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### **Student engagement and perceptions of blended-learning of a clinical module in a veterinary degree program.**

**Citation for published version:**

Kelly, R, Mihm-Carmichael, M & Hammond, JA 2019, 'Student engagement and perceptions of blended-learning of a clinical module in a veterinary degree program.', *Journal of Veterinary Medical Education*.  
<https://doi.org/10.3138/jvme.2019-0018>

**Digital Object Identifier (DOI):**

[10.3138/jvme.2019-0018](https://doi.org/10.3138/jvme.2019-0018)

**Link:**

[Link to publication record in Edinburgh Research Explorer](#)

**Document Version:**

Peer reviewed version

**Published In:**

Journal of Veterinary Medical Education

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1 **Title**

2 *Student engagement and perceptions of blended-learning of a*  
3 *clinical module in a veterinary degree program.*

4  
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6  
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13  
14 **Keywords**

15 Blended learning; Veterinary education; eLearning; Farm Animal; Clinical;  
16 Multimedia; Videos; Student perceptions; Case-based learning; Student  
17 engagement.

18  
19 **Abstract (250/250 words max)**

20 Blended learning has received much interest in higher education as a way to  
21 increase learning efficiency and effectiveness. By combining face-to-face teaching  
22 with technology-enhanced learning through online resources, students can  
23 manage their own learning. Blended methods are of particular interest in  
24 professional degrees such as veterinary medicine where students need the  
25 flexibility to undertake intra and extra-mural activities in order to develop the  
26 range of competencies required to achieve a professional qualification. Yet it is  
27 unclear how veterinary students engage with blended learning activities and  
28 whether they perceive the approach as beneficial.

29  
30 This article evaluates blended learning through review of student feedback from  
31 a 4-week-clinical module in a veterinary degree programme. The module  
32 combined face-to-face sessions with online resources. Feedback was collected  
33 using a structured-online questionnaire at the end of the module and log data  
34 collected as part of a routine teaching audit. The features of blended learning  
35 that support and detract from the student learning experience were explored  
36 using quantitative and qualitative methods.

37  
38 Students perceived a benefit from aspects of the face-to-face teaching and  
39 technology-enhanced learning resources. Face-to-face teaching was appreciated  
40 for practical activities whereas online resources were considered effective for  
41 facilitating module organisation and allowing flexible access to learning  
42 materials. The blended approach was particularly appreciated for clinical skills  
43 where students valued a combination of visual resources and practical activities.  
44 Although this study identified several limitations with online resources, which  
45 need to be addressed when constructing blended courses, blended learning  
46 shows potential in clinical courses to enhance student-led learning.

48

## 49 **Introduction**

50 Professional degree courses require a balance of workplace learning  
51 opportunities with academic elements of the curriculum (1,2). Like other  
52 undergraduate students, those studying for professional degrees have to fit their  
53 study around other life commitments, which can complicate and disrupt  
54 timetabling academic and workplace commitments (3–5). For example, in the UK  
55 professional training of veterinary surgeons is knowledge intensive, applied and  
56 focused on omni-competence (6). Historically this has led to heavy lecture  
57 schedules and significant contact time with veterinary educators to enable  
58 students to attain the competencies required to register as a veterinary surgeon  
59 (7). Students are also obliged to complete work experience in clinical practice,  
60 undertaken in addition to their academic studies, to develop clinical and  
61 workplace skills. Furthermore, as contemporary veterinary practice is becoming  
62 more specialised (8), the scope of knowledge expected of veterinary graduates is  
63 increasing further, despite the program length remaining the same. Thus, the  
64 challenge for today’s veterinary educators is to prepare graduates to enter the  
65 workplace with the applicable skills set and knowledge to “hit the ground  
66 running” by helping them to be time efficient and lifelong learners (9).

67 In response to student study and life commitments, many higher education (HE)  
68 courses are adopting student-centred learning approaches to their teaching  
69 (10,11). The aim is to allow students to choose when, where and how they learn  
70 course content (10). “Blended learning” (BL) is one of the student-centred  
71 learning approaches being adopted by HE institutions. When designing new  
72 blended courses, educators aim to balance the use of face-to-face (F2F) with  
73 technology-enhanced learning (TEL) resources to meet these personal needs of  
74 the learner (12). Technology-enhanced learning resources are often used to  
75 replace some of the F2F aspects of the course yet it is integral that all resources  
76 still align to course intended learning objectives (ILOs) (13). Increased interest  
77 in the TEL aspect of BL is set to continue for students who are increasingly able  
78 to choose their mode, pace and place of learning (14), and for organisation of  
79 course content. Blended learning techniques may be well suited to veterinary  
80 medicine training to balance academic and workplace learning commitments.  
81 Blended learning techniques may also encourage independent lifelong learning  
82 that is vital to the contemporary veterinary surgeon within their profession  
83 (9,15). Although extensive research has been conducted in medical schools (16–  
84 19), it is unknown whether BL methods are perceived as beneficial to student  
85 learning in the context of veterinary education. A main theme from medical  
86 experience is that BL methods are positively perceived by students, but only if  
87 courses are designed to benefit their learning rather than being a replacement  
88 for staff F2F teaching time (16).

89 Deep learning involves stepwise construction and application of knowledge to  
90 promote critical thinking in order to embed learning content (20,21). Developing  
91 skills in critical thinking and problem solving are vital to the clinical ability of a  
92 veterinary surgeon, requiring development throughout undergraduate studies  
93 and beyond (22,23). Using multimodal learning methods to teach students can  
94 encourage development of critical thinking and problem solving skills (24,25).

95 The overuse of TEL over F2F methods can lead to student disengagement and  
96 promote superficial learning rather than deep learning practices (26). As the  
97 quality of student learning could be influenced by the balance of F2F and TEL  
98 activities within a BL course, it is important to assess student engagement with  
99 these activities.

100 This paper explores student perceptions and engagement with a novel blended-  
101 learning module within a clinical component of a UK five year undergraduate  
102 veterinary degree program. Specifically we aimed to establish how students  
103 engage with different elements of TEL and F2F activities, including access times  
104 and patterns to online resources. We also evaluated the range of student  
105 perception of blended learning elements, including workload and relevance of  
106 TEL and F2F resources.

107

## 108 **Materials and methods**

### 109 *Context*

110 Since 2013, the Glasgow University School of Veterinary Medicine (GU-SVM)  
111 Bachelor in Veterinary Medicine and Surgery (BVMS) degree program has  
112 undergone a major curriculum restructure with a focus on ensuring the  
113 competency and employability of graduating veterinary surgeons. The  
114 restructure was more broadly supported by Glasgow University's "E-Learning  
115 Strategy 2013-2020" (27) with inclusion of BL principles. Specifically, the new  
116 degree program structure champions student-centred learning by encouraging  
117 independence, choice and flexibility in the individual students' learning  
118 experience. The new BVMS degree was split into foundation (Years 1-2) and  
119 clinical (Years 3-4) phases in order to prepare students for the supervised  
120 workplace based final year, or professional phase (Year 5). Both the foundation  
121 and clinical phases utilised BL via fewer lectures, more practical classes and  
122 small group case-based learning (CBL) sessions (28). Case-based sessions were  
123 facilitated F2F, complemented through online activities using the University's  
124 virtual learning environment (VLE). The new permutation of the BVMS program  
125 integrates scientific and clinical disciplines throughout the degree, aiming to  
126 promote better application of core knowledge through independent learning.

127

128 The first implementation of the two year clinical phase started in 2015-16, with  
129 the third year considered as a course incorporating six four week long modules  
130 and one two week long module (Figure 1). As part of the third-year clinical  
131 phase, a new four week module integrated four core clinical farm animal  
132 disciplines. These disciplines included 1. Clinical ruminant medicine and surgery  
133 2. Ruminant parasitology 3. Population medicine/ epidemiology and 4.  
134 Pharmacology. The structure of the module was organised through the UG-SVM  
135 VLE (Moodle®), where students could access resources at any time of the day.  
136 Primarily the module was made up of F2F and TEL activities (Supplementary  
137 material 1). For TEL resources, students had availability from day 1 of the  
138 module Some of the TEL activities were hosted on another VLE platform  
139 (Mahara®) linked to the UG-SVM VLE. Students were guided through the module  
140 by being given access to different activities in each of the 4 weeks via the UG-

141 SVM VLE (Figure 2). To encourage learners to apply the knowledge taught across  
142 these disciplines, online TEL resources were designed to complement F2F  
143 sessions as self-directed tasks (Figure 2). The self-directed TEL resources fitted  
144 into four core clinical farm animal disciplines (Supplementary material 1).  
145 Nominal timetable slots were allocated for TEL activities, although it was stated  
146 on the VLE that students could choose when to engage with TEL activities. All the  
147 TEL resources were designed in consultation with other members of the Farm  
148 Animal Clinical Sciences Division.

149 Compared to other modules in the Clinical phase, this module extended and  
150 formalised the use of BL approaches, for example through additional use of TEL  
151 activities, such as online CBL activities. In addition, there was an emphasis on  
152 designing complementary use of TEL activities to enhance the benefit of F2F  
153 sessions, such as online clinical examination videos provided before a practical  
154 clinical examination class.

155

### 156 *Study design and data collection*

157 To assess student engagement and perceptions of blended learning, we sampled  
158 students who were enrolled in the first cycle of the module (January and  
159 February 2016).

160 To assess student engagement in the module, attendance at F2F teaching  
161 sessions was recorded by class registers. To evaluate the access and use of the  
162 online TEL activities for the module; log data were accessed for each TEL activity  
163 within the module through UG-SVM VLE and exported as CSV files for further  
164 analysis. Each student access event was defined as the student either starting or  
165 downloading the TEL resource, depending on the nature of the resource. For  
166 example, a download of a lecture and accessing a quiz from the start were each  
167 classified as a singular access. Class attendance and log data was collected for all  
168 students enrolled in the module. Data was recorded for 6 weeks, 4 weeks of the  
169 module and 2 weeks leading up to submission of the summative assessment was  
170 collected from all students enrolled in the module.

171 To assess student perception of the module, we used student feedback collected  
172 as part of routine teaching evaluation and audit. Specifically, student feedback on  
173 the module were collected via a structured-online questionnaire. All students  
174 enrolled in the module had access to the questionnaire from the middle of the  
175 fourth week of the module. An email sent to request students completed the  
176 feedback questionnaire, although feedback was voluntary and did not influence  
177 academic progression. An email was sent to request students to complete  
178 feedback. Students were also reminded in a lecture on the last day of the module.  
179 It was assumed that students were familiar with using the UG-SVM VLE feedback  
180 tool, as similar methods have been used in previous modules in the Foundation  
181 Phase (Years 1 & 2) of the BVMS degree. The questionnaire was created using a  
182 survey tool within the UG-SVM VLE (Supplementary material 2). Questions were  
183 split into three sections: 1. Quality of module content related to the module  
184 Intended Learning Outcomes (ILOs), 2. F2F teaching practices and 3. TEL  
185 resources. Questions were predominantly in the form of statements that invited

186 students to choose their level of agreement with the statement. Options were  
187 based on a 5-point Likert scale of “Strongly agree” (SA), “Agree” (A), “Neutral”  
188 (N), “Disagree” (D) and “Strongly disagree” (SD) (29). Additional free text  
189 questions were added to allow further elaboration on certain aspects of the  
190 questionnaire particularly concerning TEL resources.

191

### 192 *Data analysis*

193 Both qualitative and quantitative data were anonymised prior to analysis.  
194 Quantitative data collected from the questionnaire (including Likert scale  
195 responses) and UG-SVM VLE logs were analysed using simple summary statistics  
196 (Median and proportions) and descriptive graphs in Microsoft® Excel.

197

198 Qualitative data collected through the questionnaire were analysed by the lead  
199 author (RK) employing a simple thematic analysis using an inductive approach  
200 (30,31). Two researchers were involved in this process. The lead author (RK)  
201 was the organiser of the module and has a background in farm animal practice.  
202 The second author (JH) is not directly involved with the module, but has an  
203 understanding of the curriculum as leader of the final year of the BVMS  
204 Programme with a background in small animal practice and veterinary  
205 education.

206

207 Firstly, qualitative questionnaire data was exported as a Microsoft Excel®  
208 spreadsheet. All questionnaire statements were read and re-read to develop a  
209 preliminary coding structure. Then the lead author coded all statements to each  
210 of the preliminary codes and grouped related codes to form subthemes using  
211 colour coding within the spreadsheet. Each response may have had more than  
212 one subtheme attributed to it. Once completed, the subthemes were organised  
213 into major themes using a second colour code. A second author (JH) reviewed  
214 the initial coding approach and both authors discussed areas of difference,  
215 agreeing a final coding structure and allocation of comments to codes, related  
216 codes to subthemes, and subthemes to themes. Although the aim of the exercise  
217 was to represent rather than quantify the range of perceptions captured in the  
218 free-text comments, the number of statements associated with each theme and  
219 subtheme is reported to illustrate that the themes identified are characteristic of  
220 this set of individuals and to illustrate the diversity of perceptions in the group  
221 studied(32).

222

### 223 *Ethics*

224 The teaching evaluation was conducted at GU-SVM (part of the College of  
225 Medical, Veterinary and Life Sciences (MVLS) at the University of Glasgow).  
226 Ethical approval for retrospective analysis of routinely collected data has been  
227 granted under MVLS VLE research guidance and the GU-SVM privacy notice  
228 published on the Vet School General Resource read by all students, and projects  
229 are under the oversight of a School Data Custodian to ensure appropriate use  
230 under the General Data Protection Regulation. In addition, ethical approval for  
231 the evaluation of blended and online learning developments was granted by the  
232 MVLS Research Ethics committee under license number 200160080.

233

## 234 **Results**

### 235 *Student engagement*

236 In January 2016, 123 students were enrolled in the first cycle of the module.  
237 Students had individual timetables for all F2F sessions and 100% of students  
238 attended.

239

240 The proportion of students accessing each type of TEL resource was recorded  
241 over the duration of the module and for 2 weeks after (Figure 3). All 123  
242 students downloaded lecture material and small group teaching (CBL and  
243 practical class) guidance. A majority of students accessed clinical examination  
244 videos (95.9%), the parasitology textbook (85.4%), farm calendars (72.4%),  
245 pharmaceutical online CBL (69.9%) and the end of module quiz (64.2%). Less  
246 than half of the students chose to provide end of module feedback (44.7%).  
247 There were differences in how often students accessed each type of TEL  
248 resource (Figure 4). Most students accessed practical/ CBL guidance, clinical  
249 examination videos and parasitology textbooks 2-5 times or less. Lecture  
250 material was accessed 6-10 times and the end of module quiz between 21-50  
251 times by the majority of students. The frequency of access to the pharmaceutical  
252 online CBL varied much more between students than other TEL resources, with a  
253 much wider range of frequency of access. Looking at the time of day when TEL  
254 resources were accessed (Figure 5), few students accessed any TEL resources  
255 between 0.00-07.00. Lecture material was mainly accessed between 07.00-13.00,  
256 whereas most other resources were accessed during the afternoon and evening  
257 (13.00-18.00 and 18.00-00.00).

258

259 All 123 students undertook the group end of module summative assessment .  
260 Students worked in groups of 4-5 students, with a submission deadline 2 weeks  
261 after the end of module teaching. A group mark was given to individual students  
262 within each group using a grading rubric. Subsequently, all students achieved a  
263 passing standard grade in the summative assessment.

264

### 265 **Student feedback**

#### 266 *Questionnaire statements*

267 The response rate for the feedback questionnaire was 44.7%, which represents  
268 less than half of the students enrolled on the module (Supplementary material  
269 2). Student statements to questionnaire statements are summarised in table 1.  
270 Overall, students were satisfied with the module and agreed that it was made  
271 clear what they were expected to learn. Most students agreed or strongly agreed  
272 that module content was pitched at the right level and the workload manageable.

273 In respect to F2F teaching (Table 1), students agreed that lecturers made  
274 teaching material interesting and provided useful feedback. Over half of  
275 respondents agreed that group classes and assessment enabled them to work as  
276 a team, with less than 10% disagreeing. For TEL resources, most students agreed  
277 or strongly agreed that online content was well organised, relevant and easy to  
278 navigate. Online communication was appreciated, instructions clear and online  
279 support adequate. Half of students agreed that the online calendars and

280 parasitology textbook were useful. However, the majority of students disagreed  
281 that the pharmaceutical online CBL was useful, with the remainder neutral to  
282 this activity. Three quarters of students found the formative module assessment  
283 interesting and expressed that it brought together module content, with the  
284 remainder of students being neutral to the assessment.

285

### 286 *Free text statements*

287 The majority of students who undertook the questionnaire, responded to some  
288 of the free-text questions with a total of 195 free-text statements  
289 (Supplementary material 2). Three major themes were identified relating to  
290 student perceptions of blended learning in the statements to the free text  
291 questions: "Balance of F2F and TEL resources", "Module design and delivery" and  
292 "Participant factors". Table 2 summarises the number of statements coded to  
293 major and sub-theme.

294

### 295 Balance of face to face and technology enhanced learning activities

296 Of the free-text statements, 93 related to balance of F2F and TEL activities within  
297 the module. These statements split into two sub-themes: "Synergistic resources"  
298 and "Student-lecturer interaction".

299

#### 300 Synergistic resources:

301 Many statements were positive about the mix of F2F and TEL activities (55  
302 statements) within the module. For F2F activities, statements related to  
303 appreciation of practical classes and CBL seminars (13/55), complimenting  
304 lectures which were pitched at the right level (4/55). A number of students  
305 explained they enjoyed these sessions that were complimented by TEL resources  
306 as they provided an opportunity to apply theoretical knowledge into a practical  
307 setting:

308

309 *Student 39: " "It (RE: Online farm calendars) made me review a lot of*  
310 *diseases/procedures and think about when in the year they occur. It was very*  
311 *useful to then be given the completed calendar (after the lectures) so that I could*  
312 *begin to build a better idea of when in the farming year certain things occur."*

313

314 Students expressed their positive impression of TEL activities, mainly  
315 commenting on online CBL activities. Similarly, students felt that the  
316 pharmaceutical prescription activity assisted applying theory into practice  
317 (15/55 statements). For other online CBL activities, such as the farm calendar  
318 and parasitology textbook, students felt they were mainly useful for revision by  
319 consolidating learning (19/55 statements). For parasitology teaching in  
320 particular, students commented that online materials supported F2F practical  
321 class teaching (8/55 statements):

322

323 *Student 29: "You wouldn't understand what you're doing in the parasitology*  
324 *practical without these resources they are very good."*

325

326 Nonetheless, students expressed that TEL activities should not be used to replace  
327 F2F teaching activities (3/55). This was particularly relevant for clinical skill



328 teaching, where students felt that the physical aspects of activities could not be  
329 mimicked online:

330

331 *Student 12: "I feel like sometimes for the clinical skills practicals they expect you to*  
332 *have already learnt everything on the videos before you arrive. The videos should*  
333 *be an aid to assist your learning and prepare for the class but not a substitute for in*  
334 *class teaching."*

335

336 Student-lecturer interaction:

337 A small number of students (18) commented on student-lecturer interaction. For  
338 F2F sessions, including lectures and practical sessions, most commented that  
339 content was pitched at the right level. Such statements praised staff interaction  
340 with them highlighting that the interaction assisted in applying the lecture  
341 content to real-life scenarios (7/18) such as in CBL tutorials:

342

343 *Student 27: "Enjoyed the CBLs case scenario discussion as they help me identify*  
344 *where in my thoughts process did I went (sic) wrong or have done correctly, and*  
345 *eventually guides me to the final diagnosis. Which I felt is really useful"*

346

347 In contrast, three students expressed that similar interaction was lacking from  
348 online CBL sessions. For example, 6 students felt that they lacked guidance for  
349 the farm calendar or pharmaceutical prescription online CBLs. Other statements  
350 suggested that students felt that they missed out on the opportunity to discuss  
351 released answers, which would have helped them prioritise topics for further  
352 study.

353

354 Module design and delivery factors

355 In total 67 statements related to module design and delivery. These statements  
356 were divided into three sub-themes: "Module content organization", "Time  
357 management and allocation" and "Software limitations".

358

359 Module content organization:

360 This theme included both positive and negative comments. The majority of  
361 negative comments related to module factors that affected students managing  
362 their own learning time (23/67). For example, a small number of participants  
363 (12/23) were frustrated that not all module content was hosted on the VLE and  
364 found it difficult to locate these resources:

365

366 *Student 15 (Re: Parasitology textbook): "I was not even aware of this. There's a*  
367 *whole lot of information scattered in a lot of different places, which makes it really*  
368 *hard to keep track of it all, as well as prioritize."*

369

370 Other negative comments related to late provision of both TEL and F2F teaching.  
371 Nine participants reported that some staff arrived late to give lectures and that  
372 sometimes lecture materials were uploaded to the VLE after lectures were given.  
373 Student's perception were that tardiness made it difficult to prioritise content in  
374 their study time. Also, a number of these comments (3/9) expressed dislike of  
375 last-minute changes to lecture materials:

376

377 *Student 47: "There were several occasions throughout this module where lectures*  
378 *had been posted to moodle, but then changed without any notice to students. This is*  
379 *particularly frustrating when students print these lectures out or review them*  
380 *beforehand..."*

381

382 Specifically, only two respondents commented on appreciating the organisation  
383 of online TEL content into folders making content easy to navigate content on  
384 the VLE.

385

386 Time management and allocation:

387 Over half of statements related to module design were related to time  
388 management and allocation of module activities (43/67). The majority of  
389 comments related to TEL activities taking longer than expected, specifically the  
390 farm animal calendar and the group summative assessment. A common  
391 explanation was that researching for such activities from content elsewhere in  
392 the module was too time consuming for the time available to study. Although  
393 respondents (6/43) did appreciate the learning experience after the activity was  
394 completed:

395

396 *Student 24 (Re: Farm animal calendar online CBL activity): "(It was) difficult to*  
397 *find the information so it took a long time to find anything relevant, but useful*  
398 *when done."*

399

400 Despite the extended length of some sessions, only one student negatively  
401 commented that F2F activities overran allocated time slots. A number of  
402 statements (6/43) commented that to some TEL resources, such as the  
403 parasitology textbook and online pre-reading material, were too extensive  
404 making it difficult to prioritise what to study in the time allocated. Yet a similar  
405 number of statements (5/43) praised the extent of these resources, providing  
406 the opportunity for students to study topics more in depth than taught material.

407

408 Software limitations:

409 Nine students commented on the limitations of the software used to design TEL  
410 activities, mostly relating to the pharmaceutical prescription online CBL activity.  
411 It was highlighted that even if students got the answer right, but their free-text  
412 answer was phrased differently to the automated answer, the software marked  
413 the answer as incorrect (Figure 6) resulting in much lower global marks in this  
414 activity than individual students expected. This student describes the negative  
415 impact on learning of these software limitations:

416

417 *Student 02 (Re: Pharmaceutical prescription online CBL activity): "Many things*  
418 *were marked as incorrect but the correct answers were not given, so cannot review*  
419 *it and learn from mistakes."*

420

421 Yet students also expressed that the activity was useful in developing prescribing  
422 habits. Two students suggested that a potential solution to the software marking  
423 limitations would be producing example answers at the end of activity rather  
424 than the software marking individual answers. These comments highlight the  
425 perceived benefit of the activity, despite the software marking limitations.

426

#### 427 Participant factors

428 Of all free-text statements, 43 related to individual participant factors that  
429 influenced perception of, and engagement with, module content. Twenty nine  
430 student statements described how engagement in activities was affected by their  
431 previous knowledge of module subjects. Respondents who identified as having  
432 insufficient background knowledge (ruminant livestock and agriculture), felt  
433 that TEL activities were difficult and time consuming to partake in (9/29). This  
434 was exemplified in the farm calendar activity:

435

436 *Student 14: "With no background knowledge in livestock farming, I don't know*  
437 *where to start."*

438

439 Students also mentioned that some of the module overlapped with content  
440 elsewhere in the veterinary degree program. While some perceived too much  
441 overlap (3/29), others took overlap as positive (14/29). Overlap seemingly  
442 helped students to integrate module content with assumed background  
443 knowledge (livestock and agriculture):

444

445 *Student 6: "Useful to be able to work through a calendar and link up the times of*  
446 *the year to management procedures and diseases to look out for."*

447

448 Students mentioned that various F2F and TEL activities were relevant to their  
449 future career choices (10/43). Responders who specifically intended to go into a  
450 career related to the module content, enjoyed engaging with TEL content within  
451 the module (3/43):

452

453 *Student 45: "Really fun module - has made me consider going into mixed (species*  
454 *clinical) practice."*

455

## 456 **Discussion**

457

458 Blending learning practices are proposed to encourage students to manage their  
459 own learning, around other commitments, whilst still meeting the learning  
460 outcomes of a course (12). As a student-centred approach, BL could be useful for  
461 professional veterinary degree programmes to support students to balance  
462 academic, workplace and personal commitments. The fact that students in this  
463 study accessed TEL resources outside of traditional working hours supports this  
464 idea. The majority of students engaged with course material, with various TEL  
465 activities accessed throughout the day depending on the activity. Blended  
466 learning can also encourage students post-graduation to learn independently,  
467 which is an important attribute to continued professional development (33).  
468 Assessing student engagement and perception of courses can provide an insight  
469 into the experience of BL, its impact on learning and highlight areas to consider  
470 when designing courses using BL. Although there are well-documented  
471 limitations in questionnaire-based student feedback studies (34), this study  
472 provided insights into student perceptions on BL. Aspects of F2F and TEL  
473 activities were well received by students, particularly activities that integrated  
474 and applied course topics. Interaction between students and teachers was also

475 highly valued. In the wider context, student feedback highlighted a number of BL  
476 factors that affected the learning experience of students and should be  
477 considered when developing courses based on BL principles.

478

479 In our study, we investigated student engagement with F2F and TEL activities.  
480 F2F and TEL activities were nominally timetabled in “working hours” (9.00-  
481 17.00 hours Monday to Friday), although TEL activities could be completed in  
482 their free time, within or out of working hours, if individual students wished. The  
483 majority of TEL activities were accessed during working hours, with the trend of  
484 lecture material being accessed in the mornings when lectures were timetabled  
485 and complementary activities being accessed in the afternoon or evening.  
486 Flexibility in students planning their study time is widely seen as a positive step  
487 within HE, to allow them to direct their learning to what is most effective for  
488 individuals when and wherever it suits them (35,36). It is therefore unsurprising  
489 that in our study, individual students managed their time differently and there  
490 are likely various reasons for different study strategies. Although we did collect  
491 data on individual student study patterns and what factors drives them to  
492 manage their own study time, students did not highlight whether they were  
493 accessing TEL activities around life commitments. A study by Holley and Dobson  
494 looked at a cohort of >1000 undergraduate students undertaking a BL course  
495 and their access to online TEL activities over the duration of the course (37).  
496 Students particularly accessed TEL activities over weekends to manage their  
497 learning around part-time jobs and to work at their own pace. However,  
498 veterinary and other professional degree students have additional course related  
499 commitments on their time, which potentially restricts their time for other life  
500 commitments (38). As BL courses potentially could have negative effects on  
501 student work-life balance, the amount of time spent on non-timetabled activities  
502 and students’ ability to utilise this time, has to be considered when designing BL  
503 courses. It is recommended that the amount of time taken to complete course  
504 activities, within and outside the academic timetable, should be audited to make  
505 sure that students can manage their time with other commitments (13). For the  
506 UK veterinary profession in particular, increasing mental health problems have  
507 been associated with problems relating to work-life balance (39). Work overload  
508 can impact on academic performance, satisfaction and mental health (40,41).  
509 Students should be empowered to develop the skills to manage their study, work  
510 and life commitments from the early stages of their degree. Although time was  
511 allocated to complete TEL activities, the amount of time to complete specific  
512 activities was not recommended. In hindsight, this may have led to students  
513 spending inappropriate amounts of time on individual activities. “Sign-posting”  
514 recommended time to complete a TEL activity, may assist students in time  
515 allocation and assist promoting a healthy work-life balance. This is particularly  
516 important given our observation that a number of students commented that  
517 activities took longer than they expected. There is also an onus on Veterinary  
518 Schools to ensure that expectations of student workload are reasonable and  
519 clear to applicants.

520

521 Students also used TEL activities to prepare for F2F sessions, particularly for  
522 practical classes, with students perceiving these materials as a benefit. Just like  
523 any educational intervention, motivation to engage with a topic is likely to affect

524 student engagement (42). In our study, it is possible that students were  
525 interested in doing well in F2F practical classes as topics covered were perceived  
526 as important to their future career choices as veterinary surgeons (23). Clearly,  
527 incorporating relevance and interest in TEL activities is integral in BL courses.  
528 For example, students interested in farm animal career pathways particularly  
529 commented on the relevance of the module. Highlighting the relevance and  
530 transferable skills gained from completing course activities may increase  
531 engagement with students less interested in specific topics within a BL course.

532  
533 Students described both F2F and TEL activities positively but highlighted that  
534 F2F and TEL activities should be complementary, rather than TEL used simply to  
535 replace F2F sessions. Getting the right “blend” of F2F and TEL activities is  
536 integral to the success of a BL course (43). Other research also found that F2F  
537 activities followed by TEL activities leads to students engaging with the content  
538 more than students access to only TEL activities (44). Blended learning activities  
539 within a course should be designed and mapped to the appropriate learning  
540 outcomes of the course (45) as certain topics are more suited to F2F or TEL  
541 activities. Specifically, we found that students appreciated TEL when its used to  
542 complement F2F sessions, such as in preparation for practical classes by  
543 studying online videos or a textbook. In other work, Morton and others explored  
544 medical and biomedical student engagement with a new BL course in  
545 pharmacology through small focus groups (16). Students identified other  
546 courses that could be suited to BL approaches, particularly those that taught core  
547 principles that moved onto real-life application of the content. Yet in our survey,  
548 students had a mixed response to TEL activities that built on background  
549 knowledge, particularly where learning built on content from previous studies in  
550 their degree course. Getting students to revisit previously learnt material can be  
551 a challenge and partly depends on how well they learnt it the first time. Students,  
552 who are less familiar with the background knowledge may feel they spend longer  
553 than expected on these activities leading to demotivation and failure to meet  
554 learning outcomes (46). Students commented that unpredictability in activity  
555 participation time made it difficult to prioritise their learning, particularly in TEL  
556 activities that required students to research topics beyond core course materials.  
557 As previously mentioned, signposting could be a potential solution to this and  
558 has been shown to increase students’ awareness of what is involved in a TEL  
559 activity. For example, signposting has been shown to be useful with flipped  
560 classroom techniques (47) and in large online learning environments (48,49).  
561 Annotating TEL activities with the expected level of background knowledge,  
562 associated course resources and expected time to complete an activity (e.g.  
563 signposting) could improve student motivation and engagement with stand-  
564 alone TEL activities.

565  
566 Preserving lecturer interaction is very important in BL courses, as interaction  
567 between students and their lecturer can increase the quality and effectiveness of  
568 F2F sessions (50). Face-to-face activities encourage lecturer interaction whereas  
569 TEL activities emphasise learner-material interactions (24). We found that  
570 students missed the interaction with teaching staff and student peers, especially  
571 for stand-alone TEL activities. Students requested more guidance to support  
572 their learning for TEL activities that were predominately self-directed. Students

573 felt that in isolation TEL interaction with teachers was not as productive as F2F  
574 interaction. Positive interactions with lecturers can improve student learning  
575 (51,52) as one-on-one direction can assist individual students learning needs,  
576 such as help in prioritising and clarifying course content. Students also value  
577 being part of a learning community, as F2F sessions in BL courses can foster a  
578 community spirit that encourages students to learn through supported  
579 interaction with teachers and their peers (43). Virtual learning environments  
580 design can maximise student-teacher interaction through discussion boards and  
581 email. For example, a study by Beer and others demonstrated that the more  
582 teachers communicate via VLE platforms the more students will engage with the  
583 content (53). Although a study looking at veterinary student engagement with an  
584 online only course highlighted that even though automated feedback was  
585 provided online, students missed personal interaction with their teachers (54).  
586 In the study, students particularly missed F2F teacher support in online case-  
587 based problem solving activities to assist them with their approach. When  
588 designing courses around BL principles, F2F and TEL activities should be  
589 synergistic in order to support student engagement and academic achievement  
590 as part of a learning community (55). Complementary F2F feedback sessions  
591 with teaching staff at the end of the course can provide students with the  
592 opportunity to interact with teaching staff directly about TEL resources used in  
593 the course.

594  
595 The online learning environment had an impact on how students engaged and  
596 perceived their learning experience. Students were generally able to navigate  
597 TEL resources hosted by the university's main VLE (Moodle®) however,  
598 students were frustrated when they could not find activities hosted on another  
599 VLE (Mahara®). Students also described software problems as a barrier to their  
600 learning. Student perception of the format and design of the online learning  
601 environment content can make a difference to how students engage with TEL  
602 resources (56). There is a complex relationship between emotions, motivation,  
603 cognition, metacognition and academic achievements. Thus an individual's  
604 emotions, such as frustration, may demotivate and hinder cognitive processes  
605 when using BL methodology (57). A large survey of over 500,000 biological  
606 science students, undertaking blended learning courses, found that highly  
607 frustrated students review less online course content and attain lower grades,  
608 than those with low levels of frustration (58). It was clear in our study that on  
609 occasion, frustrations related to the online learning environment, were  
610 perceived to have hindered student learning. Despite these frustrations, students  
611 continued to try to complete aspects of the course that had software problems.  
612 For example, the pharmaceutical prescription, farm calendar activities and end  
613 of module quiz, were mostly accessed multiple times by individual students.  
614 Other studies highlight that software problems led to a drop off in student access  
615 with students becoming demotivated and disengaged with TEL activities (59–  
616 61). It is important to understand the nature of the frequency of interaction in  
617 TEL activities and to establish whether the frequency of interaction is  
618 productive. Although we did not ask specifically why students accessed some  
619 TEL activities more than others, some of the TEL activities with the highest  
620 frequency of access, had a grade associated with the completion of the activity  
621 but also had the most negative feedback from students (pharmaceutical

622 prescription and end of module quiz activities). Drive to achieve higher grades,  
623 may have led to students attempting the activity multiple times. The use of  
624 grading to encourage students to complete TEL activities has been demonstrated  
625 from a variety of formats (49,62,63). In addition, veterinary students are  
626 regarded as highly motivated to succeed in their studies due to their passion for  
627 their chosen career (64) and might partly explain their persistence with faulty  
628 activities, as students perceived it was important to complete this activity as part  
629 of their professional training. However, software frustrations may have had a  
630 negative impact on the quality of their learning strategies. Parkinson et al,  
631 highlighted that although veterinary students are generally motivated,  
632 frustration and work overload might encourage them to utilise superficial rather  
633 than deep learning approaches (42). Students' that utilise superficial approaches  
634 retain knowledge for short-term recall, whilst those that utilise deep learning  
635 approaches are able to apply knowledge in different contexts (21). For  
636 veterinary training, deep learning is integral to developing clinical problem  
637 solving skills (65). Like F2F activities, TEL activities should be aligned with ILOs  
638 and software problems mitigated against to minimise student frustration. The  
639 majority of the frustrations to software problems were related to automated  
640 feedback in TEL activities that marked correct answers incorrectly. Veterinary  
641 students appreciate sequential feedback with relevance to their future career  
642 (54) and inappropriate feedback could be detrimental to their learning  
643 experience. Troubleshooting TEL activities, through piloting new activities and  
644 appropriate staff training in using software to design activities, is important to  
645 limit the likelihood of software issues (66,67). As this was the first run of the  
646 module teething problems were likely and highlights why trouble shooting is  
647 particularly important for newly developed TEL activities. In addition, previous  
648 experiences with TEL can influence future engagement with TEL (68). Veterinary  
649 surgeons in the UK are required to conducted regular continued professional  
650 development (CPD) throughout their careers (69). In recent years there has  
651 been an increase in distance online based platforms for postgraduate education  
652 of veterinary surgeons (9). Thus, it is important in TEL activities within  
653 undergraduate veterinary BL courses do not discourage future engagement with  
654 TEL.

655  
656 This study had various limitations that should be considered when planning  
657 future research. Our study only examined a relatively small number of students  
658 for a snap shot in time on a single course. It is accepted that end of course  
659 feedback is often given by students who have grievances about a course (70) and  
660 with the course feedback questionnaire being optional, this may have biased our  
661 results. However, end of course surveys and log data are useful for  
662 understanding an individual's engagement and perceptions of a course (71) and  
663 TEL platforms offer opportunities to monitor trends in student learning.  
664 Conducting interviews or focus groups might have provided further depth to  
665 student perceptions of BL methods (72), however the online questionnaire did  
666 facilitate sampling a larger cohort of students. Our approach has been helpful to  
667 identify factors to consider when using BL principles to design undergraduate  
668 courses as part of routine course feedback. Few studies take advantage of such  
669 audit tools (73) to research the use of BL principles in the training of veterinary  
670 surgeons. Despite module design being focused around BL principles, the

671 students that participated in our study had been taught using BL methods for  
672 two years. Students with little experience of BL courses, may have different  
673 perceptions and encounter additional challenges when participating in these  
674 courses for the first time. We did not assess access to online TEL resources from  
675 the module as part of pre-exam preparation (four months after the end of the  
676 course). Also, we could not investigate the nature of interaction with TEL  
677 activities (e.g. depth of engagement) due to limitations in the data provided by  
678 the VLE software. Other studies of online courses have identified that students  
679 often may utilise TEL material more prior to exams (74). However, it is unclear  
680 if such behaviours improve academic outcomes or, in the case of veterinary  
681 training, alignment to professional competencies. Further research should focus  
682 on improving academic staff's ability to estimate and allocate adequate  
683 independent study time for students. For veterinary students in particular, how  
684 the design of BL courses impact on students' own allocation of study time, which  
685 may relate to their professional development and their wellbeing and mental  
686 health. For this reason, future studies could consider whether TEL activity  
687 guidance (sign-posting) assists students in managing their study time and  
688 further prepares them for future independent study.

689

690 Assessing student perception and engagement with a BL course, has highlighted  
691 the benefits and challenges of using BL principles in the undergraduate  
692 education of veterinary students. Our findings support other work recognising  
693 the importance of considering course context, organisation, student time  
694 allocation skills, troubleshooting software errors and developing synergistic  
695 resources when developing a blended course. Veterinary educators wishing to  
696 incorporate BL methods in professional degree teaching, should consider these  
697 factors to improve application of course content and support students to become  
698 independent learners. While it is clear that a blended learning approach can be  
699 effective in training the next generation of veterinary surgeons, there is  
700 considerable scope for additional research to establish the most effective  
701 techniques for implementing BL in veterinary and medical education.

702

## 703 **Acknowledgements**

704 We would like to thank all the staff of the Division of Farm Animal Clinical  
705 Sciences for their assistance in producing teaching material and enthusiasm for  
706 teaching veterinary students at the University of Glasgow. In addition to Mr  
707 James McGoldrick of the Veterinary Parasitology department for assistance with  
708 the parasitology resources and Mrs Lumba Chirwa for assistance with  
709 management of UG-SVM VLE resources for the module. We would also like to  
710 thank Dr Vicki Dale at the University of Glasgow, for her constructive comments  
711 and suggestions on the first draft of this paper.

712

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## 1017 Figures

1018  
 1019 **Figure 1. Structure of the curriculum of the BVMS degree program at the Glasgow**  
 1020 **University School of Veterinary Medicine based on a spiral curriculum model.**

1021  
 1022 (2a) An example of a type of TEL in the form of farm animal clinical examination videos provided  
 1023 on the UG-SVM VLE for the clinical examination practical.

1024 (2b) An example of a type of TEL in the form of a self-directed learning pharmaceutical label CBL.  
 1025 To be worked through in own time to apply clinical skills on prescribing pharmaceuticals by  
 1026 completing the online forms from the provided clinical scenario.

1027 **Figure 2. Examples of TEL activities provided throughout the module.**

1028  
 1029 **Figure 3. Bar plot of the proportion of students using the online resources within the**  
 1030 **module and two weeks after (n=123).**

1031  
 1032 **Figure 4. Bar plot of the frequency of use of online resources, by students, within the**  
 1033 **module and two weeks after (n=123).**

1034  
 1035 **Figure 5. Bar plot of the times of use of online resources, by all students, within the**  
 1036 **module and two weeks after (n=123). Squares= Online guidance and lecture material;**  
 1037 **Lines= Online textbook resources (Videos and images); Diamonds= Online CBLs; Solid**  
 1038 **black= End of module quiz.**

1039  
 1040 **Figure 6. An example of an incorrectly marked answer, from the online pharmaceutical**  
 1041 **label CBL on the UG-SVM VLE that was actually correct. Also an example of detailed**  
 1042 **explanatory feedback possible.**

## 1044 Tables

1045

| Questionnaire statement                                | Percentage of students by Likert scale |                        |              |             |           |                     |
|--|--|------------------------|--------------|-------------|-----------|---------------------|
|  | Number of statements                   | Strongly Disagree (SA) | Disagree (D) | Neutral (N) | Agree (A) | Strongly Agree (SA) |
| 1. Overall, I was satisfied with this module.          | 55                                     | 1.8%                   | 0.0%         | 9.1%        | 63.6%     | 25.5%               |
| 2. The module was well organised.                      | 55                                     | 1.8%                   | 3.6%         | 16.4%       | 54.6%     | 23.6%               |
| 3. I was easily able to find module information on the | 55                                     | 0.0%                   | 1.8%         | 12.7%       | 67.3%     | 18.2%               |

|  |    |      |       |       |       |       |
|--|----|------|-------|-------|-------|-------|
| virtual learning environment.  |    |      |       |       |       |       |
| 4. Any changes to the module structure were communicated effectively online.   | 55 | 1.8% | 5.5%  | 21.8% | 56.4% | 14.6% |
| 5. It was made clear to me what I was expected to learn in this module.  | 55 | 1.8% | 3.6%  | 16.4% | 63.6% | 14.6% |
| 6. Overall teaching staff made this module interesting.  | 55 | 0.0% | 0.0%  | 12.7% | 61.8% | 25.5% |
| 7. The module content was pitched at the right level.  | 55 | 0.0% | 1.8%  | 14.6% | 65.5% | 18.2% |
| 8. The workload of this module was manageable.   | 55 | 0.0% | 3.6%  | 18.2% | 61.8% | 16.4% |
| 9. Staff during practicals or CBLs provided me with feedback that helped me understand how I am doing and how I could do better. | 55 | 1.8% | 1.8%  | 21.8% | 61.8% | 12.7% |
| 10. I found the beef/ sheep calendar online CBLs useful.   | 55 | 3.6% | 9.1%  | 34.6% | 50.9% | 1.8%  |
| 11. I found the pharmaceutical prescription online CBL useful.   | 55 | 7.3% | 47.3% | 38.2% | 5.5%  | 1.8%  |
| 12. I found the additional online ruminant parasitology reference resources useful.  | 55 | 0.0% | 9.1%  | 30.9% | 52.7% | 7.3%  |
| 13. The farm scenario assessment within the module stimulated my   | 55 | 1.8% | 1.8%  | 20.0% | 63.6% | 10.9% |



|  |    |      |      |       |       |       |
|--|----|------|------|-------|-------|-------|
| interest in the lecture content.   |    |      |      |       |       |       |
| 14. The farm scenario assessment within the module helped tie together the lecture content.        | 55 | 1.8% | 0.0% | 25.5% | 63.6% | 7.3%  |
| 15. I received adequate instructions on the farm scenario assessment.                              | 55 | 3.6% | 3.6% | 25.5% | 58.2% | 3.6%  |
| 16. The group work in practical classes, CBL and assessment improved my ability to work in a team. | 55 | 1.8% | 7.3% | 29.1% | 49.1% | 10.9% |
| 17. Online material, IT provision and support via forum posts were adequate for my needs.          | 55 | 0.0% | 3.6% | 21.8% | 65.5% | 9.1%  |
| 18. The online resources available were relevant.  | 55 | 0.0% | 0.0% | 18.2% | 67.3% | 12.7% |

1046 **Table 1. Student statements to Likert scale questions (n=55).** Most frequent response  
1047 highlighted in grey.

1048

| Subtheme                       | Total number of questionnaire statements | Major theme                        | Total number of questionnaire statements |
|--------------------------------|--|------------------------------------|--|
| Synergistic resources          | 55                                       | Balance of F2F and TEL resources   | 93                                       |
| Student-lecturer interaction   | 18                                       |                                    |  |
| Module content organisation    | 67                                       | Module design and delivery factors | 67                                       |
| Time management and allocation | 43                                       |                                    |  |
| Software limitations           | 9  |                                    |  |
| Relevance to student career    | 10                                       | Participant factors                | 43                                       |
| Range in student ability       | 29                                       |                                    |  |

1049 **Table 2. Summary of thematic analysis on student questionnaire statements (n=195**  
1050 **statements from 55 students).** A response may be categorised to more than one subtheme.  
1051

1052 Thus the total number of major or subtheme statements does not equal the total number of  
 1053 questionnaire statements.

1054

1055 **Supplementary material**

1056

| Type of activity                    | Name of activity                                | Description of activity  | Class size and length (If applicable)   |
|-------------------------------------|---|--|---|
| Lectures                            | Various topics in farm animal clinical medicine | Lecture based module, in a lecture theatre with clinical experts on various subjects.  | 30x 1 hour lectures with the whole class.   |
| Practical classes                   | Clinical examination practical                  | In small groups, students examine 3 cases for 30 minutes each and work out a problem list at the farm animal clinic.   | 3x 1 case per 30 minute per station with 6-7 students. One clinical teacher per case. |
|                                     | Population medicine practical                   | In small groups, students apply herd and flock health clinical skills at 3 practical stations on housing, nutrition and diagnostic sampling at the University farm.                    | 3x 30 minute per station with 6-7 students. One clinical teacher per station.         |
|                                     | Parasitology practical                          | Students work through 12 diagnostic stations to identify parasites of farm animals and answer questions on treatment protocols.  | 1x 1 hour class with 11-12 students. One parasitology teachers per group of students. |
| Case-based learning classes         | Anthelmintic and antibiotic selection           | Students work on, present and discuss 3 case scenarios on selection of diagnostics and pharmaceuticals. Case scenarios are provided online prior the class to prepare for discussions. | 2x 1 hour class with 22-23 students.  |
| <b>TECHNOLOGY ENHANCED LEARNING</b> |   |  |   |
| Type of activity                    | Name and VLE hosting the activity.              | Description of activity  | Class size and length (If applicable)   |

|   |  |   |                                  |
|---|--|---|----------------------------------|
| Complementary resources for F2F teaching. | Module organisation (Moodle®).         | i. Various guidance documents with additional reading references for lectures, practical and CBL classes.<br>ii. Online forum to discuss module topics with staff.  | Available throughout the module. |
|   | Clinical examination videos (Mahara®). | Farm animal clinical examination written guidance and narrated videos to prepare students for clinical examination practical.   | Available throughout the module. |
|   | Parasitology textbook (Mahara®).       | Farm animal parasitology image textbook to prepare students for parasitology practical.   | Available throughout the module. |
| Online case-based learning                | Farm animal calendar (Moodle®).        | Students are required to create a calendar for example beef and sheep farms. The calendars include key points in the animal production cycle and veterinary interventions. An online form is used to facilitate this. | Available throughout the module. |
|   | Pharmaceutical prescription (Moodle®). | Students work through farm animal cases to design a treatment plan. Subsequently, students calculate drug dosages or write a prescription. The scenarios include individual animal and population cases.              | Available throughout the module. |
| Assessment                                | End of module quiz (Moodle®).          | A combination of free text, multiple choice (MCQ) and extended matching (EMQ) questions on various topics covered in the module.  | Available throughout the module. |

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|  |  |  |                                  |
|--|--|--|----------------------------------|
|  | End of module summative assessment (Moodle®). <sup>+</sup> | Submission of case-based assessment of a disease investigation report, farmer factsheet and revision poster. | Available throughout the module. |
|--|--|--|----------------------------------|

Supplementary material 1. A summary of the F2F and TEL activities in the module. \* Attendance recorded by a register. <sup>+</sup> The end of module summative assessment was an obligatory activity.

| Question number   | Question  | Number of statements |
|---|---|----------------------|
| <b>Agreement questions (as Likert scale):</b><br><b>State how much you agree with the following statements:</b> |   |                      |
| 1.  | Overall, I was satisfied with this module.  | 55                   |
| 2.  | The module was well organised.  | 55                   |
| 3.  | I was easily able to find module information on the virtual learning environment.   | 55                   |
| 4.  | Any changes to the module structure were communicated effectively online.   | 55                   |
| 5.  | It was made clear to me what I was expected to learn in this module.  | 55                   |
| 6.  | Overall teaching staff made this module interesting.  | 55                   |
| 7.  | The module content was pitched at the right level.  | 55                   |
| 8.  | The workload of this module was manageable.   | 55                   |
| 9.  | Staff during practicals or CBLs provided me with feedback that helped me understand how I am doing and how I could do better. | 55                   |
| 10.   | I found the beef/ sheep calendar online CBLs useful.  | 55                   |
| 11.   | I found the drug label online CBL useful.   | 55                   |
| 12.   | I found the additional online ruminant parasitology reference resources useful.   | 55                   |
| 13.   | The farm scenario assessment within the module stimulated my interest in the lecture content.                                 | 55                   |
| 14.   | The farm scenario assessment within the module helped tie together the lecture content.                                       | 55                   |
| 15.   | I received adequate instructions on the farm scenario assessment.   | 55                   |
| 16.   | The group work in practical classes, CBL and assessment improved my ability to work in a team.                                | 55                   |
| 17.   | Online material, IT provision and support via forum posts were adequate for my needs.   | 55                   |
| 18.   | The online resources available were relevant.   | 55                   |
| <b>Free-text questions:</b>   |   |                      |
| 19.   | Why did you find/ not find the beef/ sheep calendar online CBL useful?  | 49                   |
| 20.   | Why did you find/ not find the drug label online CBL useful?  | 50                   |
| 21.   | Why did you find/ not find the online ruminant parasitology resources useful?   | 46                   |
| 22.   | Identify any aspects of the teaching of this module that you particularly enjoyed and explain why                             | 23                   |

|     |   |    |
|-----|---|----|
| 23. | Identify any issues/problems with the teaching of this module and suggest how this could be addressed | 18 |
| 24. | Do you have any other comments about this module?   | 9  |

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Supplementary material 2. Overall structure of the online student feedback questionnaire for the module. Agreement questions were recorded in a Likert scale, categorised as: Strongly disagree; Agree; Neutral; Agree; Strongly agree.