Active Learning in a Natural History and Related Courses Using Video Open Educational Resources: Observations over a Decade

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The need for open educational resources (OERs) in STEM and natural history education has never been more important given COVID-19 and the continuing cuts in state and federal funding of higher education. Over the last ten years, I have developed active learning-based (see Grossman & Simon 2020), video OERs for natural history and related environmental courses, and in this essay, describe their use as data sources for university classes. I provide examples of an exercise and a grading rubric, as well as a link to a YouTube channel with over 230 video OERs. Experience using OER-based exercises at levels ranging from first-year seminars to graduate seminars, indicates that positive student experiences only occur when assignment rubrics are carefully matched to students' biological experience, interest, and level of knowledge. First-year non-science majors require substantial detail and interaction regarding how to complete an OER-based research paper, whereas graduate students need only be instructed to develop and complete their own research project based on what they observe in the OER. The increased availability and low cost of high resolution digital video equipment and free video editing software render it easy to film OERs of animals behaving in situ. Given the shift in lecturing modes (classroom versus online) necessitated by the COVID-19 pandemic, OERs are likely to play an increasingly important role in life science instruction.

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The future requires that natural history instructors develop innovative approaches to pedagogy or risk losing an audience that has grown up peering into screens and manipulating game consoles. Pedagogical innovation becomes even more vital, as classroom instruction may increasingly shift to online platforms due to global calamities such as the COVID-19 pandemic. The current pandemic has created substantial uncertainty in both future teaching schedules and safe modes of instruction, and highlights the importance of developing meaningful exercises that appeal to technology-savvy students and can be delivered remotely.

In this essay I describe my experiences developing and employing a variety of video-based open educational resource (OER) active learning exercises in university natural history and related classes at levels from first-year to graduate (first year natural history seminars, to a general education natural history lecture course, to graduate-level seminars in fish ecology and resource management) (also see Grossman and Chernoff 2018, Grossman and Simon 2018, Grossman et al. 2020).

By active learning, I am referring to classroom exercises that require the use of the higher order cognitive processes depicted in Bloom's taxonomy (Krathwohl 2002, Grossman and Simon 2020). These approaches have been used successfully prior to the COVID-19 pandemic, but have achieved even greater relevance now that many educational institutions have been forced to move fully or in part to on-line instruction. Active learning exercises, whether based on field observations or OERs, likely produce increased classroom achievement, which should result in increased retention and subsequent professional performance (Minner et al. 2010, Freeman et al. 2014, Styers et al. 2018), although contrary evidence exists (Andrews et al. 2011).

In this paper, I use the term "natural history" to represent any similar field of biology, including conservation and natural resource management. In addition, my examples and resources are oriented towards animal biology: my area of expertise.

OERs in Natural History Pedagogy

Pedagogical techniques for the natural history classroom have advanced substantially in the last twenty years, with the development of (1) flipped classrooms, (2) multimodal learning, (3) the use of

OERs, and (4) active learning exercises. However, based on the published literature, the frequency with which these innovations are employed in natural history classrooms, especially at different institutional levels (community college versus four-year college versus Research-1 universities) is uncertain (Grossman and Chernoff 2018, Grossman and Simon 2020).

OERs represent many different resource — including text books, pre-formulated exercises, and videos — that may be accessed by students and faculty for free, typically via the internet. OERs have the potential to be tremendous tools for online instruction, but their development in natural history curricula appears to have been limited (Grossman and Chernoff 2018, Grossman and Simon 2020). It is unclear why this is so, but certainly the increased workloads and job insecurity that tenure-track, non-tenure track, and adjunct natural history faculty currently experience likely leave little time for voluntary implementation of pedagogical innovations.

While video-based OERs of animal behavior should not replace direct field observations when the latter are possible, they do offer some educational advantages. For natural history classes, OERs of animal behavior in situ may serve as a substitute for field observations for the purpose of classroom research exercises and papers. They are excellent resources not just for the development of basic science and active learning exercises, but also for long-term conservation studies given the declines in wildlands and biodiversity, as well as increases in the world's human population. In addition, their use in lieu of field labs may prevent degradation of local natural areas used repeatedly for classroom field exercises. Finally, I have previously argued that scientific societies should begin collecting video of species in situ behavior as a virtual museum that will aid future scientists and students when these species and habitats become rare (Grossman and Chernoff 2018).

Classroom research exercises based on OERs also may be crafted as authentic learning experiences for more advanced students in that they represent tasks that likely will be performed in professional research. This genre of authentic learning — that is, projects that require natural history students to generate hypotheses, make quantitative observations, summarize and analyze data, and attempt to deduce causal mechanisms — will likely increase the probability that these students become engaged and produce results that are meaningful to their career goals in either basic or applied sciences (Grossman and Chernoff 2018, Grossman and Simon 2020, Grossman et al. 2020).

Use and Development of OERs in the Natural History Classroom

The exercises developed for my classes focus on two main approaches: first, research paper exercises based on video OERs of animals behaving in situ (Grossman and Simon 2020), and second, the use of student-developed karaoke videos as a vehicle for information on the biology of species, the characteristics of habitats, or an ecological/evolutionary concept (Grossman and Simon 2018). In this paper, I focus on the first type of exercise because it is more appropriate for online student research projects employing the hypothetico-deductive method (Grossman and Chernoff 2018, Grossman and Simon 2018, 2020). I have provided an example of an authentic OER-based exercise in Appendix 1 and a grading rubric for that exercise in Appendix 2.

Frankly, it has never been easier for an instructor to make one's own biological OERs, given the variety of cameras and cell phones containing high quality digital video recorders. Technology has advanced to a level where even well-known directors shoot movies with high technical quality entirely on a cell phone (e.g., Steven Soderbergh's "Unsane"). A variety of high-quality cameras are available for both standard and underwater video filming, including dedicated cameras such as Go-Pros and high-quality point and shoot, or single lens reflex, digital cameras.

As examples of what is possible, my YouTube video channel, developed for my own OERs, has over 230 videos both edited and unedited https://www.youtube.com/channel/UCSM5ZtaKhp_5RtiAfowUA_A/videos . I have posted both edited (videos edited so they only containing animals undertaking an activity such as foraging or inter-individual interactions) and unedited videos, because the unedited videos represent an unbiased sample of what happened in a particular place at a particular time and may be useful as data sources for future studies. (Use of either type of my videos is free for the general public.)

If you are unfamiliar with making videos, asking students to film animals in natural habitats can be effective after giving the students a bit of instruction (e.g., keep the animal in the frame, don't disturb the animal, download the video immediately after fieldwork). Many videos will require some editing, and simple, easy to use, and free photo (e.g., Affinity Photo) and video editing (e.g., HitFilm Express) programs are available on the web. Finally, given the difficulty in vetting online video resources, I recommend making your own video OERs.

It is a basic tenet of pedagogy that assignments must be tailored to the students in a given class, and this is particular apt for OER active-learning exercises given

that many natural history students may be unfamiliar with this pedagogical approach. I have used OERs with natural history graduate students as well as first-year undergraduates who have not yet decided on a major, and mildly different techniques are required for these diverse audiences. My experience is that many undergraduates, especially non-science majors, require highly detailed rubrics and instructor interaction to successfully complete an active learning research project based on OERs. This is particularly true given the anxiety potentially invoked by what may be a very unfamiliar pedagogical process and the highly goal-oriented attitudes of some biologically-oriented students. Conversely, graduate students may be able to formulate their own research project with little more than a link to the video and a minimal rubric including the general purpose and format.

In my first attempt using an OER (a 15-minute video of Arctic Grayling, *Thymallus arcticus,* foraging and interacting in an Alaskan River) in a undergraduate general education, natural history class, students were asked to identify, name, and tabulate discrete behaviors performed by the fish, identify behavioral sequences (series of behaviors performed consecutively), and hypothesize about the functional significance of these behaviors using the hypothetical-deductive method.

The rubric specified that there were no "correct" behaviors (i.e., there was no key that the behaviors were being compared to), which I had hoped would encourage student creativity and make the exercise more meaningful to class members. The rubric was posted on an electronic blackboard, and time for clarifications and questions were provided in class. Based on student responses to questionnaires and triangulation interviews, many students had trouble with the first iteration of the exercise, which led me to revise the rubric to include descriptions of possible behaviors the fish might display (Grossman and Simon 2020).

Experience in the classroom also revealed that students, regardless of level, benefitted from an in-class work sessions where the instructor and teaching assistant could answer specific questions in real time. These sessions appeared to greatly reduce student anxiety and clarified the methods and goals of the OER active-learning approach. I have continued to have at least one class session devoted to working on the OER-based exercise regardless of the level of student because it appears to reduce uncertainty and increase student interest. With resources such as group video conferencing, these sessions may even be conducted online, albeit with fewer students at a time.

OER Subject Matter

Since my initial use of the Arctic Grayling exercise, I have developed OER active-learning exercises that explore (1) fishes fighting over reproductive territories, (2) birds interacting at a seed feeder, (3) birds interacting at a suet feeder, (4) time budgets and behavioral repertoires of stream fishes, (5) characteristics of winners and losers of intraspecific interactions of stream fishes, (6) how velocity affects foraging success of a drift-feeding fish, and (7) the abundance and spatial distributions of plants and animals in a soft-bottom habitat at 875m depth on the California coast (Grossman and Simon 2020, Grossman et al. 2020). Clearly the type and level of course being taught will affect the type of active-learning OER being used. In discipline-specific courses such as ornithology, one's choices are more limited than in more general courses such as ecology or general biology. I have found that giving a student a choice of taxa (birds, fishes, amphibians, etc.) increases student interest and commitment by providing a level of "ownership" over the project.

In summary, I have described my experiences using OER-based, active-learning exercises in a range of natural history class levels from first-year to graduate. I believe I have been successful in using these exercises and that the use of OERs as a source of "field data" shows great promise, especially in a world where pandemics may continue to affect curricular options. For teachers of natural history, the future likely will require new and innovative pedagogical technique that can be delivered either in person or via the internet. Preparing for such a future will benefit both faculty and students.

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Appendix 1

Exercise rubric and potential questions for first-year seminar students with little or no ecology background. The video to be used with this rubric is https://www.youtube.com/watch?v=zJunJ1Mjeoc which may be viewed by the public. This was one of the first OER based assignments I constructed and I did not create a specific grading rubric for it.

Video Assignment

Record environmental conditions and any disturbances present, then identify to species, record sexes, and briefly describe the life history (i.e., size, maximum age, diet, habitat, predators, sex differences, diagnostic characters, etc.) of each species observed. The life history information can be in bullet form. Write down your information and in the next class session, we will break into groups of three and spend five to ten minutes comparing what you have all recorded and prepare a final set of observations that will be discussed in class. After the discussion you will prepare a 2-4 pp double-spaced paper (excluding references) with your final observations that will be due January 20th (please put them in my mailbox in the Forestry Office. I will not grade based on grammar or spelling but please run your assignment through a grammar and spell checker in your word processing program.

Bird Feeder Video Study Questions

1. What species visit the feeder and what are their biological characteristics (size, maximum age, diet, habitat, predators, sex differences, diagnostic characters)
2. What conditions might affect feeding birds on the feeder (weather, disturbance, etc.)
3. What is the sequence of bird species visiting the feeder, or is there one? Is there a predictable order based on species or size?
4. How do food habits affect bird feeder usage, e.g. granivores, insectivores, omnivores?
5. How long does each species stay at the feeder, are there interspecific differences?
6. Which species tolerate other individuals or species feeding with them? Is there social facilitation – do the birds visit in clumps? Does the sight of one species feeding lead to other species/individuals visiting the feeder?
7. Are some species dominant over others?
    a. Who is dominant over who
    b. Does prior residency have an effect on dominance?
    c. Does body size have an effect on dominance?
    d. Does who initiated an interaction affect dominance

Appendix 2

Grading rubric used for a bird feeder OER-based, active-learning exercise for a lower division, non-STEM major, general education course in Natural History of Georgia.

Grading Rubric for Bird Feeder Active Learning Exercise

Name: Overall grade: /125 = %
General Comments:

Topic (max points)	Poor	Fair	Good	Excellent
Correct formatting (IMRD), length, Citations (13)	(0-3) Incorrect formatting. Below minimum length. No citations.	(4-7) Sufficient length. Errors in formatting. Insufficient or inappropriate citations.	(8-10) Sufficient length. Some factual mistakes. Insufficient peer-reviewed citations.	(11-13) Correct formatting and length. Sufficient, relevant citations.
Introduction/ Discussion (18)	(0-5) No context or connection to literature	(6-9) Little context or connection to literature	(10-14) Context and connection to literature present but lacking in depth	(15-18) Strongly linked to broader context and connected to literature
Methods (18)	(0) Methods not present	(1-7) Some Methods described but insufficient detail	(8-11) Methods described but some details missing	(12-18) Methods detailed, well-described, and easily understood.
Bird identification and natural history information (31)	(0-5) No information presented	(6-15) Information missing for many species	(16 - 25) Information presented but with insufficient detail	(26-31) All species identified and natural history correctly described
Data on behaviors, interactions, and arrival sequences (30)	(0-5) No data presented	(6-15) Little data collected. Unclear presentation.	(16-25) Some data collected and presented, but more needed on behaviors and interactions	(26-30) Quantitative data collected on all aspects of project. Information clearly presented.

Synthesis (15)	(0-2) No connection to literature, interactions, and arrival sequences	(3-8) Mostly inaccurate connection to literature interactions, and arrival sequences	(9-12) Moderate connection to literature, interactions, and arrival sequences	(13-15) Strong connection to literature, interactions, and arrival sequences
Bonus points for creativity (5)	(0) No apparent extra effort made	(1-2) Little extra effort made	(3-4) Moderate extra effort made	(5) Considerable extra effort made. Enjoyable to read.