DR MELISSA HUGHES (Orcid ID : 0000-0002-3235-487X)
PROFESSOR SUSAN BERTRAM (Orcid ID : 0000-0002-1822-3208)

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Teaching Animal Behavior Online: A Primer for the Pandemic and Beyond

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Melissa Hughes[1], Susan M. Bertram[2], Anna M. Young[3*], Justin W. Merry[4*], Gita R. Kolluru[5*], Aimee S. Dunlap[6*], Anne Danielson-Francois[7*], and Stacey Weiss[8*]
(*equal co-authors, order decided randomly)

[1] College of Charleston, Charleston, SC, USA; hughesm@cofc.edu
[2] Carleton University, Ottawa, Ontario, Canada; sue.bertram@carleton.ca
[3] Otterbein University, Westerville, OH, USA; ayoung@otterbein.edu
[4] Saint Francis University, Loretto, PA, USA; jmerry@francis.edu
[5] California Polytechnic State University, San Luis Obispo, CA, USA; gkolluru@calpoly.edu
[6] University of Missouri, Saint Louis, Saint Louis, MO, USA; aimee.dunlap@umsl.edu
[7] University of Michigan-Dearborn, Dearborn, MI, USA; danfranc@umich.edu
[8] University of Puget Sound, Tacoma, WA, USA; sweiss@pugetsound.edu

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Abstract:

Behavior courses face numerous challenges when moving to an online environment, as has been made necessary by the COVID-19 pandemic. These challenges occur largely because behavior courses, like most organismal biology courses, often stress experiential learning through laboratories that involve live animals, as well as a lecture component that emphasizes formative assessment, discussion, and critical thinking. Although online behavior courses may be remote, they can still be interactive and social, and designed with inclusive pedagogy. Here we discuss some of the key decisions that instructors should consider, provide recommendations, and point out new opportunities for student learning that stem directly from the move to online instruction. Specific topics include challenges related to generating an inclusive and engaging online learning environment, synchronous versus asynchronous formats, assignments that enhance student learning, testing format and execution, grade schemes, design of laboratory experiences including opportunities for community science, design of synthetic student projects, and workload balance for students and instructors. We designed this primer both for animal behavior instructors who need to quickly transition to online teaching in the midst of a pandemic, and for those facing such transitions in upcoming terms. Much of the manuscript's content should also be of general interest and value to instructors from all areas of organismal biology who are attempting to quickly transition to online teaching.

Keywords:

online pedagogy, inclusivity, experiential learning, active learning, community science, remote laboratories

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1. Introduction

a. Author Background

We are a group of faculty with over 100 years of combined experience teaching animal behavior and behavioral ecology courses at universities in Canada and the United States. Our experience spans public and private institutions, both undergraduate serving and research-intensive with extensive graduate programs. Our behavioral class sizes range from 10 to 200 students, and most of our courses incorporate lab components. Our experience teaching online varies, with two having extensive experience and the rest having only begun teaching in this modality since March 2020, in response to the coronavirus (COVID-19) pandemic. While we intend for this primer to be useful to anyone preparing to teach online behavior courses, because we are all North American instructors, we may have introduced some biases that partially reduce the relevance for those from other continents.

b. Goals

When we started teaching in early 2020, none of us expected our courses would be online within a few months. As instructors of behavior as well as other organismal courses, we saw the challenges of moving these courses online – courses that typically involve discussion, active student engagement, hands-on laboratories with live animals, and other components that can be challenging to replicate in the online environment. Now, many are faced with online instruction for an indefinite period of time. Our goal here is twofold: first, to summarize some of the best practices for pivoting to teaching behavioral courses in the midst of a pandemic, based both on the literature and on our collective experiences; second, to provide a valuable resource for those of you switching to an online modality in the future, whether as a matter of choice or necessitated by the ongoing crisis. As many behavior instructors may have limited experience in online teaching and limited time to read the pedagogical literature, we review some of the basic principles of online course design and implementation. We hope instructors use this primer as a single-source reference guide for redesigning their behavior courses for remote teaching.

Transitioning to pandemic-driven virtual teaching is different from the intentional online course design that has traditionally been used in remote learning (Hodges et al. 2020), and it is important to note that we do not intend for instructors to adopt all of our suggestions, as to do so would be prohibitive for anyone. Instead, we encourage instructors to choose where to focus their efforts based on their desired course outcomes, course size, available time, energy, and resources. Instructors facing an emergency return to remote teaching will necessarily employ different strategies than instructors already planning for continuing with online teaching through multiple terms, and we provide discussion and resources useful for both. We identify key questions to consider early in course planning, and identify priorities, challenges, and opportunities that may arise as a consequence of transitioning to remote teaching.

c. Embrace the Opportunity

We hope instructors will find that much of what they develop for their online courses can be re-purposed or re-imagined for face-to-face classes, leading to lasting modifications that improve content and increase accessibility for students. Reframing this pandemic driven change as an opportunity for instructors to refresh themselves on the latest developments in science pedagogy can improve not only online behavioral courses, but future face-to-face classes as well (Supiano 2020). Some opportunities to consider when teaching behavior online include:

Sharing of knowledge and resources: Online instruction affords an opportunity to collaborate and learn from our peers across institutions. There are several collaborative resources for behavior instructors to share content, ideas and questions (see section 2.a., below). If you use a shared resource, please give credit and notify the content creator so they can build the outreach and teaching portion of their curriculum vitae.

Extending collaborations in teaching and research: This pandemic could be an opportunity for developing innovative, highly distributed Course-based Undergraduate Research Experiences (CUREs). Imagine students collaborating with peers nationally or internationally, all collecting data on the same variables on the same project, and meeting with "labmates" from multiple institutions to discuss the challenges and findings (for example, see squirrel-net.org). Using this approach, it is possible to collect large amounts of behavioral data while giving students authentic research experiences, including collaborations with a diversity of peers and mentors from across the globe. Instructors also benefit by fostering interactions among colleagues who teach similar courses at different institutions.

Incorporate global guest speakers: Several virtual animal behavior conferences featured pre-recorded talks, presenting an opportunity for us to share work and incorporate current research into our courses. An online environment also facilitates seamless integration of synchronous discussion or lectures with guest speakers from any location. We particularly encourage instructors to invite guests to visit their course (synchronous or asynchronous) that represent scientists from different racial and cultural backgrounds, people with disabilities, and scientists whose work has historically been excluded from textbooks.

2. Early Considerations and Recommendations

a. Sources of Support

Our first (and perhaps most important) piece of advice is to seek support, as instructors who have strong support networks are often more successful (e.g., Dohaney et al. 2020). Ask colleagues – especially those with online teaching experience – to provide feedback on course structure, lectures, and assignments. Add them as a student to the online course, so they can provide global feedback (consider reciprocal altruism for this potentially labor-intensive task). Consult with education technologists for help comparing and learning new software options or tracking down required hardware. Provide students with opportunities to give anonymous feedback about what things are working and what things the instructor might want to change, either immediately or in future versions of the course.

Support specifically for behavior courses is also readily available through several online platforms including: *Facebook Group* – Behaviour and Evolution Teaching Exchange that currently hosts 314 instructors across multiple continents; *Slack Workspace* – Behav Evol Teaching (behavevolteaching.slack.com) currently with 114 instructors from multiple continents; *Google Docs* – share behavior course syllabi, tests, exams, labs, assignments, and videos (https://tinyurl.com/behavteach); and where instructors, Ph.D., and Postdoctoral students can sign up to give shareable short lectures on a variety of topics (https://tinyurl.com/behav-lecture). In these informal networks, participants exchange ideas and help bolster each other as challenges arise. It was such an exchange that led to us writing this publication.

b. Modes of Delivery

A fundamental decision that each instructor must make in conjunction with their institution's requirements, and early in the planning process, is how to deliver the course. As definitions of terms can vary, we use the terms as described in Table 1.

Courses may not lie fully within one of the above categories; for example, a course may combine asynchronous elements with synchronous sessions, or labs may be hybrid or fully face-to-face while the rest of the course is online. Here we outline some general course delivery considerations:

These are not the face-to-face classes we are used to: A popular hybrid model is to provide recorded lectures and other online content, and then use face-to-face time for discussions or activities. In hybrid courses, we encourage instructors to be strategic in using face-to-face time for activities that engage students and promote active learning. Remember that, as pandemic conditions change, hybrid classes may need to move entirely online with minimal notice.

During face-to-face activities, pandemic safety measures will have pedagogical consequences. Physical distancing requires either fewer students in the space, or the use of larger spaces that may not have been designed for teaching. Instructors and students alike will need to wear masks and as a result speak louder, possibly necessitating the use of microphones even for small classes, or to ensure adequate recording for students unable to attend in person. Masks also limit non-verbal communication, which can be important for conveying subtleties of content and giving critical feedback. Hard-of-hearing students may especially rely on nonverbal cues and thus be disadvantaged by masks; clear face masks have been developed and are being utilized in some institutions. The inability to share physical resources is also a concern, as time must be incorporated into the session for cleaning of equipment, and some equipment will not be able to be used. When a class meets face-to-face, we suggest asking students to bring a web enabled device so that they can simultaneously view and comment on shared documents while remaining physically distanced, or so they can log into Zoom or a similar resource and watch from a distance as instructors or teaching assistants conduct demonstrations of animals or point out behaviors. These events can be recorded for those who cannot attend, and have the added benefit of being able to be reused.

Synchronous seems better - is it? Synchronous online instruction feels more familiar to students and to instructors who are new to remote teaching, because it more closely resembles a traditional classroom. Synchronous teaching has strengths in facilitating social connections and providing opportunities for immediate feedback, especially in smaller sections. On the other hand, synchronous classes can have higher technological and internet access requirements, be harder to access in real time, and be more challenging for students with complicated responsibilities. Recording synchronous sessions is only a partial solution to these equity concerns, as it creates a tiered system in which students who need to rely on recordings have reduced access to interactions and engagement opportunities. Synchronous sessions are also more challenging in large class sections, even when break-out rooms are used; extra care is needed to ensure that participation is not limited to a small subset of students.

Asynchronous also has pros and cons: Course components that are primarily unidirectional (traditional lectures, written assignments) translate easily into an asynchronous format. Pre-recorded lectures generally have higher audio and video quality than synchronous lectures delivered via live streaming, and while students cannot ask questions "in real time" as they can in a synchronous lecture, they can pause and/or rewind mid-lecture as needed. With asynchronous instruction, students have flexibility to work around their schedules. Discussion boards and other media provide opportunities for asynchronous interactions. However, we note that the loss of real-time social connections in a fully asynchronous class can lead to feelings of disconnection and loss of engagement among students (Kebble 2017).

Thus, there is no ideal mode of delivery. Each of us needs to evaluate the costs and benefits of each mode within the context of our classes (including both learning objectives and section size), our students, our personal lives, and our institution. If the class is fully asynchronous, consider prioritizing approaches and assignments that can foster engagement and interaction. If the class is fully synchronous, we encourage instructors to record synchronous sessions and provide alternative options that allow students to engage in the course if they cannot participate simultaneously. Strategically blending synchronous and asynchronous approaches may allow instructors to maximize the benefits while minimizing the costs of both approaches. For example, in large sections, dividing the class into subgroups that attend different synchronous sessions provides more opportunities for all students to benefit.

c. Course Design

An instructor's first foray into an online format can be daunting. When moving a course online, many instructors feel overwhelmed by all of the potential tools and techniques. For others, these same features can be a siren song, leading them headlong into waters they – or their students – may not be entirely prepared to navigate. How do instructors take advantage of online tools without making courses overly complicated, and, even more critically, without losing sight of their learning objectives for the class?

i. Backwards Design

The principles of good teaching are independent of format. To adapt a face-to-face course to an online or hybrid format, we strongly recommend employing backwards design. Whereas "typical" course design often begins with content – for example, "what textbook chapters do I want to cover?" – backwards design (Wiggens & McTighe 2005) starts with the desired outcomes: what do you, the instructor, want your students to learn? Think of this in terms of content knowledge, and also in terms of the skills and metacognition you want to foster. Next, consider how you would like students to be able to demonstrate their learning of each of these, and what activities or assignments might foster that learning. Lastly, determine what content is necessary for the students to complete the activities or assignments.

While we all want our students to learn core behavioral concepts, it is likely that our behavior courses differ in specific desired learning outcomes and content. Consider: How does the course fit into the overall curriculum (e.g., student prerequisites and background knowledge, requirements for subsequent classes)? What is the ideal balance of proximate versus ultimate approaches? Do you want to prioritize the history of the field or current “hot topics”? How important is skills development in modeling, observation techniques, interpreting primary literature, or data analysis? Reviewing learning objectives is a practice in prioritization: based on the instructor’s expertise and experience, what is most important for the students in their class?

When transitioning to online, backwards design helps instructors focus on what content is critical (serving high priority learning outcomes), and therefore what activities and assignments need to be preserved. We strongly encourage instructors to take this opportunity to simplify, rather than trying to pour the entire face-to-face behavior class into an online format. As instructors learn new online tools and techniques, they should evaluate them with the same metric: is this tool or technique necessary to serve the primary learning objectives?

ii. Modular Structure

We strongly recommend incorporating a modular structure, as an online course needs a more regular structure than a face-to-face course. The more asynchronous the course, the more canalized the structure should be. If the course is normally like a novel – chapters of various lengths that flow together – think of the transition to online as a process of serializing it. Here again, the prioritized learning outcomes are an excellent start. They can be grouped into related sets based on conceptual connections and/or textbook structure. The inherent properties of learning management systems (LMS, the platform for an online course, such as Blackboard, Canvas, Moodle, D2L, etc.) can facilitate a modular structure.

Whatever the instructor uses as the basis of the modules, they should ensure that each has clearly stated learning objectives, with a consistent format and pathway for progressing through connected activities, assessment, and related content. It is best if the schedule for the activities and assessment within each module follows a weekly routine (see section 3, below), larger assignments are thoughtfully scaffolded across weeks, and skills-related outcomes are distributed across the term. We strongly encourage strategic use of LMS restrictions (sometimes called “access gateways” or “release conditions”) for quizzes, assignments, etc., so students do not start down a path that they are not prepared for.

iii. Grade Scheme

We address specific strategies for testing and assessment in more detail below (see section 7), but in the design phase, it is worth considering what overall grade scheme to use in the class. The online environment is particularly well-suited to alternative grade schemes versus the more classic points- or percentage-based calculations (Nilson 2014). Specifications-based grading schemes, for example, come in many forms (e.g., mastery-based, labor-based, grading contracts), and are well-established in composition and mathematics pedagogy (e.g., Inoue 2019). Specifications grading shares a set of common features: assignments and activities are accompanied by a set of clear, well-defined specifications; evaluation of whether student work meets each specification is binary (no partial credit); and a system of thresholds for translating the degree to which the student completes work meeting specifications, sometimes in combination with percentage scores from traditional quizzes or exams, to final letter grades. In specifications grading, final grades are a direct reflection of student mastery of course learning outcomes (at least to the extent that assignments and assessments reflect these).

Specifications grading can foster a growth mindset, the belief that learning and intelligence is not fixed (Dweck & Yeager 2019), by providing opportunities for students to be re-assessed. The online environment readily allows assignment resubmissions and/or taking a new version of a quiz, as this medium provides inherently greater flexibility in scheduling. Instructors may offer limited or unlimited resubmissions, or use a flexible model via tokens earned for extra credit work. A key benefit of specifications grading is that students are given agency, in that they can see precisely what they need to do to receive their target grade and are rewarded for revisiting and mastering material they struggle with. For the instructor, grading is simpler, takes less time, and is devoid of the angst often associated with assigning partial credit. Indeed, many of the low-stakes assignments and action-based lab activities (e.g., “collect an hour of focal animal observations” or “create an ethogram of an animal’s behavior”) designed for online courses make more sense to grade as meeting or not meeting specifications than by a points or percentage system.

iv. Inclusivity, Equitability, Flexibility, and Accessibility Mindset

We encourage instructors to adopt a flexible and inclusive mindset. During the pandemic we have often heard the adage “We are all in this together,” although a more fitting phrase is “We are all in the same storm, but not in the same boat” (paraphrased from Damian Barr, 2020). The pandemic impacts on students are neither equal nor equitable, based on multiple factors surrounding race, socioeconomic disparities, age, traditional/non-traditional student status, and whether students are first-generation. Access to reliable internet and technology can impact when and how students can engage with their online course. Additionally, students could be spread across multiple time zones. These factors may limit their ability to participate in synchronous sessions. To maximize inclusivity and equity, we encourage instructors to have asynchronous options for all course components. We also encourage instructors to allow for flexibility in due dates, provide alternative assessment options, and promptly respond to emails to help enhance learning and ensure that all students feel a sense of belonging as they juggle these challenges with course demands. While we touch on specific topics related to inclusivity and equity below, for additional recommendations on how to incorporate inclusive teaching practices into online courses we refer instructors to Box 1 and Harris et al. (2020).

3. Course-Wide Recommendations

While we address specific course components in later sections, there are some considerations that span all aspects of our courses.

a. Be Consistent, Informative, and Transparent

Prior to the first class we encourage instructors to communicate with the students, describing the course format, providing clear information about what students should expect from the course and the instructor, and what the instructor expects from the students. Box 2 outlines specific recommendations. Be consistent in those expectations throughout the course.

We also encourage instructors to incorporate a clear, consistent and uncluttered online structure with regular labels in their LMS. Create a high-profile “start here” area, with an “overview video” where the instructor walks students through the LMS site to show students where to find the syllabus, modules, schedule, descriptions of assignments, and gradebook, as well as where and how they submit assignments and take tests. Create a routine weekly schedule to help students remember what happens when. Integrate due dates and course events with the LMS calendar or to-do list features. Use the LMS gradebook and keep it organized and with assignments properly weighted, according to the syllabus. Post weekly videos providing topic overviews and work for the upcoming week, preferably alongside written instructions, are also helpful.

Given this is more detailed information than students often experience in face-to-face courses, we encourage the instructor to start with a Syllabus Quiz, so that students are required to listen to the introductory videos and read the syllabus, identify Wi-Fi/browser issues, and familiarize themselves with the LMS tools they will be using throughout the course (e.g., a quiz portal). If the instructor has a synchronous component, students could work together in groups to answer the quiz questions to enhance peer-to-peer learning, help them build team skills, teach them about breakout rooms, and provide an early engagement opportunity.

b. Provide Opportunities for Social Interactions

We emphasize that it is important to incorporate opportunities for social engagement into the course as it can lead to increased student success directly (e.g., impromptu peer study groups allow for learning by teaching) and indirectly (enhanced psychological motivation to study, reduced mental health issues). Engagement helps students develop a sense of belonging, a large factor in whether or not students persist in STEM degrees (Good et al. 2012; Nostrand and Pollenz 2017; O'Brien et al. 2020). We provide recommendations for fostering social engagement in Box 3.

c. Utilize Teaching Assistants Effectively

If the instructor has teaching assistants, preceptors, or graders, now is the time to maximize the use of that source of practical support, which in turn will offer employment opportunities, usually for graduate students, at an especially tenuous time. These assistants can provide key support in the following ways: 1) Assistants can help with creating novel multiple choice and short answer questions and complete much of the grading. These are very important components, given that creating questions and grading burden may be substantially higher due to our recommendation that all testing be frequent and 'open book' (see section 7, below). 2) Teaching assistants are an important liaison between the instructor and students because they are sometimes perceived as more accessible and less intimidating than the instructor, and may therefore help students navigate online course content, relay concerns to the instructor (and vice versa), offer valuable learning opportunities in a casual setting, and provide emotional support during a time when student anxiety has increased (Elmer et al. 2020, Odriozola-González et al. 2020). 3) Assistants can hold small group review sessions that enable students to work through study guides, and run student question-driven review sessions prior to tests. 4) Assistants can join instructors in moving between break-out rooms in synchronous lecture or lab sessions, ensuring that students do not have long waits for help when they get stuck. 5) Assistants can help instructors prepare demonstration videos of lab and field techniques to share on the LMS.

4. Lecture Recommendations

Beyond the question of whether to deliver content synchronously or asynchronously, there are several other factors to consider when designing online lectures, each of which may impact comprehension and retention of material, inclusivity, and student and instructor stress levels

a. Maximizing Comprehension and Retention of Material

As higher education suddenly moved to a virtual format in early 2020, instructors and students experienced the difficulties associated with learning solely by watching computer screens. Many students find it a challenge to pay attention, take good notes, and retain course material in the absence of social interaction, which would normally afford opportunities for learning by teaching others, asking quick questions of instructors in the halls, and forming impromptu study groups. Furthermore, both instructors and students experience “Zoom fatigue” (e.g., Blum 2020), as staring at a screen for prolonged periods can make it difficult to remain engaged with the material. However, strategic use of some of the tools described in Table 4 when preparing online lecture content may ameliorate these problems. Box 4 provides detailed suggestions for ways in which online lectures can be prepared efficiently and effectively.

b. Fostering Engagement While Minimizing Stress

Even asynchronous lectures can be active. Scattering opportunities for group discussion and polling questions throughout lectures may help maintain student engagement and focus. Discussion boards, Flipgrid, and social media all can be utilized to encourage social interaction among students in asynchronous settings in response to questions posed by the instructor. Polling and informal quizzing can be readily integrated in small and large synchronous classes alike via apps commonly used in face-to-face classes (e.g., Kahoot!, Poll Everywhere) and those provided within video conferencing platforms (e.g., Zoom and Big Blue Button). You can also use polling questions in asynchronous classes through some of the same apps, or by having students add comments to question slides; VoiceThread and Kaltura Capture allow student comments to remain private, so they can also serve as mid-lecture quizzes. Many platforms allow for (and track) student comments on lectures, allowing an easy way to give credit for participating. Section 10 provides software recommendations.

5. Discussion Recommendations

Discussion is a key component of most behavior classes, and so considering how to replicate this experience online is important. Discussions can be held synchronously (via video or chat rooms) or asynchronously (via discussion boards, etc.). While many of us are more comfortable with a synchronous approach, some students prefer an asynchronous approach, as it provides time to develop questions and compose thoughtful replies. As a result, some students who said little during early 2020 in face-to-face discussions later participated extensively in online asynchronous discussion boards. Our suggestions include:

Discussions of core principles, experiments, or current research: Students can be assigned readings and discussion prompts that are submitted prior to a class discussion, which become low-stakes assignments amenable to specifications-based (satisfactory/unsatisfactory) grading. These have the added benefit of helping instructors know students' prior level of understanding. Consider subdividing students into discussion groups and assigning different prompts to each student. For example, if the topic is to discuss five key questions about a literature article, each student within a group of five could be responsible for presenting an initial answer to one of the questions; other group members could then be tasked with improving the answers. When held on an asynchronous discussion board, we have found it helpful to use the "reply before seeing other posts" option available in many LMS's so that students must craft their own responses before seeing and responding to others. An additional tip is to require students to make responses at multiple time points throughout the discussion period, increasing back-and-forth conversation. Finally, we encourage instructors to be cognizant of their direct participation in discussions; students should perceive that the instructor is reading their posts, but student participation can be stifled by frequent instructor commentary. A weekly summary post by the instructor that reflects upon interesting student ideas that emerged from various groups, and adds instructor insights, can be an effective and time-efficient way to recognize student participation and take advantage of teachable moments.

Journal club: Another fruitful option for discussion is having students take turns leading discussions of primary literature articles. We encourage the instructor to model the first one or two sessions and provide explicit expectations for the discussion leaders. In more advanced classes, leaders may be asked to develop learning goals for the discussion and provide additional content, such as information from background readings. To ensure students are adequately prepared for a lively discussion, consider requiring a preparation assignment prior to class (e.g., critique the article in 100 words or less; create a 2 minute podcast that explains the article to a high schooler; these approaches are amenable to satisfactory/unsatisfactory marking by teaching assistants). Alternatively, provide explicit expectations for discussion participation and alternative means of participation for those uncomfortable speaking up or unable to attend (e.g., write questions/comments in the chat; submit a critique).

Invited guests: Consider inviting an author of the article to join in on discussions. For asynchronous courses, an author could answer some of the best questions stemming from discussion boards, either via pre-recorded video, podcast, or text.

Case studies: Case studies are excellent fodder for online discussions focusing on behavior, as well as the scientific process. The National Center for Case Study Teaching in Science (NCCST; https://sciencecases.lib.buffalo.edu/) has a wealth of published cases relevant to behavior courses. Many of these are designed to use with periods of small-group discussion punctuated by new information or prompts provided by the instructor. This can be done synchronously or asynchronously using LMS restrictions to ensure students progress through the assignment in the correct sequence, discussing each step in a threaded discussion board.

6. Assignment Recommendations

As a general rule, the benefits of more, low-stakes assignments exceed those of fewer, high-stakes assignments. Low-stakes assignments can maximize student engagement and learning while minimizing stress, because no one assignment contributes a great deal to their final grade. One way to do this is with "pools" of low-stakes assignments which are individually small grade contributions, and can be placed into weighted categories of different assignments, quizzes, etc. While larger, higher-stakes assignments remain important, it is critical that they be highly scaffolded, as students need more guidance than in face-to-face courses. The following examples could be viewed along a continuum of low to high-stakes assignments:

Self-evaluation: Provide opportunities for self-reflection to serve as a type of "ungrading" assignment (Flaherty 2019). Clear cut ways for students to self-assess their performance and grade themselves can encourage critical thinking about what they can do to improve. For example, ask students to assess their work relative to provided rubrics, or to reflect on their note-taking skills and approach to studying, or engagement with assignments (e.g. respond to scaled questions about how completely and carefully they completed the assigned readings).

Short, task-based assignments: Students can be asked to observe an animal, and then construct an ethogram, develop a list of proximate and ultimate questions, and/or post their informal observations and inferences with prompts like "I noticed…" or "I wonder…" To encourage discussion, students could then be asked to respond to their peers' work by, for example, proposing alternative questions, hypotheses, or explanations.

Creativity-based assignments: While the instructor can ask students to outline key concepts in a chapter or an article, they could also provide options for students to engage with the course content in more creative ways. For example, asking students to write a limerick or haiku about a concept or article and post it to the discussion board (and tweet it to @Science_Poetry) can help students focus on the key takeaways of the concepts without resorting to patchwriting or worrying about “sounding scientific”, and these responses can quickly reveal to the instructor how well the students comprehend the ideas. Another possibility is instructors could provide photos and ask students to construct a meme for one, illustrating course concepts in a humorous way. Given that memes are something many students relate well to, students often participate enthusiastically and with remarkable creativity as well as scholarly rigor. Instructors can showcase the best poems and memes in future course offerings and on departmental and institutional social media platforms.

Abstracts: Writing a strong abstract requires solid understanding of a study’s broad context, hypothesis, methods, statistical analyses, conclusions, and implications, and requires good synthesis skills. Thus, an abstract assignment can serve as a relatively low-stakes way to assess student understanding. For lab projects, consider reducing some of the formal lab report assignments to only an abstract. For an advanced class, consider requiring a “stats appendix” that demonstrates the statistical approach students used to generate their conclusions. For class activities that require students to read primary literature, provide them an article without the abstract and ask them to write it themselves.

Peer review: For any writing assignment, incorporating peer review increases student interaction and the ability to learn from their peers. Thoughtfully design rubrics to guide students in their assessment, avoid yes/no responses, and prompt detailed comments. For example, ‘Propose two specific suggestions for how the author can improve their Methods section.’ For advanced classes writing manuscript-style lab reports, the instructor can promote authentic practice of professional work by using the reviewer questions for specific behavior journals.

Primary literature dissections: Require students to find primary literature articles related to current course topics, and post very brief and targeted summaries that deconstruct the article: for example, in <100 words identify the primary question, experimental design, primary results, and conclusion. Conversely, ask students to post one figure from a primary literature article, state what question the authors were asking, the experimental design relevant to that figure only, and how that figure contributes to the overall interpretation. These short assignments can be quickly graded by teaching assistants (if one has them), while providing students with opportunities to explore how interpretations are constructed in science. Students can also be asked to comment on each other’s posts, propose alternative interpretations or summarize posted results (see *Peer-review,* previous paragraph).

Social annotation of articles is a great way to provide support to novice students who are encountering literature for the first time, and to encourage advanced undergraduates and graduate students to achieve deeper reading and collaborative discussion. Some social annotation software options, like Perusall, scale well for very large classes thanks to their ability to divide students into small groups, and through effective, automated grading algorithms

Student debates: Both synchronous and asynchronous debates are amenable to the online forum, and established debate platforms can help facilitation (e.g. Kialo). Separate meetings can be held for each group to prepare position points and choose a spokesperson for live or recorded opening statements. Follow up counterpoints can be contributed by the entire team, with the instructor, teaching assistant, and opposing team asking questions.

Student presentations: While students can present their work in either synchronous or asynchronous formats, we suggest pre-recorded presentations that can be viewed and responded to asynchronously via discussion boards. Many applications used in asynchronous lectures (e.g., VoiceThread, FlipGrid) allow for text, audio, and video responses from classmates, furthering opportunities for asynchronous discussion of student work. However, we recognize that there is often camaraderie to be found in synchronous meetings online where student presenters can be asked questions in real-time after their pre-recorded presentations are played by a moderator. Because pre-recorded presentations can be readily shared, consider working with your institution to communicate student work via social media platforms. Also consider the value of developing assignments targeted for the broader community that may take the form of popular science radio clips (like those at birdnote.org) and vlog posts to be shared with local zoos, conservation organizations, museums, K-12 classrooms, and more.

Mock grant proposals: Regardless of class format, mock grant proposals provide opportunities for students to take ownership of their learning and select a topic they are motivated to learn more about. Guidelines for the final product can follow those of student grant programs such as the Animal Behavior Society's graduate student grant or the National Science Foundation Graduate Research Fellowship Program. Scaffolded development of this assignment could include: 1) sharing broad topics of interest; 2) presenting a key "anchor article" foundational to a given student's development of their proposal ideas; 3) annotated bibliographies, 4) recorded "elevator pitch talks" and written drafts; 5) peer-review discussions; 6) final proposal submissions; and 7) peer-review panel discussions to determine who gets "funded". We recommend sprinkling in a few required one-on-one conversations between student and instructor, and giving feedback along the way. We have seen these projects help seniors find graduate school mentors. We have also watched students' eyes grow wide when we show them a recently published article testing the same questions they proposed, illustrating how they have been generating truly novel and significant questions in behavior, making this assignment inspiring and transformational.

Course wrap activity: Online courses can have a feeling of ending abruptly, so ending with a short reflection assignment can bring a sense of closure. This could take the form of writing a letter of advice to next year's class about how to succeed and what challenges to work through; the instructor can share the best ones with their next class.

7. Testing and Assessment Recommendations

Perhaps no aspect of teaching online triggers as much angst in instructors as the question of how to give tests and exams. Testing in an online environment is fundamentally different from testing in a classroom. As with other aspects of developing an online course, however, the instructor may find that testing and assessment techniques applied in an online environment become their preferred approach in face-to-face classes as well.

With the pivot to online classes in early 2020, many institutions subscribed to online proctoring services to reduce cheating. It is worth considering why students might be tempted to cheat during assessments; reasons include anxiety, the high-stakes nature of exams, the preparation "gap," and peer behavior, which can normalize cheating and instill fear that other students are cheating and "getting ahead" (McCabe et al. 2001). If the instructor wants to try to mimic the in-class exam experience, they can use one of these online proctoring services (e.g., Respondus). However, these options can add to student expenses, place additional technological constraints on students, raise privacy and equity concerns, and reinforce an adversarial, rather than collaborative, relationship. For these reasons, we discourage lockdown browsers and webcam monitoring during assessment activities. Fortunately, there are many alternative approaches that are well-suited for online behavior classes, which we outline below. These approaches, while potentially challenging to implement at first, especially while trying to minimize the grading burden, are also readily applicable to face-to-face classes. Some of us have found that we never want to give a "traditional" exam again.

Lower the stakes: Just as with assignments, the benefits of more, low-stakes tests exceed those of fewer, high-stakes tests. Frequent low-stakes tests (i.e., at least one per topic or module) can maximize student engagement and learning while minimizing stress, because no one test contributes a great deal to the final grade. This strategy helps keep students from falling behind or procrastinating, while providing the instructor with a much more fine-grained analysis of what students do and do not understand, allowing for a more adaptive approach to teaching. Frequent low-stakes quizzes reduce student anxiety about the "preparation gap" and also work well with a specifications-based grading scheme (see section 2.c., above). Perhaps most importantly, frequent testing is also highly impactful on student learning. Indeed, in a review of active learning methods, frequent quizzing was found to have the most support in effectively improving student learning (DeLozier & Rhodes 2017).

Everything is "open-book": Write questions with the explicit expectation that students will (and should) consult their notes or other course resources. Focus on questions at higher levels of Bloom's taxonomy (a continuum of question types: starting at the low level with recalling or explaining facts and basic concepts, moving to applying, analyzing and drawing connections across ideas, to the highest level of creating new or original work (Bloom 1956)). For example, instructors can ask students to interpret data, explain relationships, design experiments, and solve problems.

Include a mix of question types: Consider using "multi-select" ("select all that apply") questions instead of single-choice multiple choice questions, to allow for partial credit (further lowering the stakes and rewarding partial understanding). Avoid single-answer multiple choice with combined answer options (ex. A & B, all of the above except C, etc.), as these penalize partial knowledge and reward students with extensive standardized test training. Matching and fill-in-blank formats are also useful for higher order questions and can be autograded. Combine multiple choice questions with a few short answer questions to help provide additional insight into what students are learning and give them vital practice writing about science.

Quiz delivery do's and don'ts: Do take advantage of the LMS quiz settings to minimize sharing of quiz information: display one question at a time in random order; randomize selections in multiple choice questions; and build question banks so not all students receive the same questions. Do not restrict students' ability to move backwards in the quiz; taking the quiz is part of the learning process, and it is a good thing when a question helps a student realize an earlier mistake. Do not overly restrict the quiz duration. Students will run into technological problems, and may be working in distracted environments. Provide a large time window in which they can take the quiz (e.g., full day), and a quiz duration that is 2-3x longer than normal for a similar length face-to-face assessment, as the instructor may have students in different time zones, working full time, or with other responsibilities.

Collaborative assessments: We almost never operate in isolation as scientists, so aligning assessment practices with professional practices to be more authentic could manifest as collaborative exams. This could be in the form of short essays or oral exams. Clear guidelines are needed to establish that part of grade is ensuring participation and equal mastery of learning objectives from all group members, and how the instructor will be assessing the quality of the contributions. Collaborative approaches result in less grading, making it more feasible to incorporate essays and oral exams into larger classes. One limitation of collaborative assessments is that students may distribute the workload such that no student fulfills all intended learning objectives. A mechanism to prevent this is a 2-stage structure: students complete the assessment individually, then retake it in groups; grades are a predetermined ratio of independent and group attempts (typically with a caveat that group grades cannot lower individual grades).

Exam alternatives: Exams do not reflect professional practices, and while frequent quizzing enhances learning (DeLozier & Rhodes 2017), infrequent long exams are unlikely to promote long-term retention of material. Thus, consider replacing exams with alternate options. Reflection statements in response to a general prompt used throughout the class or specific prompts highlighting key principles of each course module can be impactful ways for students to interact with material. Reflective writing requires students to use writing as a natural part of the thinking process, summarize information, and integrate content. As a result, engagement with course material is enhanced, knowledge is personalized and contextualized, and learning is deepened (Tewksbury 1996; Fuller 2017; Chang 2019). Reflection portfolios can be written for the instructor’s eyes only, or can be peer-reviewed (Gopen 2005). We encourage allowing students space in their reflections to comment on their learning process itself, including their engagement level in class, challenges faced, etc.

In lieu of a final exam, consider an alternative assignment focused on a skill-development learning goal instead of a content-based learning goal (see Backwards Design). For instance, written analyses of data sets or journal articles are valuable ways to assess the development of key academic skills students have developed through class paper discussions and other course components. If community-building was a critical course goal, consider allowing these final analyses to be performed collaboratively by student groups.

8. Laboratory Recommendations

Animal behavior labs are often immersive, hands-on, and require working with live animals. At first glance, adjusting for a face-to-face physically distant lab experience, let alone a fully online one, may feel somewhere between arduous and impossible. And yet, with careful choices and planning, one can offer meaningful and intellectually rewarding lab experiences, including authentic and collaborative research opportunities. Keep in mind that laboratories do not need to be weekly stand-alone exercises, and students can benefit from multiple-week and term-long projects. By carefully scaffolding these projects with multiple small assignments that culminate in a final paper, proposal, poster, or presentation, lab time can be used to support student efforts and encourage peer-to-peer sharing. For instance, several of us typically teach our face-to-face courses with only a few weeks of "standard" lab exercises developed to teach basic observation skills, ethogram construction, use of event recorders, and experimental design. The remaining weeks of lab are used to support term-long research projects that could include: collaborative studies at local zoos, aquaria or animal shelters, and/or the development of mock grant proposals (section 6 above). While these labs still require careful redesign for the remote format, the structure reduces the total number of "topic-based" labs that need to be reimagined for the remote learning environment. Below we offer some suggestions:

a. Physically Distanced In-Person Labs

During the pandemic, laboratory rooms generally need to be at 30-50% capacity to meet the guidelines for physical distancing (based on room size). As a result, only one third to one half of the typical number of students can be present at any time. A cohort approach is best because it does not require additional instructors or physical lab space; choose the most important labs and cycle subsets of students through those labs over the course of the term, possibly putting the remainder of the labs online. Alternatively, shorten the in-person time spent in the lab room and have cohorts arrive at different times: for example, half of the students arrive for the first 2 hours, clean the lab for 15 min, and then the other half arrive for the last 2 hours. In-person labs are made all the more complex by the requirement to wear masks and all the ramifications that result (discussed in section 2.b., above) apply here. Behavior labs that meet outside can allow for more physical distancing and reduced viral transmission rates. Labs that focus on observing animals in the field can use this approach effectively. Staggering the times that students come to the field site can reduce contact time, but can be logistically difficult. Thus, easily accessible on-campus sites should be prioritized when possible, and safely managing travel to off-campus sites by car or public transportation should be carefully considered.

b. Online Remote Labs (Synchronous or Asynchronous)

When deciding whether a given lab activity should be conducted synchronously or asynchronously, consider the structure of the lab exercises and the expected amount of student-to-student collaboration. Some ideas for remote labs include:

Fieldwork: Students could do field observations remotely, near their homes. Depending on the student's location, birds, squirrels, insect pollinators, cockroaches, flies, ants, and spiders may be readily available subjects. Students could use community science mobile applications like eBird and iNaturalist to submit checklists of observations (be mindful of data quality), submit short videos of behavior they observe near their homes, or conduct independent research projects. One important consideration for remote fieldwork is that it is hard to ensure student safety, even in local public parks (see Mock 2020; #BlackBirdersWeek, #BlackInNature). Minority, LGBTQIA2+, and female students alone in the field are vulnerable targets (#MeToo, Flaherty 2017). To overcome this obstacle, one can suggest observations in a public zoo or private backyards. This may not work for all students, so we recommend a flexible approach that allows students to choose between fieldwork or remote subjects.

Remote subjects: There are many excellent sources of study subjects including live nestcams, zoo livestream feeds, pre-recorded videos of animals (Table 2), or experimental trials that are video-recorded by the instructor or colleagues. Additionally, instructor's could opt to post video recordings of the same animals that students would have typically viewed in-person during a lab exercise. Students could view these recordings and do much of the same work they would have done in person. Libraries of sound recordings (Table 3) also have great potential for use in remote lab exercises, especially when coupled with open-source audio visualization software (Audacity, etc).

At-home study subjects: If budget permits, mailing kits to each student's home is also possible: aphids, bean beetles, ants, and zooplankton are all reasonable possibilities. Students can make observations, construct ethograms, develop and test simple experiments, and present results to peers. However, if the instructor's ability to oversee humane and ecologically appropriate endpoints for these animals is uncertain, we advise against this approach.

Datasets: Datasets can be used effectively to help students test hypotheses, analyze data, and practice graphical construction and interpretation. Such datasets can come from the published literature, community science mobile apps (see section 10, below), the instructor and colleagues' personal research, and/or previous class-based lab exercises.

Collaborative studies: Remote students can still collaborate in groups. For example, pairs of students living in different geographic regions can agree to a study plan and then combine observations to make comparisons across populations. Similarly, teams of students can examine nestcam options, conduct basic observations of at-home study subjects, or review potential datasets. Teams could develop a research question and sampling methodology together, and share data collection and analysis duties. If students work on lab projects in groups, time should be provided for the collaborative process.

Given the pandemic, many animal behavior classes world-wide will be conducted online. This unique situation provides opportunity for global collaborations (section 1c) on lab projects with an explicit geographic component – something that would be difficult for students to explore in a typical face-to-face format.

9. Office Hours Recommendations

Instructor-student interactions, including those that occur outside the classroom and in office hours, are essential for student success, especially in asynchronous formats (Wallace and Wallace 2001, Cokley 2000, Delaney 2008). Unfortunately, many students do not attend office hours due to insecurity about interacting with instructors one-on-one, time constraints, or because they are not aware of the benefits (Briody et al. 2019). A remote format for class and/or office hours can further exacerbate low office hour attendance. Thus, a conscientious effort should be made to encourage participation. See Box 5 for specific suggestions.

10. Resource and Software Recommendations

An overwhelming variety of software is available that can enhance online instruction, including those that enhance student engagement, allow for data collection, and incorporate community science. We have highlighted many of these in the sections above. As with other course content decisions, let your learning goals drive your selections. We recommend minimizing the number of new tools that your students must learn; focus on a few key tools that will facilitate high-impact learning and that students will use throughout the semester (i.e. the Triple-E Framework, Kolb 2017). This will allow you to provide training and support as students develop proficiency with each tool, which might include helping students secure access to the technology (e.g. loaner devices or through small grants). Furthermore, keeping it simple will keep students focused on exploring animal behavior, not learning course software. We provide a concise list of tools that you can consider, and what you might do with them, in Table 4.

11. Intellectual Property Rights

Instructors are both creators and consumers of intellectual property, so both sides should be considered. Most of us assume that we have control over our own behavior course content, as we created it, and creators of a document are normally the first copyright holder. However, intellectual property rights vary widely across jurisdictions and institutions. For example, in many jurisdictions, there is a rule under copyright law that work "made for hire" is actually owned by the employer, unless there is an agreement to the contrary. It is important, therefore, to find answers to the following questions: Does the instructor maintain the intellectual property rights once the course is posted to the LMS? If the instructor does not, and they deliver their course asynchronously, can the institution re-use the instructor's course materials without them? Can the institution sell the instructor's course materials to other institutions, without the instructor's permission or knowledge? Understanding the rules governing online teaching at the instructor's institution may influence the approach they adopt in course design.

We encourage instructors to conduct a fair-use (also known as fair dealing) analysis to determine if permission is required to use material for their class. To do so, determine whether the material lies in the public domain, is open access, or if others hold the copyright. Libraries and campus bookstores are often willing to help with assessing whether material meets the institution's policies, and help obtain permission to use material. Instructors can also take steps to clarify how their intellectual property may be used. For example, one can include statements in the syllabus stating that only the instructor may record class meetings and lectures, and that these will only be posted securely within the LMS for use by enrolled students.

12. Conclusion

All teaching is a work-in-progress; although online teaching may not be our first choice, remember that a growth mindset benefits us and our students alike. Your course is unlikely to be (and does not need to be) perfect on the first day of the class. As we tell our students, you will learn by doing. Be comfortable with that, and make space for your learning as the term progresses. Ask your students for anonymous feedback and discuss how you are responding to their comments. Take advantage of peer teaching expertise both at your institution and via the professional networks that have emerged (see Early Considerations and Recommendations; Seek Support, above). Keep track of common questions that arise on assignments and problems that you discover in the course structure so that you can improve in future classes. While we all hope for a return to face-to-face teaching soon, planning for more than one term in which a significant component of coursework is online may be wise.

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14. References

Appleton, N.S. 2019. Do Not 'Decolonize' . . . If You Are Not Decolonizing: Progressive Language and Planning Beyond a Hollow Academic Rebranding. Critical Ethnic Studies. February 4, 2019. University of Minnesota Press. http://www.criticalethnicstudiesjournal.org/blog/2019/1/21/do-not-decolonize-if-you-are-not-decolonizing-alternate-language-to-navigate-desires-for-progressive-academia-6y5sg

Barr, Damian. 2020. https://www.damianbarr.com/latest/https/we-are-not-all-in-the-same-boat

Blum, S.D. 2020. Why we're exhausted by Zoom. Inside Higher Ed. April 22, 2020. https://www.insidehighered.com/advice/2020/04/22/professor-explores-why-zoom-classes-deplete-her-energy-opinion

Briody, E. K., Wirtz, E., Goldenstein, A., & Berger, E. J. 2019. Breaking the tyranny of office hours: Overcoming professor avoidance, European Journal of Engineering Education, 44:5, 666-687, DOI: 10.1080/03043797.2019.1592116

Brown, S. and Kafka, A.C. 2020. Covid-19 Has Worsened the Student Mental-Health Crisis. Can Resilience Training Fix It? The Chronicle of Higher Education. May, 11, 2020.

Casey, N. 2020. College made them feel equal. The virus exposed how unequal their lives are. New York Times, April 4.

Chang, B. 2019. Reflection in learning. Online Learning, 23(1), 95-110. doi:10.24059/olj.v23i1.1447

Chapman, K. J., Meuter, M., Toy, D., & Wright, L. (2006). Can't We Pick our Own Groups? The Influence of Group Selection Method on Group Dynamics and Outcomes. *Journal of Management Education*, *30*(4), 557–569. https://doi.org/10.1177/1052562905284872

Cokley, K. 2000. Perceived Faculty Encouragement and its Influence on College Students. Journal of College Student Development 41 (3): 348–352.

Delaney, A. M. 2008. "Why Faculty-Student Interaction Matters in the First Year Experience." Tertiary Education and Management 14 (3): 227–241.

DeLozier, SJ & Rhodes, MG 2017. Flipped classrooms: a review of key ideas and recommendations for practice. Educ Psychol Rev 29:141-151

Dohaney, J., de Roiste, M. Salmon, R.A. and Sutherland K. 2020. Benefits, barriers, and incentives for improved resilience to disruption in university teaching. International Journal of Disaster Risk Reduction. 50:101691. https://doi.org/10.1016/j.ijdrr.2020.101691

Dweck, C. S. & Yeager, D. S. 2019. Mindsets: a view from two eras. Perspectives on Psychological Science. 14, 481–496.

Elmer T, Mepham K, Stadtfeld C 2020. Students under lockdown: comparisons of students' social networks and mental health before and during the COVID-19 crisis in Switzerland. *PLoS One*. 2020;15(7):e0236337. doi:10.1371/journal.pone.0236337

Flaherty, C. 2017. Harassment in the field. Inside Higher Ed. October 17, 2017.

Flaherty, C. 2019. When Grading Less Is More. Inside Higher Ed. April 2, 2019. https://www.insidehighered.com/news/2019/04/02/professors-reflections-their-experiences-ungrading-spark-renewed-interest-student

Freire, P. 1970. Pedagogy of the Oppressed. Continuum Books.

Fuller, K. 2017. Beyond reflection: Using ePortfolios for formative assessment to improve student engagement in non-majors introductory science. The American Biology Teacher 79: 442-449

Gopen G. 2005. Why so many bright students and so many dull papers?: Peer-responded journals as a partial solution to the problem of the fake audience. The WAC Journal. 16: 22-48

Good, C., Rattan, A. and Dweck, C.S. 2012. Why do women opt out? Sense of belonging and women's representation in mathematics. Journal of Personality and Social Psychology 102(4):700-717.

Harris, B., McCarthy, P., Wright, A., Schultz, H., Boersma, K., Shepard, S., Manning, L., Malisch, J., and Ellington, R. From panic to pedagogy: Using online active learning to promote inclusive instruction in ecology and evolutionary biology courses. *Authorea.* July 16, 2020. DOI: 10.22541/au.159493366.69859736

Hodges, C., Moore, S., Lockee, B., Trust, T. and Bond, A. (2020). The Difference Between Emergency Remote Teaching And Online Learning. *EDUCAUSE Review*. https://er.educause.edu/articles/2020/3/the-difference-between-emergency-remote-teaching-and-online-learning

Hoquet, Thierry. 2020. Bateman (1948): rise and fall of a paradigm? Animal Behaviour 164:223-231.

Inoue, Asao B. (2019). *Labor-Based Grading Contracts: Building Equity and Inclusion in the Compassionate Writing Classroom*. Perspectives on Writing. The WAC Clearinghouse; University Press of Colorado. https://wac.colostate.edu/books/perspectives/labor/

Kebble, P. G. (2017). Assessing online asynchronous communication strategies designed to enhance large student cohort engagement and foster a community of learning. *Journal of Education and Training Studies*, 5(8), 92. https://doi.org/10.11114/jets.v5i8.2539

Kimmel, K., & Volet, S. (2012). University students' perceptions of and attitudes towards culturally diverse group work: does context matter? Journal of Studies in International Education, 16(2), 157–181.

Kolb, L. (2017). *Learning first, technology second: the Educator's guide to designing authentic lessons.* International Society for Technology in Education, Portland, Oregon.

Lee, D. 2020. Diversity and inclusion activisms in animal behaviour and the ABS: a historical view from the U.S.A Animal Behaviour 164:273-280.

Lederman 2020. The student view of this spring's shift to remote learning. Inside Higher Ed. May 20, 2020. https://insidehighered.com/print/digital-learning/article/2020/05/20/student-view-springs-shift-remote-learning

McCabe, D. L., Trevino, L. K., & Butterfield, K. D. (2001). Cheating in academic institutions: A decade of research. Ethics and Behavior, 11, 219–232.

Mock, J. 2020. 'Black Birders Week' Promotes Diversity and Takes on Racism in the Outdoors. Audubon Magazine.

Monk, J., Giglio, E., Kamath, A., Lambert, M. & Mcdonough, C. (2019). An alternative hypothesis for the evolution of same-sex sexual behaviour in animals. Nature Ecology & Evolution. 3. 10.1038/s41559-019-1019-7.

Murphy, M. C., Gopalan, M.,Carter, E.R., Emerson, K. T. U.,Bottoms, B. L. & Walton, G. M. (2020). A customized belonging intervention improves retention of socially disadvantaged students at a broad-access university. Sci. Adv. 6, eaba4677.

Nilson, Linda B. (2014) Specifications grading: restoring rigor, motivating students and saving faculty time. Stylus Publishing.

O'Brien L.T., Bart, H.L. & Garcia, D.M. 2020. Why are there so few ethnic minorities in ecology and evolutionary biology? Challenges to inclusion and the role of sense of belonging. Soc Psychol Educ 23:449–477.

Oettingen, G. (2014). Rethinking positive thinking: Inside the new science of motivation. New York, NY: Penguin Group.

Odriozola-González, P., Planchuelo-Gómez, Á., Irurtia, M. J., & de Luis-García, R. 2020. Psychological effects of the COVID-19 outbreak and lockdown among students and workers of a Spanish university. Psychiat. Res. (2020): 113108

Reinties, B., Alcott, P and Jindal-Snape, D. 2013. To let students self-select or not: that is the questions for teachers of culturally diverse groups. Journal of Studies in International Education 18(1):64-83. https://doi.org/10.1177/1028315313513035

Shrewsbury CM 1997. What is feminist pedagogy? Women's Studies Quarterly 1/2: 166-173

Supiano, B 2020. How the pandemic is pushing professors to improve their pedagogy. Chronicle of Higher Education, August 28, 2020.

Tewksbury, B. J. 1996. Teaching without exams – the challenges and benefits. Journal of Geoscience Education. 44(4): 366-372

Tolmie, A. & Boyle, J. 2000. Factors influencing the success of computer mediated communication (CMC) environments in university teaching: a review and case study. Computers and Education 34(2):119-140.

Tuck, E., & Yang, K. W. (2012). Decolonization is not a metaphor. *Decolonization: Indigeneity, Education & Society*, 1, 1– 40.

Wallace F.L. and Wallace, S.R. 2001. Electronic office hours: a component of distance learning. Computers & Education 37(3-4):195-209.

Wiggins, Grant & McTighe Jay (2005) Understanding by Design. Association for Supervision & Curriculum Development

Zhang, H., P. Nurius, Y. Sefidgar, M. Morris, S. Balasubramanian, J. Brown, A. K. Dey, K. Kuehn, E. Riskin, X. Xu, and J. Mankoff. 2020. How does COVID-19 impact students with disabilities / health concerns? arXiv:2005.05438.

Table 1. Our definitions for modes of delivery used in online instruction.

Mode	Definition as used here
Hybrid course	Some instruction occurs face-to-face and some is online
Synchronous course	Course is fully online; instructor and students are online simultaneously, often sharing live video feeds
Asynchronous course	Course is fully online; instructor and students are not online at the same time – lectures are pre-recorded and discussions occur via discussion boards or similar format

Table 2. Example live webcams and pre-recorded videos.

Live Webcam	URL	Highlights (more on site)
Audubon	https://www.audubon.org/birdcams	Live bird and nest cams
Cornell Labs	https://www.allaboutbirds.org/cams/explore-the-new-bird-cams-website/	Variety of live bird cams from across the United States, Canada, Panama, Carribean, and New Zealand
Explore	https://explore.org/livecams	Live cams of many wild and captive species from all over the world
Georgia Aquarium	https://www.georgiaaquarium.org/webcam/beluga-whale-webcam/	Variety of vertebrates; Beluga, sea lions, alligators, southern sea otter, puffins
Monterey Aquarium	https://www.montereybayaquarium.org/animals/live-cams	Variety of marine organisms; coral reef, jellyfish, sharks, sea otters, kelp forest, open sea cam
San Diego Zoo	https://zoo.sandiegozoo.org/live-cams	Variety of vertebrates: hippo, platypus, baboon, polar bear, apes, tigers, elephants, giraffes, koalas, penguins, burrowing owl and condor
Smithsonian National Zoo	https://nationalzoo.si.edu/webcams	Variety of mammals: black-footed ferrets, elephants,

		panda, cheetah, naked mole rat, lions

Table 3. Example sites to find sound recordings.

Taxon	Site
Anurans	https://www.pwrc.usgs.gov/frogquiz/; List of Call and Video Files on AmphibiaWeb; Frog Watch | UserGroup
Birds	http://xeno-canto.org, https://www.macaulaylibrary.org/; https://blb.osu.edu/
Cetaceans	https://patternradio.withgoogle.com/
Insects	https://www.ars.usda.gov/ARSUserFiles/3559/soundlibrary.html; http://entnemdept.ufl.edu/walker/buzz/
Rodents	https://mousetube.pasteur.fr/

Table 4. Useful software tools and online resources

Software	Uses
Learning Management Software (LMS)	Organizing & delivering content, collecting assignments, providing grades and feedback, and communication (both between students and between students and the instructor). The LMS is the classroom for online courses. Ideally, other tools are either integrated with or can be linked to the LMS.
Remote Conferencing Software Big Blue Button, Google Meet, Microsoft Teams, Zoom, Blue Jeans, WebEx	Synchronous class meetings; video lecture recording; generating lecture transcripts
Video Capture Software Camtasia, OBS Studio, Screencast-o-matic, Kaltura VoiceThread	Record screen and audio feeds, with optional inset webcam recording. Slide-by-slide narration of PowerPoint or PDF slides (by video and/or audio, drawing tools), student commenting; in-slide quizzes
Collaborative Office Software Google Docs, Google Sheets, Office 365	Allows students to share and synchronously edit papers, lab notebooks, slides, & spreadsheets on group projects.

<u>Software for Interactivity</u>	
Kahoot!, Poll Everywhere, Quizizz	Mid-lecture quiz/survey software, similar to “clickers.” Several can also be used asynchronously.
Flipgrid	Short videos for presentations or asynchronous discussions
Jamboard, Limnu, Padlet	Interactive post-it or whiteboard brainstorming activities during online lectures.
Hypothes.is, Perusall, Notability, VoiceThread	Social annotation and note-taking of literature readings or textbook chapters
<u>Behavioral Data Collection</u>	
BORIS, JWatcher	Data collection for behavioral observations, for use in lab assignments.
Animal Diversity Web/Quaardvark	Data source for dry labs on comparative behavior and/or phylogenetics
Audacity, Raven	Visualizing and analyzing sound recordings

Community Science Software	
iNaturalist, Seek	Interact with a database that uses machine learning to identify taxa and has curators to validate data. Post photographs and determine ID's on flora & fauna. Advanced users can extract data on distribution maps, behavior, interact with expert curators, etc. Many projects that students can contribute to already listed.
eBird	Submit bird species data after observation periods. Can load regionally specific guides to birds that identifies rare and unusual sightings (and potential misidentifications).
Bumble Bee Watch	Bee identification, behavior, and distribution
Taxa Identification	
Merlin Bird ID (Cornell Lab)	Can ID birds by size, color, behavior or photo.
Audubon	Can ID birds by size, color, shape, activity, habitat, song, wing shape and tail shape.
Wild Bee ID, Bumble Bee Watch	Can ID bees