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Mackay, JRD; Langford, FM; Waran, N

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Massive Open Online Courses As A Tool For Global Animal Welfare Education

Jill R D MacKay, M.Sci, Ph.D.
Researcher in Animal Behaviour and Welfare, Scotland’s Rural College, King’s Buildings, Edinburgh, EH9 3JG

Fritha Langford, B.Sc. (Hons), M.Sc., Ph.D.
Program Director International Animal Welfare Ethics and Law, Scotland’s Rural College, King’s Buildings, Edinburgh, EH9 3JG

Natalie Waran BS.c. (Hons), Ph.D.
Chair of Animal Welfare, Jeanne Marchig International Centre for Animal Welfare Education, Royal (Dick) Veterinary College, Easter Bush, Midlothian, EH25 9RG

Contact Author: jill.mackay@sruc.ac.uk, 0131 651 7396

18 **Abstract**

19 The Animal Behaviour and Welfare Massive Open Online Course (MOOC) hosted on Coursera was a free,
20 introductory animal welfare course. Through interrogating Coursera data and pre/post student
21 experience surveys, we investigated student retention, student experience, changes in attitudes and
22 changes in knowledge. The course ran for five weeks and 33501 students signed up and 16.4% (n=5501)
23 of those received a certificate of achievement, indicating they had completed all assessments within the
24 course. This retention rate is above the industry standard of 10%, however the value of retention rate as
25 a metric to judge MOOC success is questionable. Instead we focus on demographics, with Coursera data
26 estimating that 41% of learners came from Europe, 35% from North America, 11% from Asia, 6% from
27 Oceania, 5% from South America and 2% from Africa. Most learners had completed an undergraduate
28 degree. Despite this wide range of backgrounds, 57.2% of post course respondents (n=2399) strongly
29 agreed that information presented was at the right level and 64.9% strongly agreed that the course was
30 interesting. After completion, more students ($\chi^2(4)=132.40$, $P<0.001$) understood that animal welfare
31 was based on the results of scientific study and significantly fewer students ($\chi^2(4)=361.32$, $P<0.001$) felt
32 health was the most important part of animal welfare. Overall learners agreed the course was enjoyable
33 and informative and 97.9% felt the course was a valuable use of their time. We conclude that MOOCs
34 are an appropriate vehicle for providing animal welfare learning to a wide audience, but require a
35 significant level of investment.

36

37 **Keywords:**

38 Animal welfare, animal welfare education, online learning, veterinary education

39 Introduction

40 The UK's Foresight Report into the future of global farming predicts that, over the next forty years, the
41 world's production animal population will increase by 60-70% ¹. But the report also notes that
42 consumers, on a global scale, are becoming more concerned with animal welfare and what that means
43 for their purchasing habits. Animal welfare is a growing concern, not just for production animals and
44 their consumption, but also within the study of wild animals and companion animals. Veterinary
45 education programs now note, on an international scale, that animal welfare education is often
46 substandard and does not adequately equip veterinary students for practice ²⁻⁴. Furthermore,
47 conservationists are beginning to incorporate the impact of health and human effects on the welfare of
48 wild animals ^{5,6}. There is clearly both demand for and a requirement for easily accessible, international
49 animal welfare education and advocacy.

50

51 Massive Open Online Courses (MOOCs) are internet-based courses which are conducted entirely in a
52 virtual learning environment, feature a high student:teacher ratio, and learning occurs remotely and at
53 the student's leisure. The first MOOC was hosted in 2008 ⁷ and was a credit-bearing course for 2200
54 students on the 'Connectivism' theory of learning. Since the 2008 course, MOOCs have become
55 somewhat fashionable within higher education and several platforms have emerged to host these
56 courses such as MOOC.Org, Udacity.Com, Edx.Org and Coursera.Org. Both universities and organisations
57 can create MOOCs, for example, Coursera hosts courses from National Geographic, the Commonwealth
58 Education Trust and the Museum of Modern Art, alongside their many academic partners.

59

60 Animal welfare is a complex topic. Teaching animal welfare involves exchanging an understanding of
61 animal welfare science, the cultural biases which inform animal welfare and recognition of how ethical
62 philosophy and science interact to produce animal welfare policies ⁸. From a subject perspective, the
63 *'Animal Behaviour and Welfare'* MOOC proves challenging as it must engage people with very different
64 points of view, levels of understanding, background knowledge and levels of education. The diversity of
65 audiences has already been considered as a barrier to MOOC uptake ⁹ and one of the possible
66 contributors to the poor retention rate of students, which can be as poor as 5-10% ¹⁰. The poor
67 retention rate has also been attributed to users wanting different outcomes from the course, e.g. not
68 wishing to sit examinations, or looking for entertainment rather than education ¹¹. Other obstacles in
69 the delivery of MOOCs include the student workload, which is often too high, leading to some claims
70 that the retained students are the 'MOOC survivors' ¹². Despite this, MOOCs have generally been
71 perceived positively by both the students and the teaching staff ¹³, and are currently very popular.

72

73 The University of Edinburgh has partnered with Coursera.Org to produce, as of July 2014, 13 MOOCs,
74 ranging from *'Astrobiology and the Search for Extraterrestrial Life'*, to *'Critical Thinking in Global
75 Challenges'*, *'EDIVET: Do you have what it takes to be a veterinarian?'* and *'Equine Nutrition'*. Despite
76 the prolific nature of MOOCs, the concept is still relatively new and there is little information as to the
77 efficacy of a course in delivering learning, how the user experiences the course, and whether they are a
78 worthwhile use of researcher's time. In this paper we assess our own *'Animal Behaviour and Welfare'*
79 MOOC on all three of these outcomes, using pre and post surveys of knowledge, attitudes and
80 experience, and in-course assessments.

81

82 **Materials and Methods**

83 *Course and Study Overview*

84 The MOOC in question was hosted on the Coursera platform under the title '*Animal Behaviour and*
85 *Welfare*' (coursera.org/course/animal). It was a joint program between the University of Edinburgh and
86 Scotland's Rural College. The course was advertised as an entry-level course with no background reading
87 required to encourage learners with little to no formal science education to take part. It was delivered
88 over a five week period covering The Introduction to Animal Welfare, Measurements for Animal
89 Welfare, Companion Animal Welfare, Production Animal Welfare and Captive Wild Animal Welfare. The
90 course was delivered in English with approximately 1-3 hours of teaching time per week, delivered via
91 video lectures and interactive flash-based presentations created via Articulate (Articulate Global Inc.,
92 2014, New York, The United States). The course began on 14th July 2014. Each week began on a Monday
93 with a weekly Google Hangout Session occurring on the same Friday, where the week's tutor would
94 answer commonly raised questions on the forum. For the purposes of this evaluation, we chose to have
95 a discrete study end date which would allow for comparison between our user surveys and the data
96 provided via Coursera. The study end date was the 25th August, 2014, a full six weeks post the course's
97 start. The teaching commitment from the staff was considered to be completed and no longer available
98 and no longer available to the course participants. As we were interested in the benefits of a
99 connectivism approach to animal behaviour and welfare teaching, it was not considered appropriate to
100 use data post staff involvement. It was on this date that we closed the survey and recorded data from
101 Coursera's usage statistics, although it was still possible for learners to interact with the course materials
102 after this date.

103

104 *Course Conception and Design*

105

106 It could be said that the challenges of a broad user base, high user number and high staff-student ratio
107 are integral to the MOOC format, which is based upon the learning theory of connectivism, ¹⁴.
108 Traditionally MOOCs adopt a connectivism theory of teaching, and these style of MOOCs are often
109 called cMOOCs, to be contrasted with the xMOOC which is closer in style and pedagogy to the
110 traditional classroom, with a 'sage-on-the stage' approach to teaching ¹⁵. While the Coursera platform
111 has been described as an xMOOC platform ¹⁶, many of the connectivism concepts are highly applicable
112 to animal welfare science, which is a dynamic and changing science, requiring continual refreshment
113 training. As one of the major challenges of this course was to provide animal welfare teaching which
114 would be relevant to an international audience, the course was conceived as having a strong
115 connectivist approach, necessitating the broad adoption of discussion boards, the production of a
116 behind the scenes video diary, live Google HangOuts to give learners the opportunity to interact with
117 researchers and vice versa, and learner-led study groups.

118

119 *Course Content and Completion*

120 The content of the course was predominantly custom made for the MOOC, with the exception of two
121 interactive sessions which were adapted from continuing professional development materials created
122 for the International Fund for Animal Welfare ¹⁷.

123 The five weeks of the course were given marketable titles along with their descriptive titles and stated
124 aims (described as learning outcomes on the week's page, although not all aims strictly follow learning
125 outcome format) as detailed in **Table 1**. In addition to these learning outcomes there were also three

126 overarching key messages which dictated the course content. These were based off of the staff
127 experience in communicating animal welfare science to an international audience and were:

- 128 • What we can measure we can manage.
- 129 • It is the animal's experience that matters.
- 130 • Small changes can make a big difference.

131 Each week had core content in the form of video lectures, and then a number of additional content
132 elements such as interactive sessions created in the e-learning Articulate software, interviews with
133 experts, and external links which would allow the students to seek out more information if they so
134 chose. By layering content in this manner, the aim was to accommodate for those who only had a basic
135 understanding of science, while still facilitating those learners who wanted a more comprehensive
136 learning experience.

137

138 Coursera offers two forms of completion certificate to learners who complete course-set standards.
139 These are the Signature Track certificate and the Statement of Achievement (sometimes called the
140 Certificate of Completion or Certificate of Achievement depending on Coursera documentation). To
141 receive a Signature Track certificate, a Coursera user must pay a fee of \$49.00 per course within two
142 weeks of the course's start date. This payment is incurred regardless of whether the user successfully
143 completes the course. The Signature Track uses a web-cam and typing style to confirm the identity of
144 the user taking the test, and is what Coursera promotes as a 'verified certificate', and what Coursera
145 recommends for users who wish to use the course as professional development. We did not promote
146 Signature Track ourselves, but referred users to Coursera's documentation when asked. Our course
147 standard for completion was a score of at least 60% on the five multiple choice quizzes. Three attempts
148 were allowed. The quizzes were not intended to be difficult, but instead were to act as a self-check for

149 the learners. This was the only time learners were asked to demonstrate their knowledge in a
150 conventional form, however demonstration and application of knowledge was observed although not
151 quantified in student-researcher interactions on the discussion boards and Google HangOuts. No
152 element of the course was university credit bearing or accredited by an external body. Example
153 questions are below:

154 What is speciesism?

- 155 a) Allocating the same consideration to all species no matter our personal bias towards particular
156 animals.
- 157 b) Different levels of consideration given to an animal as a consequence of their species rather
158 than any evidence of their ability to feel positive or negative emotions.
- 159 c) Wanting to do research with as many different animals as possible

160

161 Which one of the following was not discussed as a method to enrich the environment of a commercial
162 broiler chicken shed?

- 163 a) vegetables
- 164 b) hay or straw bales to sit on or peck at
- 165 c) perches
- 166 d) footballs
- 167 e) whole grains scattered in the wood shavings litter
- 168 f) natural daylight from windows

169

170

171 *Course Users*

172 The course was advertised via Coursera, the University, the Jeanne Marchig International Centre for
173 Animal Welfare Education (JMICAWE) blog and website, the SRUC website, course tutors personal
174 websites, and via a Behind The Scenes Video Log on YouTube and through the JMICAWE twitter website
175 with the hashtag #EdAniWelf. At the beginning of the course, on 14th July 2014, Coursera recorded
176 25398 students, which rose to 33501 students by the 25th August, considered to be the end total
177 number of students enrolled in the course. 5501 (16.4% of end total) students completed all five
178 multiple choice assessments with a grade of at least 60% in all, qualifying them to receive a certificate of
179 achievement. For demographic data such as gender, age, education status, highest education level and
180 employment status, Coursera estimates percentages based on a subset of learners enrolled who have
181 responded to the Coursera demographic survey. 95% confidence intervals and number of respondents
182 are included for these. Learner location is based off of IP resolution and as such is not always resolved to
183 a specific country (e.g. Europe or 'anonymous proxy IP').

184

185 *Course Evaluation*

186 The course was evaluated in two main formats. The first was through the Coursera platform as an
187 assessment of student performance in weekly multiple choice tests. Pre and post knowledge, attitudes
188 and experience were also assessed through surveys hosted on Survey Monkey. The survey consisted of
189 ten questions assessing demographics, attitudes to animal welfare, knowledge of animal welfare, and
190 learner experience. Questions were developed based on the relevant research of the MOOC literature
191 and the authors' and course instructors' experience of teaching and were based on that used by Read et
192 al.,(2015). First drafts of the questionnaire were circulated around the teaching staff (n=5) for comment
193 and then further refined. The first survey was sent out on the 19th June, 2014 through Coursera emails.

194 Reminders were sent out on the 24th June and 2nd July. The pre survey responses were collected on the
195 14th July. The post-survey was sent out on the 20th August with reminder emails sent out on the 22nd
196 August. The link remained active on the front page of the course until the 10th September when the post
197 survey responses were collected.

198

199 The elective questionnaire was designed to assess three aspects of the learner's progress before and
200 after the MOOC. These were: learner confidence in their animal behaviour and welfare knowledge;
201 learner attitudes to animal behaviour and welfare; and user knowledge about animal behaviour and
202 welfare. With a few exceptions (such as 'What is animal welfare') these were all assessed with a Likert-
203 type scale question, with learners stating how much they agreed with a given statement on a five-point
204 scale from 'No Agreement Whatsoever' to 'Strongly Agree'. All three sections had questions in this
205 format to mask the different aspects of the survey to the respondents. The knowledge questions were
206 phrased as 'true/false' statements, although the respondents answered with agreement.

207

208 Differences between pre course and post course confidence, attitudes and knowledge were assessed
209 using X^2 tables in R (R version 3.1.1., the R Foundation for Statistical Computing). Due to the large
210 numbers of respondents in some categories standardised residuals (as z-scores) are also reported.

211

212 *Processing Survey Data*

213 Users were not counted if they did not answer the first questions "What is animal welfare" resulting in
214 3268 usable respondents in the pre-MOOC assessment. In the post-MOOC assessment, due to the
215 different structure of the questionnaire, users were not counted if they did not answer the question

216 “Did you find the course enjoyable?” resulting in 2397 usable respondents in the post-MOOC
217 assessment. Due to discrepancies in how people entered their native language, all Chinese languages
218 (Cantonese, Mandarin, Chinese, etc.) were described as Chinese. Brazilian Portuguese was collapsed into
219 Portuguese, Bahasa Indonesia into Indonesian, Malay into Malayalam, and the Slovenian, Slovak and
220 Slovene languages were collapsed into Slovene. User’s educational status was collapsed into the main
221 categories based off of ‘other information’ field.

222

223

224 **Results**

225 *Demographics*

226 A comparison of Coursera demographics at the start and end of the course, and elective survey sample
227 pre and post course is given in Table 2. 12.87% (n=3268) of users at the start of the course responded to
228 the elective survey (86.87% Female, 11.96% Male, 0.76% Prefer Not To Say, 0.40% Transgendered). Of
229 these, 35.13% lived in a city, 14.01% in a rural area, 26.71% in a semi-rural or small town, 24.14% in an
230 urban area or large town. Although the majority (67.75%) were English speakers, there were 60 native
231 languages present overall, with Spanish being the next most prevalent at 8.08%, followed by Portuguese
232 (3.12%) and Polish (2.45%). Coursera estimated that 41% of users came from Europe, 35% from North
233 America, 11% from Asia, 6% from Oceania, 5% from South America and 2% from Africa. From both
234 Coursera data and the elective surveys, there was no evidence of a particular demographic leaving the
235 course. The majority of post-course survey respondents (93.1%, n=2232) completed the course and
236 expected to receive a statement of achievement. A small proportion (3.6%, n=86) completed the course
237 but did not expect to receive a statement of achievement, whereas 1.3% (n=32) expected to receive a
238 statement of achievement without completing the course. 1.5% of the respondents (n=35) did not
239 complete all aspects of the course and did not complete the assessments and 0.5% of the elective
240 survey respondents (n=12) dropped out of the course or lost interest. All these respondents were kept
241 in the post-course survey as the experience of those who dropped out or did not complete was
242 considered to be valuable information.

243

244 *Pre and Post Course Confidence*

245 In the elective surveys users were asked to rate their knowledge of both animal behaviour and welfare.
246 There were significant improvements in user rating of post-course confidence in these fields (Behaviour
247 $\chi^2(3)=165.43$, $P < 0.001$, Welfare $\chi^2(3)=238.66$, $P<0.001$). The relative changes in learners knowledge
248 self-rating is shown in **Figure 1**. Overall, significantly more learners rated their knowledge of behaviour
249 and welfare to be 'better than average' or 'excellent' after the course.

250

251 Learners were asked whether they thought they could identify poor welfare and good welfare when
252 they saw it. There was a change between the numbers of learners which felt they 'slightly agreed' or
253 'strongly agreed' with each statement after the course (poor welfare $\chi^2(4)=35.19$, $P<0.001$; good welfare
254 $\chi^2(4)=47.76$, $P<0.001$), with significantly more learners likely to 'agree' rather than 'strongly agree' post
255 course (poor welfare $z=3.18$, $P<0.01$, good welfare $z=3.85$, $P<0.001$) (**Figure 2**).

256

257 *Pre and Post Course Attitudes*

258 Learners were asked to rate their agreement on a 5 point scale (No agreement whatsoever to strongly
259 agree) with the statements "All vertebrate/invertebrate animals have the capacity to suffer". There was
260 a significant difference in pre and post course attitudes to vertebrate suffering ($\chi^2(4)=23.91$, $P<0.001$),
261 with significantly more students agreeing with the statement post course ($z=3.14$, $P<0.01$), although the
262 difference between the numbers of students strongly agreeing with the statement post course was not
263 significant. There was no significant difference in attitudes to invertebrate animal suffering pre and post
264 course ($P=0.06$). This is shown in **Figure 3**. The vast majority of students strongly agreed that it was

265 important to consider both the animal's mental needs (pre 92.7%, n=2954, post 91.2%, n=2105) and
266 physical needs (pre 93.1% n=2966, post 92.0%, n=2109) when thinking about its welfare.

267

268 *Pre and Post Course Knowledge*

269 In the pre and post elective surveys, students were asked to rate their agreement with a series of
270 true/false style statements on a five-point scale. The changes between these answers are given in **Table**
271 **3**. After the course significantly fewer students ($\chi^2(4)=361.32$, $P<0.001$) felt that health was the most
272 important part of animal welfare. More students ($\chi^2(4)=132.40$, $P<0.001$) understood that animal
273 welfare was based on the results of scientific study. Fewer students ($\chi^2(4)=130.10$, $P<0.001$) felt that
274 animal welfare had only recently become an issue for societies. Fewer students ($\chi^2(4)=86.70$, $P<0.001$)
275 felt that wild animals could not experience poor welfare. More students ($\chi^2(4)=404.90$, $P<0.001$) felt
276 that stereotypic behaviours were an indicator that an animal had suffered poor welfare; and more
277 students disagreed ($\chi^2(4)=120.54$, $P<0.001$) that all conservation programs considered animal welfare in
278 their strategies. These were all the expected outcomes post education. However, there was a small but
279 significant increase in the number of students slightly agreeing that it was not possible to have high
280 welfare farming systems ($\chi^2(4)=47.64$, $P<0.001$, $z(\text{post 'slightly agree'})=4.01$) and more students were
281 likely to strongly agree that all companion animals have excellent welfare ($\chi^2(4)=17.6$, $P<0.001$, $z(\text{post$
282 $\text{'strongly agree'})=2.56$), both of which ran contrary to the learning objectives for the course.

283

284 Interestingly, after the course a small but significant portion of students found it harder to define what
285 good welfare was, with more responding it was neither a state of naturalness, contentment, good
286 health, or a combination of all three ($\chi^2(4)=45.83$, $P<0.001$). However the vast majority of students, both

287 before and after taking the MOOC, strongly agreed that it was important to consider both an animal's
288 mental and physical needs (**Figure 4**) with no significant difference between pre and post MOOC
289 responses for mental needs ($\chi^2(2)=2.19$, $P=0.33$) or physical needs ($\chi^2(2)=4.09$, $P=0.13$).

290 *Coursera Assessments and Engagement*

291 As might be expected, there was an ever declining number of students who watched the video lectures
292 (**Figure 5**) but across all video material an average of 5837 (± 2680.2) students watched each lecture.
293 When considering only the main video lectures (e.g. excluding extra interviews with experts, archived
294 Google HangOuts and behind the scenes videos) an average of 6991 (± 2333.2) students watched each
295 lecture. Over the five multiple choice assessments the average score was 89% (± 0.04 percentage points)
296 and an average of 6311 (± 1223.1) students took each quiz, with Week 1 being the most popular (n=8385
297 students) and Week 5 the least (n=5285 students). Note that students were able to submit quizzes post
298 the end date of our study, resulting in 5501 students receiving a statement of achievement having
299 passed all five quizzes to the 60% mark.

300

301 *Post Course Student Experience*

302 98.4% of the post-course respondents agreed or strongly agreed that the course was enjoyable
303 (total=2399) and 97.9% agreed or strongly agreed that the course was a valuable use of their time. A
304 breakdown of student experience can be found in **Table 4**. 69.0% of students agreed or strongly agreed
305 that the information they learned in the course would help them in their professional life and 90.6%
306 agreed or strongly agreed the information they learned would help them in their personal life.

307

308 By separating the course into three main arenas of learning, video lectures, interactive sessions and
309 Google HangOuts, we can compare how enjoyable and informative each arena was for the students. As
310 can be seen in **Figure 6**, most students found the various arenas to be both enjoyable and informative,
311 with 95.0% (n=2265) of respondents agreeing or strongly agreeing that the video lectures were
312 enjoyable and 96.3% (n=2295) agreeing or strongly agreeing that they were informative. Approximately
313 21.6% of respondents said the interactive sections were not applicable to them and 46.6% said the
314 Google HangOuts were not applicable to them. However, of respondents which did choose to utilise the
315 interactive sessions 94.2% (n=1763) enjoyed the interactives and 96.1% (n=1794) thought they were
316 informative. Of respondents who chose to utilise the Google Hangouts, 90.2% (n=1144) enjoyed them
317 and 93.1% (n=1192) thought they were informative. The forums, which did not contain learning material
318 directly but facilitated the learning experience, were also popular with 92.3% (n=2213) of respondents
319 agreeing or strongly agreeing that they were a welcoming environment and 94.5% (n=2264) agreeing or
320 strongly agreeing that they were a safe environment. However it should be noted that the forums were
321 also a source of stress for some users (see below).

322

323 *Post Course Staff Experience*

324 The course had five instructors (including the three authors of this paper) from SRUC and the University
325 of Edinburgh who presented video lectures, created content, participated in Google HangOuts and
326 managed the forum experience. In addition, ten other staff members were present in video lectures or
327 interviews. The five instructors were not formally debriefed, but anecdotally found the experience to be
328 exhausting but mostly positive. We estimate that each week of the course took 4 hours of pre-planning,
329 6 hours of script writing, 6 days of filming, 5 days of editing, and 25 hours to create the interactive
330 sessions. During their week an instructor could spend 3 hours per day moderating the boards, and 3

331 hours for the HangOut and associated preparation. In addition, JM acted as a coordinator. Prior to the
332 course start it's estimated that the coordinator spent 10 hours preparing the site and an additional 5
333 days of editing. During the course, the coordinator offered a more continued presence on the
334 discussion boards (3 hours per day for 5 weeks) and each week would spend 5 hours on the Google
335 HangOut, including preparation and archival. Overall, a staff member responsible for a week's worth of
336 content could expect to spend 152 working hours to prepare the content (760 hours over 5 staff
337 members). If one considers the 5501 learners who received a certificate to have fully engaged with the
338 course, each hour of researcher time was equivalent to 7 unique certificates of achievement.

339

340 Much of the staff time was spent on the elements relating to a connectivism approach, e.g. HangOuts
341 and discussion forum time. The high level of staff engagement with the forums was highlighted in the
342 qualitative comments left in the post-MOOC survey. Within the forums there were issues surrounding
343 'animal rights' versus 'animal welfare', particularly surrounding diet choice, and this was the
344 predominant concern raised by students in the qualitative comments of the elective survey:

345

346 [What was the most negative part of the course?] *"Some of the comments from*
347 *participants in the forums were judgmental and/or promoted their personal agendas*
348 *as being the "right" or "only" way to be. An overwhelming amount of comments to*
349 *get through, so I was unable to read them all."*

350

351 [What was the most negative part of the course?] *"The forums. However, I realize*
352 *that a topic such as this can cause more difficulty when discussing. I was*

353 *disappointment[sic] by a post from one instructor issuing a warning to someone*
354 *based on a comparison that commentator used. It discouraged me from participating*
355 *and it reluctantly finished the course.”*

356

357 It should also be noted that staff members had a policy of non-interference with regards to posts that
358 asked for situation specific advice or clinical consultation. We also noted that in such threads there was
359 sometimes misinformation and poor advice given by other students, although these cases were in the
360 minority. This did provide some of the staff with ethical dilemmas. There was also one instance of
361 repeated abuse of staff, both of a sexual and political nature, which resulted in one user being banned
362 from the forums. While these abuses were by far a minority of cases, the political volatility of the subject
363 at large cannot be ignored. By taking a connectivism approach to teaching the subject of animal welfare,
364 staff members are left vulnerable to abuse.

365

366 **Discussion**

367 The aims of this course were to:

- 368 • Provide an introduction to animal behaviour and welfare to an international audience.
- 369 • Facilitate the flow of information between animal welfare research and the public.
- 370 • Provide an accessible way to upskill current workers in animal related industries.

371 With a course retention rate of 16.4%, the Animal Behaviour and Welfare MOOC can be considered
372 successful in comparison to MOOCs in general ^{11,18}. The large drop off in student attendance from the
373 first learning material (Figure 5) is typical of MOOCs ¹⁸ and yet this MOOC had a shallower drop off than

374 most and boasted an impressive retention rate well above the industry standard of 10% and other
375 course retention rates reported in the online and in literature (7% for Software Engineering ¹⁹, 5% for
376 Circuits and Electronics ¹⁶, 3% Bioelectricity ¹¹. Over 95% of students felt that the video lectures were
377 enjoyable and informative, which may explain the higher retention rate as courses pitched at too high a
378 level ¹² are associated with lower retention. In addition it may be that the practical need for good
379 quality animal welfare teaching ^{20,21} and the ability to use the certificate as evidence of continued
380 learning was a strong motivator for some of the students to remain within the course. The high
381 retention rate of this MOOC may indicate the need and demand for resources such as this, and should
382 be taken into consideration by others endeavouring to spread animal welfare science knowledge.

383

384 Retention rates are commonly used as a metric of course success, and by this metric the Animal
385 Behaviour and Welfare MOOC was successful, however retention rate is a relatively blunt tool to use to
386 assess the learner response to materials. As MOOCs themselves are highly variable in content, design
387 and aims, the easily calculated retention rate has been a go-to metric to compare courses, although not
388 without criticism ^{11,16}. We would argue that, despite our own success in retention rate, it does not
389 adequately represent the student experience or course evaluation. To fully describe student satisfaction
390 there needs to be a greater understanding of what MOOCs offer to prospective students, and what
391 motivates learners to take MOOCs. For example, if a potential learner is curious about what animal
392 welfare is, they may join the course, but receive the answer to their question in the course's
393 introductory materials. They may then choose not to participate any longer in the course, their initial
394 question answered. In terms of retention rate this situation is an abject failure, as the student has not
395 completed the quizzes and so isn't counted as having 'completed' the course. However, in terms of that
396 learner's experience it may in fact be a highly positive outcome as they have fulfilled their motivations

397 without spending more time than they wanted to. It is very difficult to capture this kind of interaction
398 quantitatively, but this example serves as a reminder that MOOC learners are not necessarily the
399 traditional students aiming to receive certification. The narrow focus on retention rate in MOOCs is too
400 concentrated on certification, therefore in this evaluation we attempted to capture the learner's
401 experience as alternative measures of success. For example, despite the wide audience and previously
402 mentioned cultural variation in attitudes to animal welfare, 57.2% of post course respondent strongly
403 agreed that the information presented was at the right level and 64.9% strongly agreed that the
404 information in the course was interesting. This is a more promising indicator that the MOOC was
405 successful in its aims to provide flexible learning for learners from a range of backgrounds. It is still not
406 possible to gauge the experience of those who did not interact with the community or the surveys, but it
407 would not be reasonable to assume their experience was a negative one.

408

409 Bearing in mind both the criticisms of retention rate and the overall high drop-out rate for these
410 courses, are MOOCs a waste of educator's time? While it is difficult to say without knowing the details
411 of time spent on other MOOCs, we suggest the relative success of this MOOC is proportional to the time
412 spent creating the course materials and engaging with learners. Science outreach is well supported both
413 by the Royal (Dick) School of Veterinary Studies and Scotland's Rural College, both of which have a
414 mandate to produce impactful research. At an outreach event such as the Royal Highland Show, a single
415 researcher might be expected to spend 10-20 hours in face-to-face time with 30-40 stakeholders at best,
416 some for less than a minute. At 150 hours per week of the MOOC, each educator/researcher has had
417 sustained interaction with the 5000+ students who received a statement of achievement at the end of
418 the course. 7 certificates per 1 hour of educator/researcher time is a greater return on time investment

419 than a traditional, high impact face-to-face science outreach event, and this rate should increase with
420 each iteration of the course.

421

422 The high exam scores and generally good acquisition of animal behaviour and welfare related
423 knowledge are encouraging, but should not be overly exaggerated as these are effectively open-book
424 exams. They can at least demonstrate basic knowledge retention and 'know-where' learning, as the
425 information was neither unable to be recalled or found. For most of the knowledge related statements,
426 post-MOOC agreement concurred with the learning outcomes, however there were a few statements
427 where students agreement did not follow the intended learning outcomes, for example with
428 significantly more students strongly agreeing that all companion animals had good welfare and slightly
429 agreeing that it was not possible to have high welfare farming systems. While this may not be factually
430 incorrect, it is an unexpected outcome from the teaching materials. It may be that companion animal
431 welfare, in comparison to wild and productive welfare examples, was presented as being easier to
432 maintain or achieve. Comparably, practical production animal welfare may have appeared more
433 disturbing in comparison to wild and companion animal welfare. It may be that this second conclusion
434 was reached in part because of the strong animal rights component in the forums, and this should be
435 considered for future courses as an inevitable outcome of the connectivist approach where staff are not
436 the only teachers. While we think it is important that students draw their own conclusions from an
437 evidence based analysis, we also think it's important to present animal welfare science in a balanced
438 manner, and it may be that we did not appropriately highlight welfare challenges faced by some
439 animals. Despite this, the change in the learners' confidence to recognise good and poor animal welfare
440 at the end of the course was very encouraging. More students were likely to agree that they were able
441 to recognise different welfare conditions, and fewer students were likely to strongly agree. It may be

442 that they recognised what knowledge they did not have after the course, particularly as learners were
443 significantly more likely to recognise that animal welfare was based on the results of scientific study.
444 This is also seen in the significant increase in the number of students who answered that good welfare
445 was not a combination of good health, contentment and naturalness. If, after the course, some students
446 found animal welfare harder to define, this may reflect a greater understanding of the complexity of the
447 subject.

448

449 While the forums and HangOuts are an important aspect of connectivism related teaching, they did
450 present an added challenge. Connectivism has underpinned MOOC learning through promoting the role
451 of social and cultural context within learning and is often considered to be a 'learning theory for the
452 digital age'²². It identifies several trends in learning, such as the mobility of learners into different
453 fields, the importance of informal learning (e.g. outside of a classroom environment), the uptake of life-
454 long learning, and change from 'know-how' and 'know-what' to 'know-where', where students
455 understand where to find learning materials, rather than memorising facts by rote. The main thrust of
456 connectivism theory proposes that learning occurs in communities and the interaction, sharing and
457 dialogue are integral parts of the learning process²³. In some respects, animal behaviour and welfare,
458 with the hotly contested issues of animal rights, is a challenge to communicate in this medium.
459 Challenging disruptive classroom influences in an online environment is very different from the
460 classroom, much as others have discovered before us²⁴. Kellogg notes that many MOOC sceptics do not
461 believe that the same breadth of knowledge can be achieved in an online course as in a classroom
462 course. We recognise this conundrum, but argue that within the aim of introducing a wide user base to a
463 subject, MOOCs have almost no rival. They should not be viewed as a replacement to classroom based
464 learning, but as a complimentary method of further science education. We should note that 3.6% of the

465 post-course respondents had completed the course but did not expect to get a certificate of
466 achievement, i.e. they had not carried out the assessments. In addition, 1.3% of respondents had not
467 completed all aspects of the course but still expected a statement of achievement. While these are small
468 proportions of the post-course respondents, they represent two distinct components of the MOOC-
469 taking population: those who prioritise the learning and materials, and those who prioritise the
470 achievement of 'finishing'. It is entirely likely that these subpopulations were under-sampled in both
471 elective questionnaires. The MOOC sceptics may wonder which populations should be targeted, i.e. how
472 can one encourage the learning-focussed population to increase their engagement and receive
473 certificates, thus making them part of the 'success' output receiving certificates. We would argue this is
474 not the function of MOOCs and, if anything, the different needs of users should be more fully catered
475 for. More informative labelling of materials, for example, into 'core', 'additional' and 'for interest' may
476 help to allow students to choose how much depth they wish to go into for a given subject. To this end,
477 when we ran the course for its second iteration we are added a sixth week to pick up on some of the
478 issues some users wanted to see more of, but marked it as 'additional' to indicate that students are not
479 required to take this week to understand the main learning outcomes of the course.

480

481 Overall, while the 16% retention rate is an impressive indicator of the MOOC's success, we would
482 strongly argue that those wishing to use the MOOC format to teach should adopt a multi-layered
483 approach and investigate whether students left the course satisfied, rather than necessarily aim for a
484 high retention. We would also encourage MOOC providers to report on their numbers, as there appears
485 to be a tipping point in retention rate between appealing to a large general audience (many of whom
486 are not invested in completion), and appealing to a small specific audience (who are invested in
487 completion). Further, potential MOOC providers should consider whether they wish to spend time

488 creating a truly connectivist MOOC (or cMOOC), versus a less time intensive xMOOC, and whether the
489 exchange of knowledge between researcher and learner is a key aim

490

491

492 **Conclusions**

493 In conclusion we are satisfied that the aims of this MOOC were met, and that it can be considered
494 successful by most metrics. We are keen to develop the community aspect of learning, making it more
495 friendly and approachable for users and instructors. We believe that the free distribution of animal
496 welfare science teaching has significantly improved the animal behaviour and welfare knowledge of
497 thousands of users, some of whom are in prime positions to make an impact in practical animal welfare.
498 For this reason, we believe that animal welfare educators should attend to the need and desire for more
499 animal welfare resources.

500

501

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563 **Figure Headings**

564 **Figure 1** *Learners self-ratings of the animal behaviour knowledge and animal welfare*
565 *knowledge before and after MOOC.*

566 **Figure 2** *Learners self-ratings of their ability to recognise good and poor animal welfare pre and*
567 *post MOOC.*

568 **Figure 3** *Pre and post MOOC responses to the question “What is good welfare”, * denotes*
569 *P<0.001 in a Chi2 test.*

570 **Figure 4** *Pre and post MOOC agreement that it is important to provide for mental and physical*
571 *needs of animals. ‘Unsure or Disagree’ encompasses ‘Neither Agree nor Disagree’, ‘Slightly*
572 *Disagree’ and ‘No Agreement Whatsoever’.*

573 **Figure 5** *Total number of individual students which viewed each video lecture hosted on*
574 *Coursera, both Signature Track (who paid \$49.00 for an identification verified certificate) and*
575 *Non Signature Track (who received a free, non identification verified certificate) users.*
576 *† denotes an archived Google HangOut and does not include YouTube viewership.*
577

578 **Figure 6** *User agreement with learning tools being described as ‘enjoyable’ and ‘informative’.*

579

Table 1 *Content of Animal Behaviour and Welfare Massive Open Online Course and Learning Aims*

Week Number (Title)	Learning Outcomes
1 The Introduction to Animal Welfare (What is Animal Welfare and Why Does it Matter?)	<ul style="list-style-type: none"> • Recognise that animal welfare is a complex subject and involves a number of different disciplines including ethics, science and law. • Understand there are a number of different ways to define and describe animal welfare. • Understand there are international standards that can be applied to safeguard animal welfare. • Define animal sentience, i.e. that animals feel, so ultimately is the animal's own experience that counts most when considering animal welfare
2 Measurements for Animal Welfare (What We Can Measure We Can Manage)	<ul style="list-style-type: none"> • Recognise that what we can measure can be managed, e.g. through behavioural testing and physiological measures. • Understand that we need to be careful about keeping our perceptions and expectations of our pets separate from the animal's experience. For example, a dog's needs remain the same regardless of whether it is a shelter dog, a street dog, or a pet dog.
3 Companion Animal Welfare (The Truth About Dogs and Cats)	<ul style="list-style-type: none"> • Recognise the need to keep our perceptions and expectations of our pets separate from the animal's experience. • Contrast the various issues that arise as a result of the different dog situations. • Consider the role of pets in a society - surrogate child (dog), utility and sport (horse) and meat (e.g. dogs and cats). • Identify the main welfare issues for many household pets (e.g. lack of control). • Describe the specific welfare issues and solutions with dogs and cats in the shelter environment in different parts of the world
4 Production Animal Welfare (Down on the Farm)	<ul style="list-style-type: none"> • Recognise there are many reasons for the increased numbers of production animals and the general issues associated with an intensification of farming. • Consider the welfare challenges associated with farming pigs, poultry and dairy cows for producing animal based products. • Discuss the different points in the production cycle that can be of welfare concern. • Describe the evidence for welfare challenges in live animal transport and understand where solutions can be applied.
5 Captive Wild Animal Welfare (Lions, Tigers and Bears, Oh My!)	<ul style="list-style-type: none"> • Describe common conflicts between ecological conservation and animal welfare. • Describe the management of wild animals in captivity and the various ways they are kept - e.g. zoo, circus, sanctuary. • Discuss the role of the responsible zoo in conservation and animal welfare.

581 **Table 2** Student demographics based on data from Coursera and the elective surveys.

	Coursera Sample At Course Start (14/07/2014)	Coursera Sample At Course End (25/08/2014)	Pre-Course Elective Survey	Post-Course Elective Survey
Total Students/ Respondents	25,398 Female 72% Male 27%	33501 Female 70% Male 29%	3268 Female 86.87% Male 11.96% Prefer Not To Say 0.76% Transgendered 0.40%	2397 Female 81.44% Male 17.40% Prefer Not To Say 0.83% Transgendered 0.33%
Age Range (Years)	±2 percentage points			
	Females	Males	Females	Males
13-19	2%	1%	2%	1%
20-29	25%	10%	24%	10%
30-39	16%	7%	15%	7%
40-49	12%	3%	12%	4%
50-59	10%	3%	10%	4%
60-69	5%	2%	5%	2%
70+	1%	0.70%	2%	0.80%
Highest Education Level	±2 percentage points, based on 1,895 learners			
No Schooling Completed	0.20%	0.10%		
Some primary or elementary school	0.80%	0.70%	0.37%	0.50%
Some High School	4%	3%	3.27%	3.33%
High School Diploma	9%	9%	8.84%	7.68%
Some College but No Degree	15%	15%	25.46%	22.99%
Completed a college or university degree	40%	39%	37.91%	37.17%
Completed a postgraduate qualification (e.g. M.Sc, PhD, PGDip)	31%	33%	24.14%	28.12%

Employment Status	±2 percentage points, based on 1850 learners			
Full Time	37%	38%	42.84%	39.29%
Part Time	13%	13%	12.67%	11.51%
Unemployed	25%	13%	15.94%	16.52%
Self-Employed	12%	12%	14/72%	16.77%
Other	13%	14%	N/A	N/A
Student	N/A	N/A	13.83%	15.89%

583 **Table 3** Learner agreement with fact-related statements pre and post MOOC, X^2 and z-scores
 584 given (* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$)

Statement	Agreement	Pre % of Respondents (n)	Post % of Respondents (n)	X^2 and Post z scores.
Animal health is the most important part of animal welfare.	No agreement whatsoever.	0.9% (28)	4.1% (94)	$z=6.02$ ***
	Slightly disagree.	5.6% (178)	14.9% (341)	$z=8.42$ ***
	Neither disagree nor agree.	15.6% (496)	23.5% (536)	$z=5.03$ ***
	Slightly agree.	40.0% (1271)	36.9% (843)	$z=-1.38$
	Strongly agree.	37.9% (1204)	20.5% (469)	$z=-8.72$ *** $X^2(4)=361.32$ ***
I understand that animal welfare is based on the results of scientific study	No agreement whatsoever.	1.5% (48)	2.1% (48)	$z=1.23$
	Slightly disagree.	5.2% (164)	5.7% (131)	$z=0.68$
	Neither disagree nor agree.	26.9% (857)	14.7% (338)	$z=-7.25$ ***
	Slightly agree.	35.1% (1117)	36.0% (825)	$z=0.43$
	Strongly agree.	31.3% (998)	41.4% (950)	$z=4.72$ *** $X^2(4)=132.40$ ***
Animal welfare has only recently become an issue for human societies	No agreement whatsoever.	10.5% (323)	18.4% (428)	$z=5.84$ ***
	Slightly disagree.	25.6% (787)	25.2% (585)	$z=-0.21$
	Neither disagree nor agree.	12.7% (390)	8.7% (203)	$z=-3.26$ **
	Slightly agree.	38.1% (1171)	29.4% (682)	$z=-4.08$ ***
	Strongly agree.	13.1% (404)	18.2% (423)	$z=3.57$ *** $X^2(4)=130.10$ ***
Unlike production and companion animals, wild animals cannot experience poor welfare.	No agreement whatsoever.	54.5% (1669)	66.3% (1533)	$z=4.18$ ***
	Slightly disagree.	31.6% (968)	22.5% (520)	$z=-4.75$ ***
	Neither disagree nor agree.	7.4% (226)	4.8% (108)	$z=-2.98$ **
	Slightly agree.	4.0% (121)	3.7% (85)	$z=-0.39$
	Strongly agree.	2.5% (76)	2.8% (65)	$z=0.56$ $X^2(4)=86.7$ ***
All companion animals have excellent welfare.	No agreement whatsoever.	66.7% (2047)	66.8% (1545)	$z=0.04$
	Slightly disagree.	25.2% (774)	23.5% (544)	$z=-0.94$
	Neither disagree nor agree.	4.9% (149)	4.4% (101)	$z=-0.62$
	Slightly agree.	2.1% (65)	3.0% (69)	$z=1.50$
	Strongly agree.	1.1% (34)	2.3% (53)	$z=2.56$ ** $X^2(4)=17.6$ ***
Stereotypic behaviours are an indicator that an animal has suffered poor welfare.	No agreement whatsoever.	5.8% (178)	5.0% (116)	$z=-0.95$
	Slightly disagree.	17.0% (519)	12.8% (297)	$z=-2.91$ **
	Neither disagree nor agree.	30.7% (938)	13.4% (311)	$z=-9.79$ ***
	Slightly agree.	29.7% (909)	31.2% (723)	$z=0.75$
	Strongly agree.	16.9% (516)	37.5% (870)	$z=11.16$ *** $X^2(4)=404.90$ ***
It is not possible to have high welfare farming systems.	No agreement whatsoever.	39.9% (1223)	36.3% (838)	$z=-1.6$
	Slightly disagree.	33.8% (1037)	36.0% (832)	$z=1.02$
	Neither disagree nor agree.	14.0% (430)	10.5% (243)	$z=-2.17$ **
	Slightly agree.	8.1% (250)	12.8% (296)	$z=4.01$ ***
	Strongly agree.	4.1% (127)	4.4% (102)	$z=0.36$

All conservation programs consider animal welfare in their strategies.	No agreement whatsoever.	13.6(418)	19.3% (446)	$\chi^2(4)=47.64$ ***
	Slightly disagree.	33.4(1024)	39.6% (916)	$z=3.87$ ***
	Neither disagree nor agree.	29.4(903)	17.6% (406)	$z=2.84$ **
	Slightly agree.	17.7(543)	16.6% (384)	$z=-6.61$ ***
	Strongly agree.	5.8(179)	7.0% (161)	$z=-0.73$
				$z=1.23$
				$\chi^2(4)=120.54$ ***

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586

587 **Table 4** *Student experience post MOOC*

Student Experience	Agreement	N	% of Respondents
The course was enjoyable.	Strongly Disagree	13	0.5%
	Disagree	23	1.0%
	Agree	885	36.9%
	Strongly Agree	1476	61.6%
The course was a valuable use of my time.	Strongly Disagree	14	0.6%
	Disagree	35	1.5%
	Agree	986	41.1%
	Strongly Agree	1362	56.8%
The course was easy to use.	Strongly Disagree	11	0.5%
	Disagree	41	1.7%
	Agree	900	37.6%
	Strongly Agree	1445	60.3%
The course pages looked appealing.	Strongly Disagree	9	0.4%
	Disagree	25	1.0%
	Agree	1043	43.5%
	Strongly Agree	1320	55.1%
The course videos looked good.	Strongly Disagree	15	0.6%
	Disagree	35	1.5%
	Agree	891	37.2%
	Strongly Agree	1456	60.7%
The information in the course was interesting	Strongly Disagree	20	0.8%
	Disagree	29	1.2%
	Agree	793	33.1%
	Strongly Agree	1555	64.9%
The information was at the right level	Strongly Disagree	26	1.1%
	Disagree	177	7.4%
	Agree	824	34.4%
	Strongly Agree	1370	57.2%
A traditional, more paper based approach would have been better.	Strongly Disagree	754	31.5%
	Disagree	1297	54.1%
	Agree	122	6.1%
	Strongly Agree	224	9.4%

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