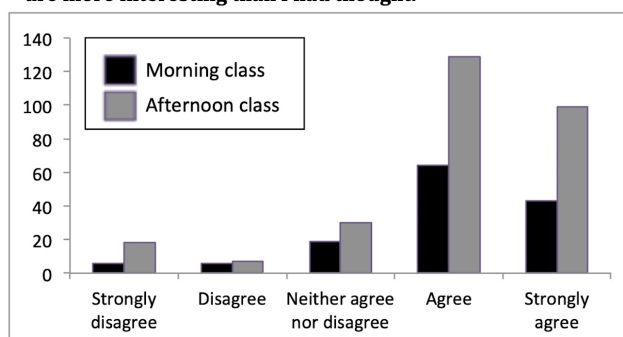
This study received approval from the Institutional Review Board (IRB) at UCSD. All student data were de-identified before analysis.

The primary goals of the Biodiversity Show and Tell activity are to inspire students' appreciation of and interest in biodiversity, help them build a personal connection to biodiversity, and broaden their knowledge of our planet's species. To assess how well the students believe the activity achieves these goals, I

(Stockwell) asked students to respond to iClicker questions in lecture after all the discussion sections had finished the activity. I have used this activity, with minor variations, in the discussion sections of my introductory Organismic and Evolutionary Biology class 13 times since Fall 2016. Figures 1-3 show how students in my two Fall 2019 classes responded to the questions.

The activity clearly achieved the learning goal of increasing students' appreciation of and interest in biodiversity, as measured by students' self-evaluation. Most respondents “agreed” or “strongly agreed” that the activity had made them feel that our planet's species are more interesting than they had thought (78% in the morning class, 81% in the afternoon class). Most respondents also enjoyed doing the activity (“agree” plus “strongly agree” is 71% in each class) (Figure 1). The mood of the discussion sections was lively and fun. Some students used a search engine to find a top ten list (coolest, weirdest, strangest, etc.), as indicated by the number of repeating species across discussion sections. However, the most popular presentations were from students who found a unique angle, such as giving a dramatic presentation or finding species with high cute, gross, or ick factors. The “Donald Trump's hair” moth (the caterpillar stage of *Megalopyge opercularis*) made many appearances. There were a lot of laughs, a couple of groans, and an air of excitement.

“This activity made me feel that our planet's species are more interesting than I had thought.”



“I enjoyed doing this activity.”

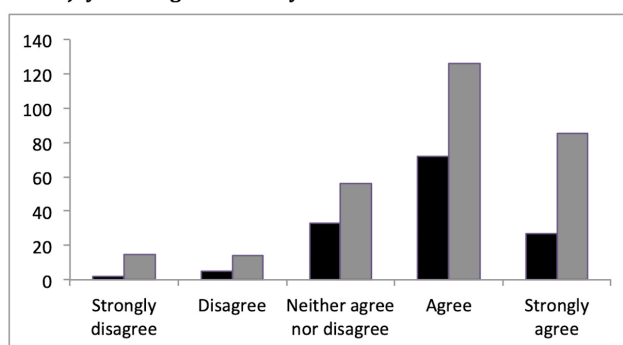
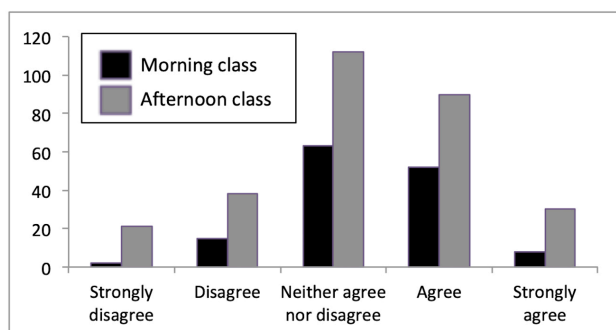


Figure 1. iClicker responses for Fall 2019 classes indicated that the Biodiversity Show and Tell activity achieved the learning goal of *increasing student appreciation of and interest in biodiversity*. Students were told that in these questions, “this activity” included their Internet research, the worksheet, and the discussion section presentations. Morning class: 10 AM MWF lecture, 190 students enrolled, 140 respondents. Afternoon class: 1 PM MWF lecture, 384 students enrolled, 296 respondents. Bar heights represent the number of students who gave each response. Students excluded from this figure did not participate in the iClicker poll or were excluded from the study by the protocols approved by the Institutional Review Board.

Every time we teach this lesson, we hear from IAs that the activity builds a sense of community among their students and is many students' favorite discussion section of the quarter. The fun serves a serious purpose too: capturing students' interest in a topic makes students more likely to learn the material and increases their motivation (16,17). Our results demonstrate that this activity succeeds at getting students interested in biodiversity.

A substantial number of responding students reported that the activity made them feel more of a personal connection to the biodiversity of the natural world ("agree" plus "strongly agree" was 43% for the morning class and 41% for the afternoon class; Figure 2). A class with the capacity to bring students outside to interact with actual living organisms would undoubtedly achieve higher percentages. However, considering that the students' research about their species for the activity was largely confined to the Internet, these were surprisingly high numbers. When I (Davids) taught the discussion sections, students were passionate about their chosen species. Some even shared their personal connection to the characteristics of a species, calling it their "spirit animal." For many students this experience was their first time communicating scientific information. While enthusiasm for the public speaking aspect of the assignment varied, all students wanted their peers to see why their species was interesting. In the in-person discussion sections, student engagement and enthusiasm increased when IAs offered a variety of public speaking options: remaining seated, standing at their desk, or standing at the front of the room. If one student chose to stand at the front of the room, others often followed suit, so I recommend putting a gregarious student's slide early in the Google Slides document.

"I feel more of a personal connection to the biodiversity of the natural world as a result of this activity."



"I talked to somebody else (another student, friend, family, etc.) about biology as a result of this activity when I otherwise probably would not have."

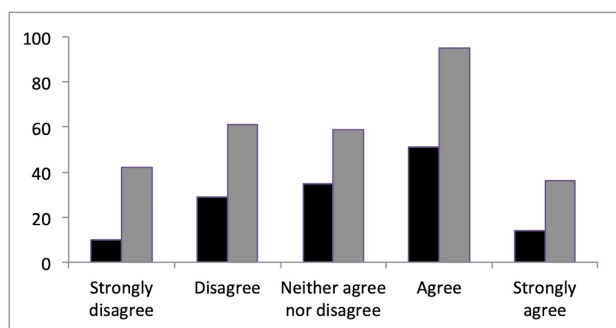


Figure 2. iClicker responses indicated that for many students, the Biodiversity Show and Tell activity achieved the learning goal of *helping students build a personal connection to biodiversity*. Conditions and populations were the same as in Figure 1.

Interestingly, many students took this activity as an opportunity to bring biology outside the classroom and share it with other people in their lives. 47% (morning class) and 45% (afternoon class) of the responding students "agreed" or "strongly agreed" that "I talked to somebody else (another student, friend, family, etc.) about biology as a result of this activity when I otherwise probably would not have" (Figure 2). One of our goals in creating this activity was to encourage students to think of biodiversity as a source of fun discoveries that they can explore and discuss outside of school. We think the "fun facts" section of the worksheet contributes to this impulse to share what they have learned about biology. Some students shared with me (Davids) that they had recruited the help of their friends or roommates to find an interesting or bizarre species. Most of the students were invested in learning and sharing something new.

Our third primary learning goal was broadening students' knowledge of our planet's species. We covered most of the content for the topic of Biodiversity in the lecture and reading of the main part of the course. However, the Biodiversity Show and Tell discussion section activity supplemented the whole-class lecture by introducing students to an array of individual species as they listened to their fellow students' presentations and researched their own species. Students overwhelmingly reported that the activity succeeded in this goal: 87% of the morning class respondents and 84% of the afternoon class "agreed" or "strongly agreed" that they learned something new about the species that live on our planet as a result of this activity (Figure 3).

"I learned something new about the species that live on our planet while doing this activity."

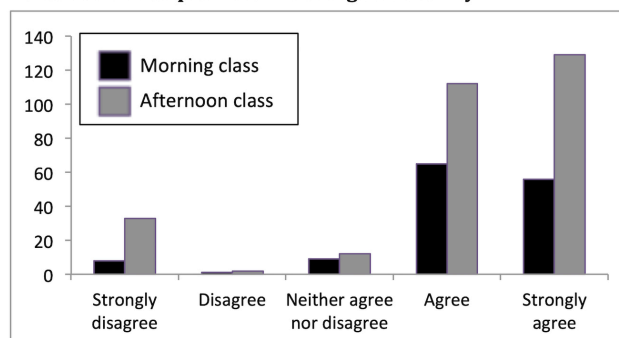


Figure 3. iClicker responses indicated that the Biodiversity Show and Tell activity achieved the learning goal of *broadening students' knowledge of our planet's species*. Conditions and populations were the same as in Figure 1.

We also structured the activity to encourage students to learn about human effects on their species and on its ecosystem. In their worksheets, many students described conservation concerns about their species, indicating that their research helped raise their environmental awareness. Students highlighted how humans had caused a population decline in their species and offered suggestions for how their fellow students could help. While this could be tricky to navigate with some of the more passionate students, many students also shared inspiring personal habit changes that they were going to make. A common example was decreasing their use of single-use plastics.

Some sample answers to the worksheet question, "In what ways do humans affect this species? In what ways does this species affect humans?" follow:

- *Myanmar snub-nosed monkey (Rhinopithecus strykeri)*: These monkeys are hunted by humans for their fur, meat, bones, and brains, which humans use for various purposes, including food and clothing. The monkeys also get caught in bear traps, and human development has threatened their habitats.
- *Irrawaddy dolphin (Orcaella brevirostris)*: Humans affect Irrawaddy dolphins pretty negatively in general. Humans accounted for a lot of their deaths through (destructive) fishing, water polluting, dam development, etc. Irrawaddy dolphins affect humans positively in general. They engage in cooperative fishing with humans, help the fishermen to catch more fishes as well as attract tourists, increasing economic interests.
- *Green Tree Python (Morelia viridis)*: Logging/destruction of habitat. Many are sought after for the pet trade industry. Will bite when threatened, but not venomous so it's okay.

Note: The data presented here were collected in a version of the activity where students voted by secret ballot for the most interesting species and the student who presented it earned a small amount of extra credit. In our experience, this works well, in part because the IAs emphasize that the votes are for the most interesting *species* rather than the most interesting *presentation*. However, because of concerns that this could devolve into a popularity contest that excludes some students or groups of students, we suggest dropping the extra credit and voting when you teach this exercise. We have revised the IA and student instructions included in the Supporting Files to reflect this modification. We do not expect that this small change would significantly affect student responses to the survey questions or their learning gains from the activity.

Student Species Choices

Figure 4 illustrates the species that students chose to investigate in Fall 2019. There was an unsurprising emphasis on vertebrates, especially mammals, but less-familiar organisms were well represented. Tardigrades were surprisingly popular.

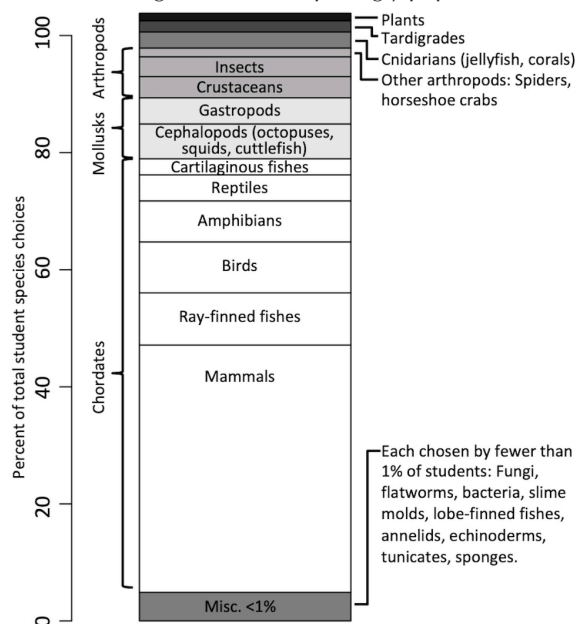


Figure 4. An illustration of the species that 489 students in Fall 2019 selected to research and present, grouped by taxon. Students excluded from this figure did not turn in a slide or were excluded from the study by the protocols approved by the Institutional Review Board.

Variations on the Activity

Online version

In Spring 2020, I converted the activity to an online-only format, which worked well and required only minor tweaks. Discussion sections were held as Zoom videoconferences. The IAs shared their screens to show the slides while students took turns speaking about their organisms. Everything else about the activity was the same, except that students turned in their worksheets online instead of in person. Students who could not attend their discussion section “live” were given the option of recording a 1-2 minute video presentation about their species and submitting it separately. S5. Biodiversity Show and Tell – Instructions for Discussion Leaders has instructions for the online version of the activity.

Adding more rigor

We have deliberately kept this activity lightweight and fun. The substantive parts of the biodiversity topic -- descriptions of fungi, plants, prokaryotes, and the major animal phyla, all presented in a phylogenetic context -- are covered in the reading and lecture of the main class. The primary goal of the Biodiversity Show and Tell activity is to engage students in the topic. The lecture and reading teach students what mollusks are; the Show and Tell activity teaches students why mollusks are cool.

As part of this lightweight approach, we have allowed students to use any Internet source for their information. Some students rely on Wikipedia while others choose to do in-depth research on their species. However, you could make this activity more rigorous by restricting the kinds of sources students are allowed to use. For example, you could require that students find and/or research their species using websites such as these:

- <http://www.iucnredlist.org>
- <http://animaldiversity.org>
- <http://eol.org> (Encyclopedia of Life)
- <http://lifemap.univ-lyon1.fr> (Explore the tree of life phylogenetically; click on taxa to see pictures and descriptions)
- <http://www.birds.cornell.edu>
- <http://amphibiaweb.org>
- <https://www.inaturalist.org/>

Alternately, with some alterations to the worksheet questions, you could structure the activity as a formal search of the scientific literature. To increase the taxonomic diversity of species presented, you could offer extra credit for species outside Animalia or Chordata. If you wish students to learn more about a particular group of species (for example, insects), you could restrict the activity to that group.

For instructors who wish to tie the activity more closely to evolutionary biology learning goals, we have created an optional third page of the worksheet (see S6. Biodiversity Show and Tell – Optional Worksheet Supplement). The third page contains more challenging questions that bring in phylogenetic concepts and ask students to navigate a formal taxonomic hierarchy. These questions assume that students are familiar with phylogenetic concepts such as outgroups and parsimony. The assessment data presented above were collected from classes that did not use the optional third page.

Diversifying the presentations

If you wish, you could modify the activity to showcase the

diversity of the students' interests, as follows. Tell students that they can choose to do a traditional presentation (make a slide and talk about it), but they can earn extra credit by being more creative: doing a dance about their species, painting a picture, writing a poem, building a model, etc. and sharing it with the class. The creative presentations would still be required to communicate the name of the species and the 3 "fun facts" about it that the student found while doing their research. The resulting class would illustrate that science is much more than a PowerPoint presentation and make the lesson more inclusive by highlighting students' individual abilities, interests, and personal connections to their species. Alternatively, to increase the taxonomic diversity of the presentations, you could offer extra credit for selecting species from less well-represented taxa.

The activity could be used in a class of almost any size. We did the student presentations in the discussion sections that accompany a large lecture class, but a small class could do it as a whole-class activity. We have found that 32 student presentations are about the maximum that can fit into a 50-minute class session.

SUPPORTING MATERIALS

- S1. Biodiversity Show and Tell – Sample Google Slides Presentation
- S2. Biodiversity Show and Tell – Instructions for Students
- S3. Biodiversity Show and Tell – Worksheet
- S4. Biodiversity Show and Tell – Example Student Worksheet
- S5. Biodiversity Show and Tell – Instructions for Discussion Leaders (in person and online)
- S6. Biodiversity Show and Tell – Optional Worksheet Supplement

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REFERENCES

1. American Association for the Advancement of Science. 2011. Vision and Change: A Call to Action, Final Report. Washington, DC: AAAS.
2. Smith JJ, Cheruvilil KS. 2009. Using inquiry and tree-thinking to "march through the animal phyla": teaching introductory comparative biology in an evolutionary context. *Evol.: Educ. Outreach* 2(3): 429-44. doi 10.1007/s12052-009-0156-x
3. Staub NL, Pauw PG, Pauw D. 2009. Seeing the forest through the trees: helping students appreciate life's diversity by building the tree of life. *Am. Biol. Teach.* 68: 149-51. doi 10.2307/4451953
4. Young AK, White BT, Skurtu T. 2013. Teaching undergraduate students to draw phylogenetic trees: performance measures and partial successes. *Evol.: Educ. Outreach* 6(1): 16. doi 10.1186/1936-6434-6-16
5. Ballen CJ, Greene HW. 2017. Walking and talking the tree of life: why and how to teach about biodiversity. *PLoS Biol.* 15(3): e2001630. doi 10.1371/journal.pbio.2001630
6. Novick LR, Catley KM. 2017. Teaching tree thinking in an upper level organismal biology course: testing the effectiveness of a multifaceted curriculum. *J. Biol. Educ.* 15(4): 1-13. doi 10.1080/00219266.2017.1285804
7. McCullough EL, Verdeflor L, Weinsztok A, Wiles JR, Dorus S. 2020. Exploratory activities for understanding evolutionary relationships depicted by phylogenetic trees: united but diverse. *Am. Biol. Teach.* 82(5): 333-337. doi 10.1525/abt.2020.82.5.333
8. Zervanos SM, McLaughlin JS. 2003. Teaching biodiversity and evolution through travel course experiences. *Am. Biol. Teach.* 65(9): 683-688. doi 10.1662/0002-7685(2003)065[0683:TBETTC]2.0.CO;2
9. Greene HW. 2005. Organisms in nature as a central focus for biology. *TRENDS Ecol. Evol.* 20(1): 23-27. doi 10.1016/j.tree.2004.11.005
10. McGlynn TP. 2008. Natural history education for students heading into the century of biology. *Am. Biol. Teach.* 70(2), 109-11. doi 10.2307/30163213
11. Fleming MP. 2015. Out of your seat and on your feet! An adaptable course-based research project in plant ecology for advanced students. *CourseSource*. doi 10.24918/cs.2015.6
12. Walsh LL, Giffen CJ, Thompson CW. 2019. Teaching biodiversity with museum specimens in an inquiry-based lab. *CourseSource*. doi 10.24918/cs.2019.45
13. Migabo S, Guinan J. 2006. An investigative look at the biology of invertebrates. *Tested Studies for Laboratory Teaching: Proc. Assoc. Biol. Laboratory Educ.* 28: 227-254.
14. White, BT. 2009. Exploring the diversity of life with the phylogenetic collection lab. *Am. Biol. Teach.* 71(3): 157-161. ddoi 10.2307/27669398
15. Sossa, KG. 2013. The size of living things. *Tested Studies for Laboratory Teaching: Proc. Assoc. Biol. Laboratory Educ.* 34:260-276.
16. Hulleman CS, Harackiewicz JM. 2009. Promoting interest and performance in high school science classes. *Science* 326: 1410-1412. doi 10.1126/science.1177067
17. Harackiewicz JM, Smith JL, Priniski SJ. 2016. Interest matters: the importance of promoting interest in education. *Policy Insights Behav. Brain Sci.* 3(2): 220-227. doi 10.1177/2372732216655542.
18. Ryan RM, Deci EL. 2000. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *Am. Psychologist* 55(1): 68-78. doi 10.1037/110003-066X.55.1.68
19. Hanauer DI, Frederick J, Fotinakes B, Strobel SA. 2012. Linguistic analysis of project ownership for undergraduate research experiences. *CBE Life Sci. Educ.* 11(4): 378-385.

Table 1. Biodiversity Show and Tell lesson timeline.

Activity	Description	Estimated Time
Preparation for Class		
Instructor: Prepare template Google Slides presentations. Tell students and Instructional Assistants what to do.	<ol style="list-style-type: none"> 1. Make a Google Slides presentation for each discussion section. 2. Distribute the link to the appropriate slide presentation to the students in each discussion section. 3. Post the instructions and worksheet for students. 4. Send instructions to the Instructional Assistants who run the discussion sections. 	30-45 minutes to prepare and distribute 10 template slide presentations. 10 minutes to post information and send emails.
Discussion Section		
Instructional Assistant: Moderate student presentations	Moderate 1-minute student presentations while showing the slides students made.	50 minutes