

1 **Towards equitable evolution & ecology learning online: a perspective from a first-time**
2 **instructor teaching evolution during COVID-19**

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5
6 **Abstract**

7 The mandatory shift to online offerings of higher education courses that would typically
8 be taught face-to-face, in light of the COVID-19 pandemic of 2020, has university
9 administrators, educators, and students alike scrambling to prepare for fall. The pedagogical
10 movement towards active learning has always found a friend in the natural sciences, with
11 laboratory and field components being standard to many degree programs. For instructors of
12 ecology and evolution, the shift to online-only learning planned for autumn 2020 can be
13 daunting. As a first-time instructor teaching “Evolutionary Processes” at the time of the COVID-
14 19 outbreak concurrent with being a student of a mentored teaching course and doctoral student
15 in evolutionary ecology and animal behaviour, I offer my perspective as a simultaneous learner
16 and educator to guide decision-making by instructors planning for the 2020/21 academic year. I
17 emphasize the need to consider accessibility, equity, and compassion and the importance of
18 building trust and a safe learning environment in the absence of face-to-face instruction. I
19 describe some evolution-related resources and approaches to assessment that worked for me in
20 the pivot-to-online context of March 2020, including COVID-19 teaching tools. Finally, I
21 encourage scholars of evolution and ecology to take this opportunity to bridge in contemporary
22 scholarship on pedagogy to help teach the next generation of biologists.

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25

26 **Introduction**

27 Teaching in the absence of face-to-face tutelage is far from an Internet-age phenomenon.

28 The concept of online education's analog predecessor, the correspondence course, dates back to

29 1728 when Caleb Phillipps placed an advertisement in the *Boston Gazette* for postcard-based

30 correspondence lessons for would-be pupils to learn shorthand (Bower and Hardy 2004). It

31 would be more than a century before universities took up the idea, with the first for-credit

32 distance course being offered by the University of London in 1858 (Thompson 1990). The first

33 fully-online distance course for credit ("Women and Computers in Education") was offered by

34 the University of Toronto in 1986 by what is now the Graduate School of Education (formerly

35 the Ontario Institute for Studies in Education (Harasim and Smith 1993)). Distance and/or online

36 courses have become staples in university course calendars in the decades since. Despite their

37 ubiquitous presence, such courses have yet to fully displace face-to-face teaching on campus,

38 which continues to be the dominant mode of formal teaching in university settings.

39 This is about to change. The academic year 2020/21 is guaranteed to make its mark in the

40 ongoing history of distance learning, as the COVID-19 pandemic has forced the hand of many

41 administrators to mandate all courses offered go fully online. The possibility of a return to

42 campus teaching looks to be increasingly unlikely as we progress through summer. While

43 vaccine trials are underway, as of early May 2020 there is nothing available to immunize the

44 general population.

45 These are uncertain times. What is certain is that we must collectively move our teaching

46 practices from our familiar campus classrooms, laboratories, and field sites into our living rooms,

47 kitchens, and home offices. Will this be the moment we break higher education out of the ivory
48 tower? I will leave it to the pedagogical scholars and pundits to predict how university education
49 may or may not be transformed permanently by this historic event. Instead, I suggest here that
50 we pause, even briefly, before taking on the momentous task of moving to a fully online fall
51 term.

52 Let us, as educators, take a moment to reflect on our goals and commitments to ourselves
53 and our students (e.g., University of Saskatchewan's Learning Charter (University of
54 Saskatchewan 2018)). As instructors of ecology and evolution, we are well acquainted with the
55 adaptive potential behavioural flexibility may lead to (e.g., (Tebich, Sterelny, and Teschke
56 2010). We understand what happens to lineages unable to adapt to shifting environments. But
57 there is no reason that the shift in dominant learning environment should be viewed as nature,
58 red in tooth and claw. We have the tools and services at our fingertips to create learning
59 environments in which all students can learn and thrive. It will be the instructors who simply
60 dump existing lecture notes online who will do the greatest disservice to today's diverse student
61 body, particularly one under the strain of a pandemic.

62 Here, I offer a perspective on teaching evolution online as a first-time instructor tasked
63 with providing a meaningful educational experience for students of evolution, whilst being a
64 doctoral student of evolution myself. The COVID-19 pandemic struck in the middle of my first
65 term teaching as a university instructor. I was lecturing our *Evolutionary Processes* course to just
66 over 70 undergraduate students three times a week as part of the University of Saskatchewan's
67 Teacher Scholar Doctoral Program. The program offers the opportunity for PhD scholars to teach
68 a university course in their discipline concurrent with taking a dedicated teaching training course.
69 By early March, I had found my groove as the person at the front of the room, and while I

70 certainly have room for improvement, the formative feedback I sought from students and the
71 midterm exam results indicated that there was indeed some learning going on for all of us.

72 I marked COVID-related milestones in my dayplanner in red ink with asterisks:
73 **COVID-19 ramps up in Canada (March 6). March 13 would become my last in-person lesson.*
74 *The classroom was half empty. *2nd COVID case in Sask.* I had emailed the students the day
75 before promising to post full lecture notes and to record the class with Panopto (Seattle, WA)
76 lecture capture technology, should they feel safer at home. Later that evening, the institutional
77 memo arrived that in-class coursework would be canceled for the foreseeable future but would
78 resume remotely beginning March 19. **CLASSES CANCELED -> MOVE ONLINE.*

79

80 **What has been, and what will come**

81 I recognize that I am in the relatively rare position, at least in evolutionary ecology, of
82 being brand new to instructing while still mid-PhD, and as someone who has now taught both in-
83 person and online without the years of experience even a postdoctoral fellowship might have
84 offered to stuff under my belt, and certainly not the deeply nuanced grasp of my material that I
85 might have developed through teaching and tweaking a course over years. To that end, I do not
86 claim mastery of the teaching suggestions I make below. But as I began writing this piece, I was
87 simultaneously a teacher and a student both in a literal sense. I am also fresh from formal
88 training in delivering higher education, with recent lessons pedagogical theory and practice at the
89 forefront of my mind. I reflect now on these experiences through the lens of my teaching
90 philosophy, and share some specific suggestions and examples that may be adopted by
91 instructors moving forward.

92 To the instructors for courses to be offered remotely later this year, you have a
93 challenging road ahead of you, as do your learners. This is still not business as usual. What is
94 being asked of us will not be a demonstration of online learning at its best (indeed, the distinction
95 between online learning and emergency remote teaching has been made already (Hodges et al.
96 2020)). But with careful planning and leveraging existing supports, you have an opportunity to
97 explore and reevaluate teaching materials. Importantly, given the widespread and simultaneous
98 response by universities to the current situation, we can look to each other. Rapid dissemination
99 of information allows us to review and evaluate what other institutions worldwide have achieved
100 in the context of their respective histories of online pedagogy and their individual COVID-19
101 situations (Crawford et al. 2020). We can also be emboldened by the results of studies of
102 teaching through online asynchronous learning networks, which have found several positive
103 outcomes reported by instructors (Coppola, Hiltz, and Rotter 2002) and students (Rovai 2002).
104 You have the chance to craft your syllabus around open-source resources and to effectively
105 implement remote active and experiential learning. This will be no small amount of work, but
106 this gift of time (how little it may be) to permit advance planning is one that the Winter 2020
107 instructors didn't have and will be your greatest asset in ensuring a successful online course.

108 Through it all, we must remember that distance learning need not feel distant. In his 2003
109 reflection on distant learning, Dr Alan Tait of the Open University concluded that, even with the
110 transition of distance learning into an online format as technology advanced “the issues of
111 learning, teaching and student support have reappeared as the heart of the matter” (Tait 2003).
112 Despite the underwhelming impact on traditional university functioning in the teaching, and a
113 definitive lack of the “disruption” promised by its purveyors, large online higher education
114 initiatives such as massive open online courses (MOOCs) have nevertheless opened the door to a

115 new avenue of pedagogical research and provided the opportunity to improve accessibility and
116 social inclusion in higher education (Lambert 2020).

117

118 **Building your learning community**

119 Trust that students are doing their best. Give them a reason to trust that you have their
120 best interests at heart. I was fortunate to have begun term in-class, where non-text and non-verbal
121 communication cues can help build appropriate teacher-learner relationships and expectations.
122 For example, as the classroom was unused in the hour prior to my lecture, I made a point to
123 arrive early to allow time for conversations with students before a prompt start to the lecture. I
124 had the benefit, then, of having built trust and relationships with my students in-person before
125 pivoting online. Research and experience shows that building a supportive learning community
126 not only is possible, but it has positive outcomes for student performance (Tait 2003; Rovai
127 2002).

128 This past term, my students cared for family members, lost family members, cared for
129 children, had children, became ill, and experienced many other hardships that come with life. By
130 the end of term, students were scattered across Saskatchewan, to places where rural internet
131 connectivity may be the least of their challenges, further across Canada, and home to countries in
132 different time zones and in different states of COVID-19 infections and responses. While early
133 reports suggest that students, on average, were able to succeed despite physical distancing and
134 confinement (Gonzalez et al. 2020), not all students experienced the changes equally. Moving
135 ahead, with the pandemic ongoing we must expect that some students will become ill themselves
136 or may experience the illness or loss of family members. Compassion must be the foundation on
137 which your remote learning community is built.

138

139 *Accessibility and Equity*

140 If you have been teaching or advising students prior to the pandemic, you should be
141 familiar with your institution's accessibility and equity service (AES) already; if you are not, it is
142 essential that you access their policies and recommendations immediately. Their guidelines will
143 inform institutionally specific procedures, and importantly, provide a confidential resource for
144 students to access and ensure appropriate accommodations are provided. While many instructors
145 who have experience with AES are used to them in the traditional on-campus format, remember
146 that your institution has likely been offering online courses for some time now. AES will have
147 procedures and guidelines already in place for such delivery. Contemporary research on online
148 pedagogy has made finding best practices in building equity and accessibility into the
149 architecture of online learning much easier for instructors, and this should be front of mind for
150 all (Van Rooij and Zirkle 2016).

151

152 *Lesson format*

153 If you go the asynchronous route (and I do recommend against three hour long
154 synchronous Zoom lectures), you might choose to capture shorter, topic-driven lessons that can
155 be tackled in smaller chunks interspersed with other activities. Not only does this allow lessons
156 to be managed more easily by students trying to balance their own isolation demands, in my
157 experience it is easier to teach as well. My professional training in lesson planning has been
158 heavily influenced by the BOPPPS model: Bridge-in, Outcomes or Objectives, Pre-assessment,
159 Participatory learning, Post-assessment, and Summary (Gong et al. 2017). This model lends itself
160 nicely to short lessons with targeted learning outcomes; indeed, the internationally-recognized

161 Instructional Skills Workshop (ISW) employs the use of BOPPPS for the 10-minute mini-lessons
162 developed by participants (Pattison and Russell 2006). With a bit of rearranging (participatory
163 learning activity could occur after the learning module, for instance), this model can help break
164 down longer lectures into bite-sized chunks more easily managed by instructors and learners.

165 If you haven't revised your learning outcomes in a while, the time is now. I got in the
166 habit of providing a slide at the start of each of my in-class lectures of stating the expected
167 learning outcomes for the day. These were written as in measurable and actionable statements
168 describing the skills or knowledge that students should have gained by the end of the lesson.
169 Such learning outcomes allowed students to immediately self-assess their understanding of the
170 material, while also providing an easy source of exam question ideas.

171

172 **Texts and source material**

173 Students may not have access to the same text resources that they would if they were to
174 be on campus. While I taught roughly around Evolution (Futuyma and Kirkpatrick 2017),
175 students primarily accessed it on reserve at the library, which put them at a disadvantage for
176 accessing this resource when the library closed. Fortunately, the website for this textbook has
177 some phenomenal simulations which stood in for some lab activities, in addition to useful
178 chapter summaries and a glossary (Futuyma and Kirkpatrick n.d.). I had already made it a habit
179 to provide links to additional online resources, such as topical explainer-style YouTube videos
180 (e.g., the Amoeba Sisters (The Amoeba Sisters n.d.)) and related lessons on open educational
181 websites (e.g., Khan Academy (Khan Academy, n.d.)). This practice fortunately set me on a
182 trajectory for success when it came time to pivot online. I increased the number of links from
183 providing one every lecture or two, to providing at least two or three links per lecture (Figure 1).

184 I also indicated whether each link was required to be reviewed or just suggested. This practice
185 allowed me to rely a bit more heavily on existing online resources when they were exceptionally
186 well done as “required” so I could allocate more time to teaching concepts that didn’t have
187 sufficient online resources. The key objective guiding my decisions here was to limit data-
188 hungry sites and videos and instead try to select only text-based resources as required. This again
189 comes back to accessibility for students, both in terms of internet capability and in terms of
190 visual and auditory limitations.

191

192 **Assessment**

193 Given the limitations on student participation as discussed above, I wrote an entirely new final
194 exam that was administered as an open book take-home assignment comprising multiple choice
195 and short answer. The ten multiple choice questions I included were mostly focused on
196 interpretation of visually represented relationships. For example, I created an image depicting a
197 curve showing the relationship between fitness and trait value. The question then asked the
198 students to identify which mode of selection the curve represented. For a series of questions, I
199 created four-panel image showing four phylogenetic trees with relationships among generic
200 species A-E (Figure 2) accompanied by a character matrix. Students were asked to identify
201 which trees showed equivalent relationships, which species represented sister taxa, and so on.
202 Because the lab portion of the course was canceled after March 13, students did not get the
203 practical experience with calculations for concepts like fixation index (Wright 1949). Instead, I
204 emphasized that while students did not need to perform the calculations on the exam, they would
205 be expected to understand the relationships among the variables in the equations. For example, I
206 presented the fixation index equation and asked 1) Explain in words what F_{st} measures. 2) How

207 is F_{st} affected by drift? 3) How is F_{st} affected by migration? As you prepare for future course
208 offerings, you may be able to find ways to engage students in practical aspects of such
209 relationships in ecology and evolution much more effectively than my emergency switch to
210 online. You may also reconsider what is more pertinent in your course: is success in learning to
211 be judged by ability to apply the knowledge in calculations, or is demonstrating an understanding
212 of the general relationships sufficient?

213 While the exam was designed to be completed within the originally scheduled three-hour
214 timeframe, students had 24 hours from the time it was posted to complete it and submit it
215 electronically. This gave students who would typically need time-and-a-half the time they
216 needed, as well as allowing flexibility for students in other timezones and with other
217 commitments. I had a 100% completion rate. While I am not an algorithm, the short answer
218 responses showed no evidence of academic dishonesty, and the spread of multiple choice
219 answers were what I expected if the exam would have been written in an exam hall. For a class
220 of that size, I would, from experience, strongly suggest you have help grading such questions,
221 using rubrics to guide assistants.

222 **Trauma-informed pedagogy**

223 Teaching evolution offered a unique opportunity to provide students with evidence-based
224 knowledge and critical thinking skills rooted in evolutionary theory through which they could
225 interpret the world events shaking their daily lives. Near the beginning of term, I asked the class
226 if they would appreciate parallel information on COVID-19 as it related to course topics on
227 evolutionary processes, to which the majority agreed (see Supplementary Material for resources).
228 This addressed one of the stated learning outcomes stated on the BIOL 302 syllabus: *Be able to*

229 *read and critically assess information related to biology, medicine, agriculture, livestock*
230 *breeding, and sociology, and offer evolutionary interpretations or describe evolutionary*
231 *implications by the problems presented.* (Lane and Wishart 2020).

232 To this end, teaching COVID-19 examples in an evolution class may be appropriate and
233 useful for students seeking to grasp the situation around them. While I integrated COVID-19
234 resources during the exponential growth phase of the pandemic, if I were to be teaching this
235 course again in autumn 2020, I would remain alert to environment and to student well-being at
236 the time of teaching and let that inform my choices. Perhaps more familiar to instructors of the
237 arts, humanities, and social sciences, trauma-informed pedagogy would be a prudent approach to
238 take (Teaching Tolerance Staff 2020). Students may have lost family members to COVID-19 or
239 have become ill themselves. Even for those not directly affected, we have all collectively faced
240 upheavals and hardships directly associated with COVID-19. It very well could be that students
241 and instructors alike are fatigued by new information related to the virus. Choose your teaching
242 materials wisely. Consider whether alternative examples can be used, and if COVID-19
243 resources could be provided as case studies for students to explore when they are ready.

244

245 **Conclusion**

246 Distance learning has existed for nearly 300 years, but what institutions of higher
247 education face in 2020 is an unprecedented shift to alternative modes of course delivery as a
248 result of the COVID-19 pandemic. While it is my utmost hope that rapid and effective vaccine
249 development renders the plans to move the 2020/2021 academic year to an online format, we
250 must plan for the worst. The integration of contemporary pedagogical theory and research
251 combined with the subject-specific knowledge and experience of our educators and supported by

252 our institutions' teaching and learning centers as well as services guiding accessibility and equity
253 will be difficult, time-consuming, and frustrating at times. However, as we have come together to
254 fight the pandemic, so too can the network of humans that have already made educational
255 programming for ecology and evolution successful. Through the March 2020 transition to
256 emergency remote teaching, respect and compassion for students as well as guiding principles of
257 equity and accessibility governed much of my response and decision-making. I hope that by
258 relating my experiences and sharing relevant aspects of my teaching practice as a new instructor
259 that you feel empowered to move forward with your own teaching journey. Let us take care of
260 ourselves and each other.

261

262 **Supplementary material**

263 Supplementary file 1 – Evolutionary COVID-19 resources

264

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274 inclusive Indigenization in our classrooms.

275

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279

280 **Declarations**

281 The author has no conflicts of interest to declare. Supplementary materials and examples are
282 provided as-is to illustrate how the course described within was delivered in an emergency
283 switch to online. They have not been altered for this publication.

284

285

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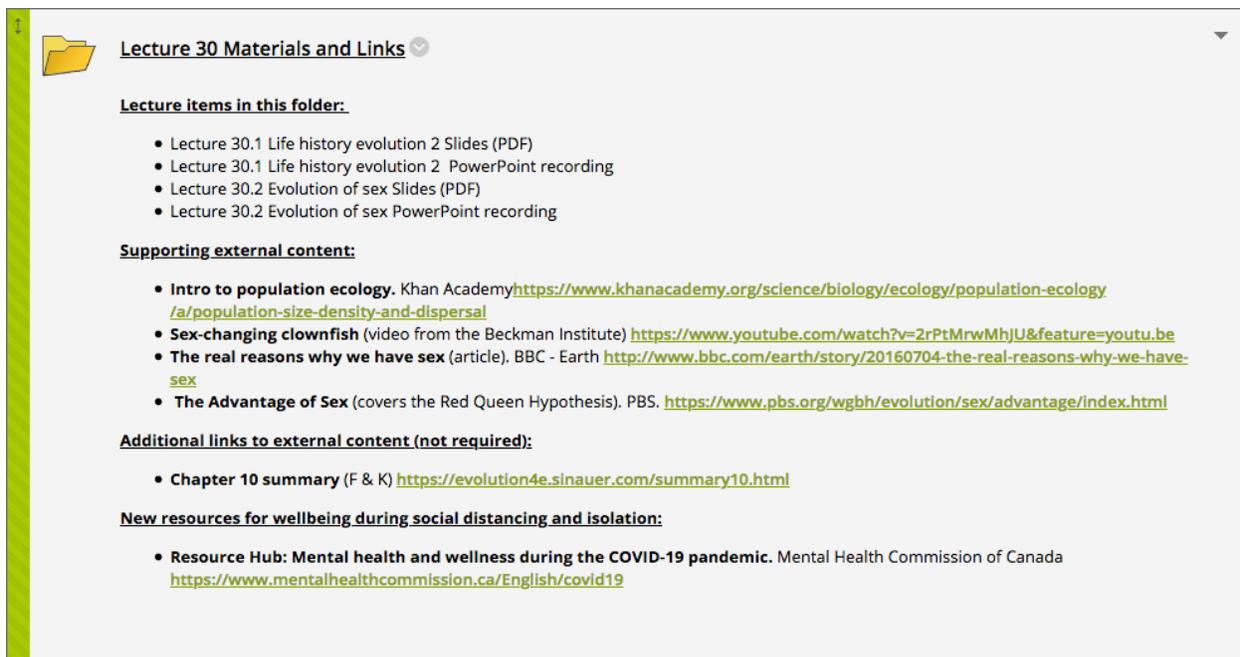
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357 **Figures & Tables**



Lecture 30 Materials and Links

Lecture items in this folder:

- Lecture 30.1 Life history evolution 2 Slides (PDF)
- Lecture 30.1 Life history evolution 2 PowerPoint recording
- Lecture 30.2 Evolution of sex Slides (PDF)
- Lecture 30.2 Evolution of sex PowerPoint recording

Supporting external content:

- **Intro to population ecology.** Khan Academy <https://www.khanacademy.org/science/biology/ecology/population-ecology/a/population-size-density-and-dispersal>
- **Sex-changing clownfish** (video from the Beckman Institute) <https://www.youtube.com/watch?v=2rPtMrwMhJU&feature=youtu.be>
- **The real reasons why we have sex** (article). BBC - Earth <http://www.bbc.com/earth/story/20160704-the-real-reasons-why-we-have-sex>
- **The Advantage of Sex** (covers the Red Queen Hypothesis). PBS. <https://www.pbs.org/wgbh/evolution/sex/advantage/index.html>

Additional links to external content (not required):

- **Chapter 10 summary** (F & K) <https://evolution4e.sinauer.com/summary10.html>

New resources for wellbeing during social distancing and isolation:

- **Resource Hub: Mental health and wellness during the COVID-19 pandemic.** Mental Health Commission of Canada <https://www.mentalhealthcommission.ca/English/covid19>

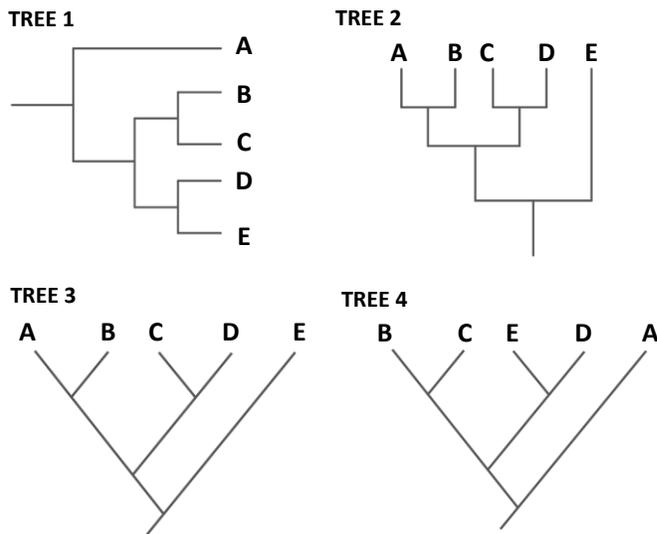
358

359 **Figure 1**

360 Screenshot of an example of a BIOL 302 lecture materials folder as provided to students in April
361 2020 on Blackboard course support software. The folder lists the downloadable lecture materials
362 to be found (including voice-over-PowerPoint lecture recordings and accompanying PDF version
363 of slides for students to follow along with). All files were clearly labeled with the lecture number
364 and sub-identifier for students to more easily keep track. Links to additional external resources
365 fall under two course categories: Supporting External Content for required materials, and
366 Additional Links to External Content (not required). “F & K” refers to (Futuyma and Kirkpatrick
367 n.d.).When relevant, additional supporting resources were provided as they became available.
368 Here, this is exemplified by the link to the Mental Health Commission of Canada’s
369 announcement of its Resource Hub for COVID-19-related support.

370

371



372

373 **Figure 2**

374 Image panel depicting evolutionary relationships among hypothetical species A-E as presented
375 on the final exam for BIOL 302. This panel, accompanied by a hypothetical character matrix,
376 provided reference material for a series of multiple-choice questions requiring interpretation of
377 these relationships.