Students' Engagement in and Perceptions of Blended Learning in a Clinical Module in a Veterinary Degree Program

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ABSTRACT

Blended learning has received much interest in higher education as a way to increase learning efficiency and effectiveness. By combining face-to-face teaching with technology-enhanced learning through online resources, students can manage their own learning. Blended methods are of particular interest in professional degree programs such as veterinary medicine in which students need the flexibility to undertake intra- and extramural activities to develop the range of competencies required to achieve professional qualification. Yet how veterinary students engage with blended learning activities and whether they perceive the approach as beneficial is unclear. We evaluated blended learning through review of student feedback on a 4-week clinical module in a veterinary degree program. The module combined face-to-face sessions with online resources. Feedback was collected by means of a structured online questionnaire at the end of the module and log data collected as part of a routine teaching audit. The features of blended learning that support and detract from students' learning experience were explored using quantitative and qualitative methods. Students perceived a benefit from aspects of face-to-face teaching and technology-enhanced learning resources. Face-to-face teaching was appreciated for practical activities, whereas online resources were considered effective for facilitating module organization and allowing flexible access to learning materials. The blended approach was particularly appreciated for clinical skills in which students valued a combination of visual resources and practical activities. Although we identified several limitations with online resources that need to be addressed when constructing blended courses, blended learning shows potential to enhance student-led learning in clinical courses.

Key words: blended learning, e-learning, clinical livestock medicine, multimedia, student perceptions, student engagement

INTRODUCTION

Professional degree courses require balancing workplace learning opportunities with academic elements of the curriculum.[1,2] Like other undergraduate students, those studying for a professional degree have to fit their study around other life commitments, which can complicate and disrupt timetabling academic and workplace commitments.[3–5] For example, in the United Kingdom professional training of veterinary surgeons is knowledge intensive, applied, and focused on omnicompetence.[6] Historically, this has led to heavy lecture schedules and significant contact time with veterinary educators to enable students to attain the competencies required to register as a veterinary surgeon.[7] Students are also obliged to complete work experience in clinical practice, undertaken in addition to their academic studies, to develop clinical and workplace skills. Moreover, because contemporary veterinary practice is becoming more specialized,[8] the scope of knowledge expected of veterinary graduates is increasing, despite the program length remaining the same. Thus, the challenge for today's veterinary educators is to prepare graduates to enter the workplace with the applicable skill set and knowledge to hit the ground running by helping them to be time-efficient and lifelong learners.[9]

In response to student study and life commitments, many higher education (HE) courses are adopting student-centered learning approaches to their teaching.[10,11] The aim is to allow students to choose when, where, and how they learn course content.[10] Blended learning (BL) is one student-centered learning approach being adopted by HE institutions. When designing new blended courses, educators aim to balance the use of face-to-face (F2F) and technology-enhanced learning (TEL) resources to meet the personal needs of the learner.[12] TEL resources are often used to replace some of the F2F aspects of a course, yet it is integral that all resources still align with the course's intended learning objectives (ILOs).[13] Interest in the TEL aspect of BL is set to continue for students who are increasingly able to choose their mode, pace, and place of learning and for organization of course content.[14]

BL techniques may be well suited to veterinary medicine training to balance academic and workplace learning commitments. BL techniques may also encourage independent lifelong learning that is vital to the contemporary veterinary surgeon.[9,15] Although extensive research has been conducted in medical schools,[16–19] whether BL methods are perceived as beneficial to student learning in the context of veterinary education is unknown. A main theme from medical experience is that students have a positive perception of BL methods, but only if courses are designed to benefit their learning rather than being a replacement for staff F2F teaching time.[16]

Deep learning involves stepwise construction and application of knowledge to promote critical thinking in order to embed learning content.[20,21] Developing skills in critical thinking and problem solving is vital to a veterinary surgeon's clinical ability, requiring development throughout undergraduate studies and beyond.[22,23] Using multimodal learning methods to teach students can encourage development of critical thinking and problem-solving skills.[24,25] The overuse of TEL over F2F methods can lead to student disengagement and promote superficial learning practices rather than deep learning practices.[26] Because the quality of student learning could be influenced by the balance of F2F and TEL activities within a BL course, it is important to assess student engagement with these activities.

In this article, we explore student perceptions and engagement with a novel BL module in a clinical component of a 5-year UK undergraduate veterinary degree program. Specifically, we aimed to establish how students engage with different elements of TEL and F2F activities, including access times and trends in access to online resources. We also evaluated the range of student perceptions of BL elements, including workload and relevance of TEL and F2F resources.

MATERIALS AND METHODS

Context

Since 2013, the University of Glasgow School of Veterinary Medicine (UG-SVM) Bachelor in Veterinary Medicine and Surgery (BVMS) degree program has undergone a major curriculum restructuring with a focus on ensuring the competency and employability of graduating veterinary surgeons. The restructuring was more broadly supported by UG's "E-Learning Strategy 2013–2020" with the inclusion of BL principles.[27] Specifically, the new degree program structure champions student-centered learning by encouraging independence, choice, and flexibility in individual students' learning experience. The new BVMS degree was split into foundation (years 1–2) and clinical (years 3–4) phases to prepare students for the supervised workplace–based final year, or professional phase (year 5). Both the foundation and the clinical phases used BL via fewer lectures, more practical classes, and small-group case-based learning (CBL) sessions.[28] Case-based sessions involved facilitated F2F, complemented with online activities using the university's virtual learning environment (VLE). The new permutation of the BVMS program integrates scientific and clinical disciplines throughout the degree, aiming to promote better application of core knowledge through independent learning.

The first implementation of the 2-year clinical phase started in 2015–2016, with the third year considered as a course incorporating six 4-week-long modules and one 2-week-long module (Figure 1). As part of the third-year clinical phase, a new 4-week module integrated four core clinical farm animal disciplines. These disciplines were (a) clinical ruminant medicine and surgery, (b) ruminant parasitology, (c) population medicine and epidemiology, and (d) pharmacology.

The structure of the module was organized through the UG-SVM VLE (Moodle), through which students could access resources at

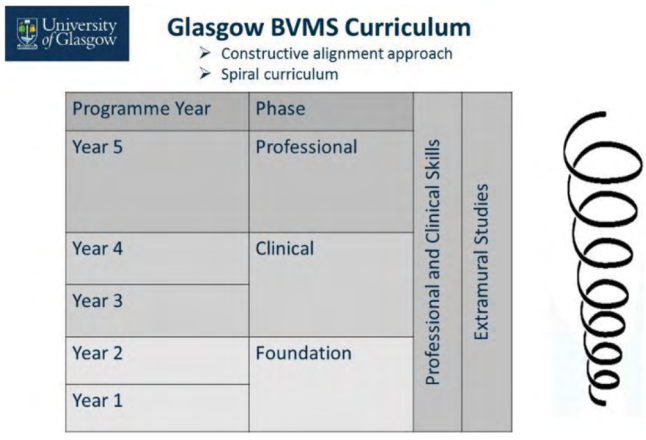

Figure 1: Structure of the curriculum of the BVMS degree program at the Glasgow University School of Veterinary Medicine, based on a spiral curriculum model

BVMS = Bachelor in Veterinary Medicine and Surgery

any time of day. The module was made primarily up of F2F and TEL activities (Appendix 1). Students were able to access TEL resources from day 1 of the module. Some of the TEL activities were hosted on another VLE platform (Mahara) linked to the UG-SVM VLE. Students were guided through the module by being given access via the UG-SVM VLE to different activities in each of the 4 weeks (Figure 2). To encourage learners to apply the knowledge taught across these disciplines, online TEL resources were designed to complement F2F sessions as self-directed tasks (Figure 2). The self-directed TEL resources fit into four core clinical farm animal disciplines (Appendix 1). Nominal timetable slots were allocated for TEL activities, and it was stated on the VLE that students could choose when to engage with TEL activities. All the TEL resources were designed in consultation with other members of the Farm Animal Clinical Sciences Division.

Compared with other modules in the clinical phase, this module extended and formalized the use of BL approaches, for example through additional use of TEL activities such as online CBL activities. In addition, emphasis was placed on designing complementary use of TEL activities to enhance the benefit of F2F sessions, such as online clinical examination videos provided before a practical clinical examination class.

Study Design and Data Collection

To assess student engagement in and perceptions of BL, we sampled students who were enrolled in the first cycle of the module (January and February 2016). To assess student engagement in the module, attendance at F2F teaching sessions was recorded by class registers. To evaluate the access and use of the online TEL activities for the module, log data were accessed for each TEL activity within the module through the UG-SVM VLE and exported as CSV files for further analysis. Each student access event was defined as the student either starting or downloading the TEL resource, depending on the nature of the resource. For example, downloading a lecture and accessing a quiz from the start were each classified as a singular access. Class attendance and log data were collected for all students enrolled in the module. Data were recorded for 6 weeks, 4 weeks of the module and 2 weeks leading up to submission of the summative assessment, and were collected from all students enrolled in the module.

To assess students' perception of the module, we used student feedback collected as part of a routine teaching evaluation and audit. Specifically, student feedback on the module was collected via a structured online questionnaire. All students enrolled in the module had access to the questionnaire from the middle of the fourth week of the module. An email was sent to request that students complete the feedback questionnaire, although feedback was voluntary and did not influence academic progression. Students were also reminded in a lecture on the last day of the module. We assumed that students were familiar with the UG-SVM VLE feedback tool because similar methods had been used in previous modules in the foundation phase (years 1 and 2) of the BVMS degree.

The questionnaire was created using a survey tool in the UG-SVM VLE (Appendix 2). Questions were split into three sections: (a) quality of module content related to the module's ILOs, (b) F2F teaching practices, and (c) TEL resources. Questions were predominantly in the form of statements that invited students to choose their level of agreement with the statement. Options were based on a five-point Likert scale: *strongly agree* (X), *agree* (X), *neutral* (X), *disagree* (X), and *strongly disagree* (X).[29] Additional free-text questions were added to allow further elaboration on certain aspects of the questionnaire, particularly concerning TEL resources.

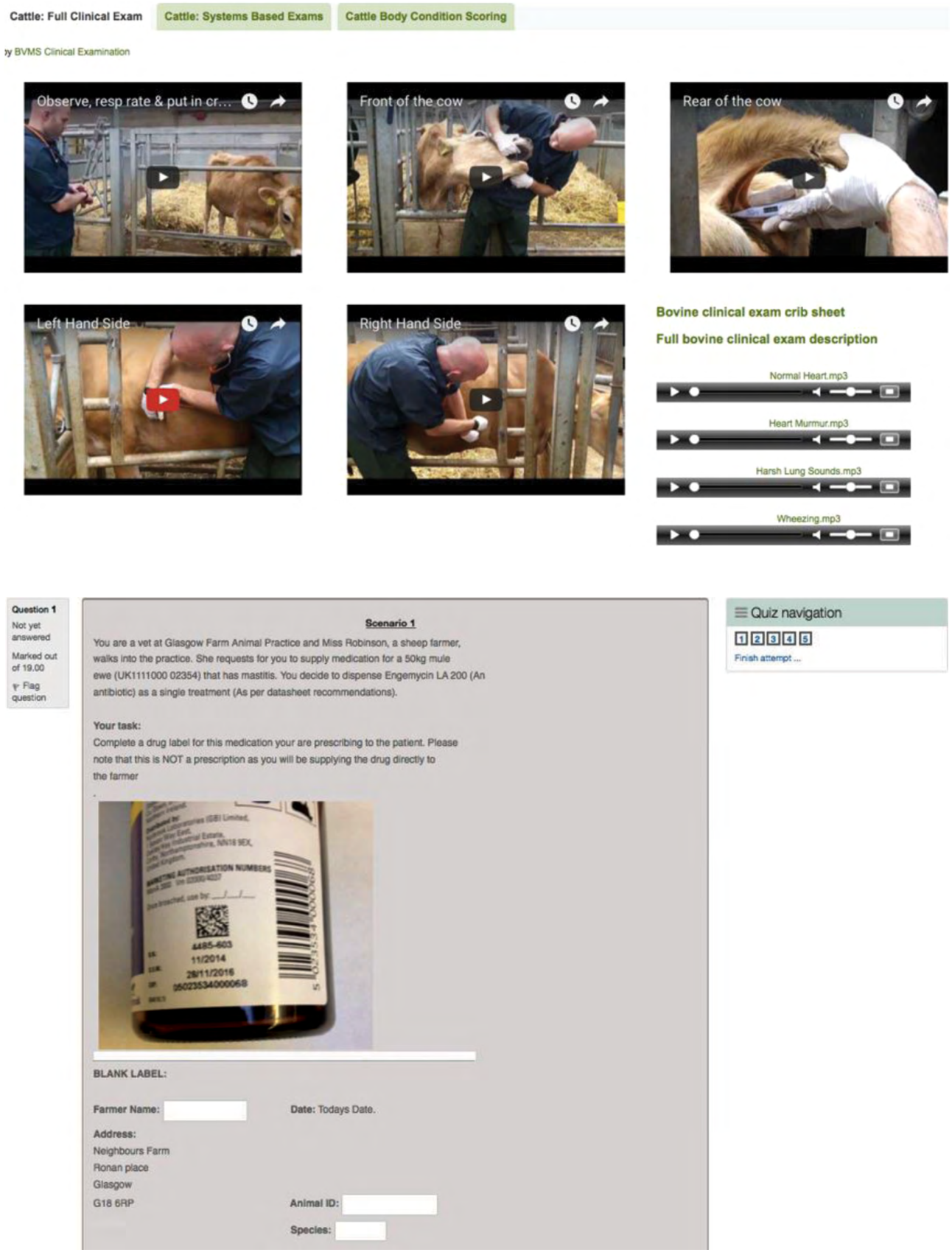

Figure 2: Examples of TEL activities provided throughout the module: (a) TEL in the form of farm animal clinical examination videos provided on the UG-SVM VLE for the clinical examination practical and (b) TEL in the form of a self-directed learning pharmaceutical label CBL

TELs were to be worked through on students' own time to apply clinical skills to prescribing pharmaceuticals by completing the online forms from the provided clinical scenario. TEL = technology-enhanced learning; CBL = case-based learning

Data Analysis

Both qualitative and quantitative data were anonymized before analysis. Quantitative data collected from the questionnaire (including Likert scale responses) and UG-SVM VLE logs were analyzed using simple summary statistics (median and proportion) and descriptive graphs in Excel (2016 version; Microsoft, Redmond, WA). Qualitative data collected through the questionnaire were analyzed by the lead author (RFK), who used a simple thematic analysis using an inductive approach.[30,31] Two researchers were involved in this process. The lead author (RFK) was the organizer of the module and has a background in farm animal practice. The third author (JAH) was not directly involved with the module but has an understanding of the curriculum as leader of the final year of the BVMS program and having a background in small animal practice and veterinary education.

First, qualitative questionnaire data were exported as an Excel spreadsheet. All questionnaire responses were read and re-read to develop a preliminary coding structure. The lead author then coded all responses with a preliminary code and grouped related codes into subthemes using color coding in the spreadsheet. A response could have more than one subtheme attributed to it. Once completed, the subthemes were organized into major themes using a second color code.

The third author (JAH) reviewed the initial coding approach, and both authors discussed areas of difference, agreeing on a final coding structure and allocation of comments to codes, related codes to subthemes, and subthemes to themes. Although the aim of the exercise was to represent rather than quantify the range of perceptions captured in the free-text comments, the number of responses associated with each theme and subtheme is reported to illustrate that the themes identified were characteristic of this set of individuals and to illustrate the diversity of perceptions in the group studied.[32]

Ethics

The teaching evaluation was conducted at UG-SVM (part of the College of Medical, Veterinary and Life Sciences [MVLS] at UG). Ethical approval for retrospective analysis of routinely collected data was granted under MVLS VLE research guidance and the UG-SVM privacy notice published on the Vet School General Resource read by all students; projects are under the oversight of a school data custodian to ensure appropriate use under the General Data Protection Regulation. In addition, ethical approval for the evaluation of blended and online learning developments was granted by the MVLS Research Ethics committee under license number 200160080.

RESULTS

Student Engagement

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

The proportion of students accessing each type of TEL resource was recorded over the duration of the module and for 2 weeks afterward (Figure 3). All 123 students downloaded lecture material and small-group teaching (CBL and practical class) guidance. A majority of students accessed clinical examination videos (95.9%), the parasitology textbook (85.4%), farm calendars (72.4%), pharmaceutical online CBL (69.9%), and the end-of-module quiz (64.2%). Fewer than half of the students chose to provide end-of-module feedback (44.7%). There were differences in how often students accessed each type of TEL resource (Figure 4). Most students accessed practical or CBL guidance, clinical examination videos, and parasitology textbooks 2–5 times or fewer. The majority of students accessed lecture material 6–10 times and the end-of-module quiz 21–50 times. The frequency of access to the pharmaceutical online CBL varied much more between students than other TEL resources, with a much wider range of frequency of access. Looking at the time of day when TEL resources were accessed (Figure 5), few students accessed any TEL resources between 12:00 a.m. and 7:00 a.m. Lecture material was mainly accessed between 7:00 a.m. and 1:00 p.m., whereas most other resources were accessed during the afternoon and evening (1:00 p.m.–6:00 p.m. and 6:00 p.m.–12:00 a.m.).

All 123 students undertook the group end-of-module summative assessment. Students worked in groups of 4–5 students, with a submission deadline 2 weeks after the end of module teaching. A group mark was given to individual students in each group

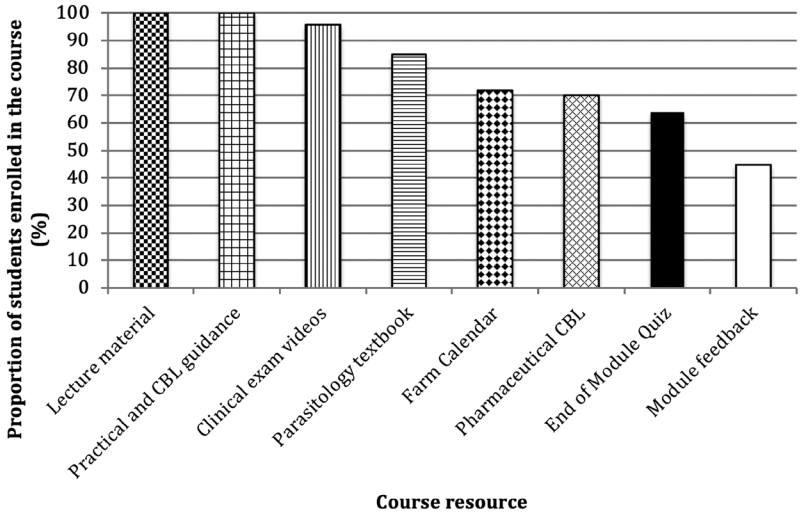

Figure 3: Proportion of students using the online resources in the module and 2 weeks afterward (n = 123)
CBL = case-based learning

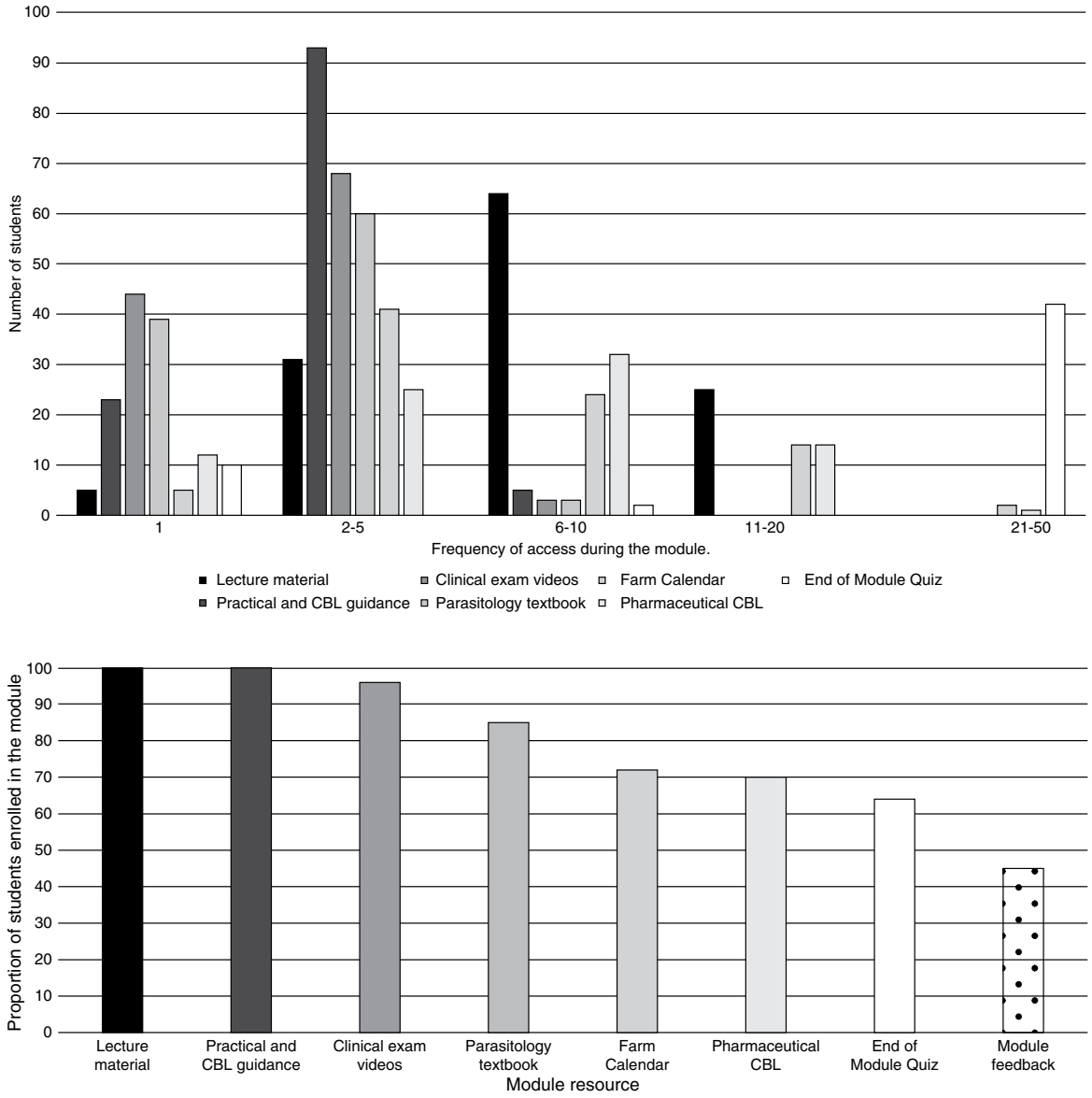

Figure 4: Frequency of students' use of online resources in the module and 2 weeks afterward (n = 123)
CBL = case-based learning

using a grading rubric. Subsequently, all students achieved a passing standard grade in the summative assessment.

Student Feedback

Questionnaire Responses

The response rate for the feedback questionnaire was 44.7%, which represents fewer than half of the students enrolled in the module (Appendix 2). Student responses to questionnaire statements are summarized in Table 1. Overall, students were satisfied with the module and agreed that what they were expected to learn was made clear. Most students agreed or strongly agreed that module content was pitched at the right level and the workload was manageable.

With respect to F2F teaching (Table 1), students agreed that lecturers made teaching material interesting and provided useful feedback. More than half of the respondents agreed that group classes and assessment enabled them to work as a team, with fewer than 10% disagreeing. For TEL resources, most students agreed or strongly agreed that online content was well organized, relevant, and easy to navigate. Online communication was appreciated, instructions were clear, and online support was adequate. Half of the students agreed that the online calendars and parasitology textbook were useful. However, the majority of students disagreed that the pharmaceutical online CBL was useful, and the remainder were neutral regarding this activity. Three-quarters of students found the formative module assessment interesting and expressed that it brought together module content, and most of the remaining students were neutral regarding the assessment.

Free-Text Responses

The majority of students who took the questionnaire responded to some of the free-text questions, for a total of 195 free-text responses

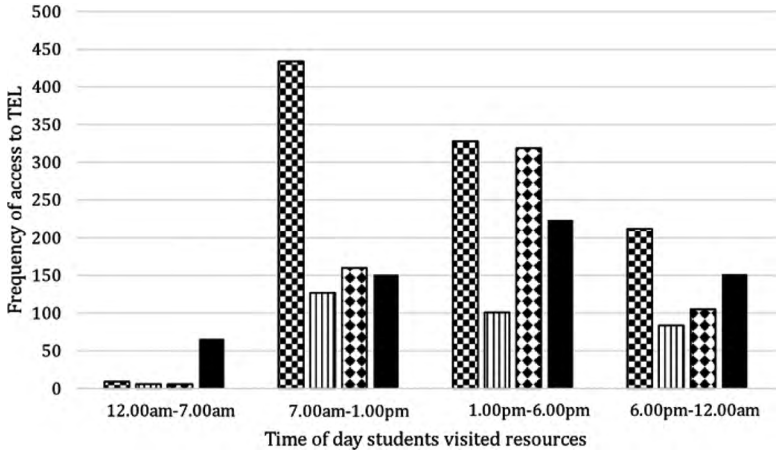

Figure 5: Times of online resource use by all students, in the module and 2 weeks afterward (n = 123). Squares = online guidance and lecture material; lines = online textbook resources (videos and images); diamonds = online CBLs; solid black = end-of-module quiz; CBLs = case-based learnings

Table 1: Students' Likert scale responses to questionnaire statements (n = 55)

	Likert scale responses, %				
State how much you agree with the following statements:	SD	D	N	A	SA
1. Overall, I was satisfied with this module.	1.8	0.0	9.1	**63.6**	25.5
2. The module was well organized.	1.8	3.6	16.4	**54.6**	23.6
3. I was easily able to find module information on the virtual learning environment.	0.0	1.8	12.7%	**67.3**	18.2
4. Any changes to the module structure were communicated effectively online.	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.	1.8	3.6	16.4	**63.6**	14.6
6. Overall, teaching staff made this module interesting.	0.0	0.0	12.7	**61.8**	25.5
7. The module content was pitched at the right level.	0.0	1.8	14.6	**65.5**	18.2
8. The workload of this module was manageable.	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.	1.8	1.8	21.8	**61.8**	12.7
10. I found the beef/sheep calendar online CBLs useful.	3.6	9.1	34.6	**50.9**	1.8
11. I found the pharmaceutical prescription online CBL useful.	7.3	**47.3**	38.2	5.5	1.8
12. I found the additional online ruminant parasitology reference resources useful.	0.0	9.1	30.9	**52.7**	7.3
13. The farm scenario assessment in the module stimulated my interest in the lecture content.	1.8	1.8	20.0	**63.6**	10.9
14. The farm scenario assessment in the module helped tie together the lecture content.	1.8	0.0	25.5	**63.6**	7.3
15. I received adequate instructions on the farm scenario assessment.	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.	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.	0.0	3.6	21.8	**65.5**	9.1
18. The online resources available were relevant.	0.0	0.0	18.2	**67.3**	12.7

Notes: The most frequent response is in boldface
SD = strongly disagree; D = disagree; N = neutral; A = agree; SA = strongly agree; CBLs = case-based learning; IT = information technology

(Appendix 2). We identified three major themes related to students' perceptions of BL in the responses to the free-text questions concerning the balance of F2F and TEL resources, module design and delivery factors, and participant factors. Table 2 summarizes the number of responses coded to each major theme and subtheme.

Balance of Face-to-Face and Technology-Enhanced Learning Activities

Of the free-text responses, 93 related to the balance of F2F and TEL activities within the module. These responses split into two subthemes: synergistic resources and student–lecturer interaction.

Synergistic resources—

Many student responses (55) about the mix of F2F and TEL activities in the module were positive. For F2F activities, responses related to appreciation of practical classes and CBL seminars (13) complementing lectures that were pitched at the right level (4). Many students explained they enjoyed these sessions that were complemented by TEL resources because they provided an opportunity to apply theoretical knowledge in a practical setting:

> It [online farm calendars] made me review a lot of diseases/procedures and think about when in the year they occur.

Table 2: Summary of thematic analysis of students' responses to questionnaire statements

Major themes and subthemes	Questionnaire responses, no.
Balance of F2F and TEL resources	93
Synergistic resources	55
Student–lecturer interaction	18
Module design and delivery factors	67
Module content organization	67
Time management and allocation	43
Software limitations	9
Participant factors	43
Relevance to student career	10
Range in student ability	29

Note: There were 195 statements from 55 students. Responses could be categorized into more than one subtheme, so the total number of major or subtheme statements does not equal the total number of questionnaire statements.
F2F = face to face; TEL = technology-enhanced learning

> It was very useful to then be given the completed calendar [after the lectures] so that I could begin to build a better idea of when in the farming year certain things occur. (Student 39)

Students expressed their positive impression of TEL activities, mainly commenting on online CBL activities. Similarly, students felt that the pharmaceutical prescription activity assisted them in applying theory to practice (15 responses). Students felt that other online CBL activities, such as the farm calendar and parasitology textbook, were mainly useful for revision by consolidating learning (19 responses). For parasitology teaching in particular, students commented that online materials supported F2F practical class teaching (8 responses): "You wouldn't understand what you're doing in the parasitology practical without these resources; they are very good" (Student 29).

Nonetheless, students expressed that TEL activities should not be used to replace F2F teaching activities (three responses). This was particularly relevant for clinical skill teaching, for which students felt that the physical aspects of activities could not be mimicked online:

> I feel like sometimes for the clinical skills practicals they expect you to have already learnt everything on the videos before you arrive. The videos should be an aid to assist your learning and prepare for the class but not a substitute for in-class teaching. (Student 12)

Student–lecturer interaction—

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

> Enjoyed the CBL case scenario discussion as they help me identify where in my thoughts process did I went [sic] wrong or have done correctly, and eventually guides [sic] me to the final diagnosis. Which I felt is really useful. (Student 27)

In contrast, three students expressed that similar interaction was lacking in online CBL sessions. For example, six students felt that they lacked guidance for the farm calendar or pharmaceutical prescription online CBLs. Other responses suggested that students felt they missed out on the opportunity to discuss released answers, which would have helped them prioritize topics for further study.

Module Design and Delivery Factors

In total, 67 responses related to module design and delivery. These responses were divided into three subthemes: module content organization, time management and allocation, and software limitations.

Module content organization—

This theme included both positive and negative comments. The majority of negative comments related to module factors that affected students managing their own learning time (23 of 67 responses). For example, a small number of participants (12 of 23) were frustrated that not all module content was hosted on the VLE, and they found it difficult to locate these resources. For example, regarding the parasitology textbook, 1 student commented, "I was not even aware of this. There's a whole lot of information scattered in a lot of different places, which makes it really hard to keep track of it all, as well as prioritize" (Student 15).

Other negative comments related to late provision of both TEL and F2F teaching. Nine participants reported that some staff arrived late to give lectures and that sometimes lecture materials were uploaded to the VLE after lectures were given. Students' perception was that tardiness made it difficult to prioritize content in their study time. Also, several of these comments (three) expressed dislike of last-minute changes to lecture materials: "There were several occasions throughout this module where lectures had been posted to Moodle, but then changed without any notice to students. This is particularly frustrating when students print these lectures out or review them beforehand" (Student 47).

Only two respondents commented appreciatively that the organization of online TEL content into folders made content easy to navigate on the VLE.

Time management and allocation—

More than half of the responses related to module design pertained to time management and allocation of module activities

(43 of 67). The majority of comments related to TEL activities taking longer than expected, specifically the farm animal calendar and the group summative assessment. A common explanation was that researching for such activities from content elsewhere in the module was too time consuming with the time available to study. Of the 43 respondents, 6 did, however, appreciate the learning experience after the activity was completed. For example, regarding the farm animal calendar online CBL activity, a student commented, "[It was] difficult to find the information so it took a long time to find anything relevant, but useful when done" (Student 24).

Despite the extended length of some sessions, only one student negatively commented that F2F activities overran allocated time slots. Six of 43 responses commented that some TEL resources, such as the parasitology textbook and online pre-reading material, were too extensive and made prioritizing what to study in the time allocated difficult. Yet a similar number of responses (5 of 43) praised the extent of these resources, commenting that they provided an opportunity for students to study topics more in depth than taught material.

Software limitations—

Nine students commented on the limitations of the software used to design TEL activities, mostly relating to the pharmaceutical prescription online CBL activity. Students highlighted that even if they got the answer right, but their free-text answer was phrased differently than the automated answer, the software marked the answer as incorrect (Figure 6), resulting in much lower global marks on this activity than individual students expected. A student described the negative impact on learning of these software limitations: "Many things were marked as incorrect but the correct answers were not given, so cannot review it and learn from mistakes" (Student 2).

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

Participant Factors

Of all free-text responses, 43 related to individual participant factors that influenced perception of, and engagement with, module content. Twenty-nine student responses described how engagement in activities was affected by their previous knowledge of module subjects. Respondents who identified having insufficient background knowledge (ruminant livestock and agriculture) felt

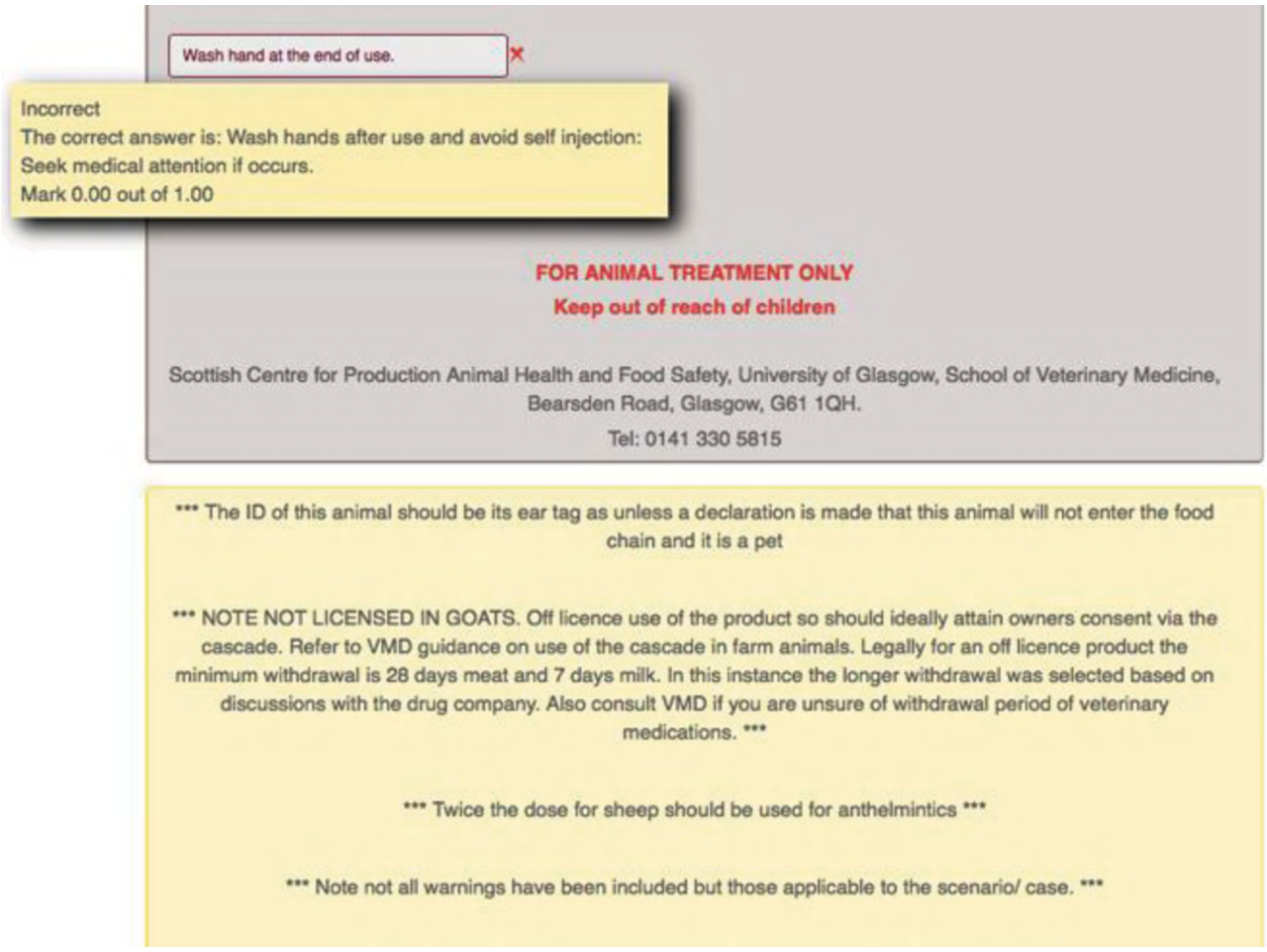

Figure 6: An example of an incorrectly marked answer from the online pharmaceutical label CBL on the UG-SVM VLE that was actually correct and an example of possible detailed explanatory feedback

CBL = case-based learning; UG-SVM VLE = University of Glasgow School of Veterinary Medicine virtual learning environment.

that TEL activities were difficult and time consuming to partake in (9 of 29). This was exemplified in the farm calendar activity: "With no background knowledge in livestock farming, I don't know where to start" (Student 14).

Students also mentioned that some of the module overlapped with content covered elsewhere in the veterinary degree program. Although some perceived too much overlap (3 of 29), others found the overlap positive (14 of 29). Overlap seemingly helped students to integrate module content with assumed background knowledge (livestock and agriculture): "Useful to be able to work through a calendar and link up the times of the year to management procedures and diseases to look out for" (Student 6).

Students mentioned that various F2F and TEL activities were relevant to their future career choices (10 of 43). Respondents who specifically intended to go into a career related to the module content enjoyed engaging with TEL content in the module (3 of 43): "Really fun module—has made me consider going into mixed [species clinical] practice" (Student 45).

DISCUSSION

BL practices are proposed to encourage students to manage their own learning around other commitments while still meeting the learning outcomes of a course.[12] As a student-centered approach, BL could be useful for professional veterinary degree programs to support students to balance academic, workplace, and personal commitments. The fact that students in this study accessed TEL resources outside of traditional working hours supports this idea. The majority of students engaged with course material, with various TEL activities accessed throughout the day depending on the activity. BL can also encourage students to learn independently after graduation, which is important to continued professional development.[33] Assessing student engagement with and perception of courses can provide insight into the experience of BL and its impact on learning and highlight areas to consider when designing courses using BL.

Although questionnaire-based student feedback studies have well-documented limitations,[34] this study provided insights into student perceptions of BL. Aspects of F2F and TEL activities were well received by students, particularly activities that integrated and applied course topics. Interaction between students and teachers was also highly valued. In the wider context, student feedback highlighted a number of BL factors that affected students' learning experience and should be considered when developing courses based on BL principles.

In this study, we investigated student engagement with F2F and TEL activities. F2F and TEL activities were nominally timetabled in working hours (9:00 a.m.–5:00 p.m. Monday through Friday), although TEL activities could be completed in students' free time, in or outside of working hours, if individual students wished. The majority of TEL activities were accessed during working hours, with the trend of lecture material being accessed in the mornings when lectures were timetabled and complementary activities being accessed in the afternoon or evening. Flexibility in students planning their study time is widely seen as a positive step within HE, to allow them to direct their learning to what is most effective for them when and wherever it suits them.[35,36] It is therefore unsurprising that individual students managed their time differently, and there are likely various reasons for different study strategies. Although we collected data on individual student study patterns and what factors drove them to manage their own study time, students did not highlight whether they were accessing TEL activities around life commitments. A study by Holley and Dobson looked at a cohort of more than 1,000 undergraduate students undertaking a BL course and their access to online TEL activities over the duration of the course.[37] Students particularly accessed TEL activities over weekends to manage their learning around part-time jobs and to work at their own pace. However, veterinary and other professional degree students have additional course-related commitments that potentially restrict their time for other life commitments.[38]

Because BL courses could potentially have a negative effect on students' work–life balance, the amount of time spent on nontimetabled activities and students' ability to use this time have to be considered when designing BL courses. It is recommended that the amount of time taken to complete course activities, within and outside the academic timetable, should be audited to make sure that students can manage their time with other commitments.[13] For the UK veterinary profession in particular, increasing mental health problems have been associated with problems relating to work–life balance.[39] Work overload can have an impact on academic performance, satisfaction, and mental health.[40,41] Students should be empowered to develop the skills to manage their study, work, and life commitments from the early stages of their degree. Although time was allocated to complete TEL activities, the amount of time to complete specific activities was not recommended. In hindsight, this may have led to students spending an inappropriate amount of time on individual activities. Signposting the recommended time to complete a TEL activity may assist students in time allocation and assist in promoting a healthy work–life balance. This is particularly important given our observation that a number of students commented that activities took longer than they expected. There is also an onus on veterinary schools to ensure that expectations of student workload are reasonable and clear to applicants.

Students also used TEL activities to prepare for F2F sessions, particularly for practical classes, with students perceiving these materials as a benefit. As with any educational intervention, motivation to engage with a topic is likely to affect student engagement.[42] In our study, it is possible that students were interested in doing well in F2F practical classes because the topics covered were perceived as important to their future career choices as veterinary surgeons.[23] Clearly, incorporating relevance and interest in TEL activities is integral to BL courses. For example, students interested in a farm animal career pathway particularly commented on the module's relevance. Highlighting the relevance of and transferable skills gained from completing course activities may increase engagement with students less interested in specific topics in a BL course.

Students described both F2F and TEL activities positively but highlighted that F2F and TEL activities should be complementary, rather than simply replacing F2F sessions with TEL. Getting the right blend of F2F and TEL activities is integral to the success of a BL course.[43] Other research has also found that F2F activities followed by TEL activities leads to students engaging with the content more than do students with access to only TEL activities.[44]

BL activities within a course should be designed and mapped to the appropriate learning outcomes of the course because certain topics are more suited to F2F or TEL activities.[45] Specifically, we found that students appreciated TEL when it was used to complement F2F sessions, such as in preparation for practical classes by studying online videos or a textbook. In other work, Morton et al. explored medical and biomedical student engagement

with a new BL course in pharmacology through small focus groups.[16] Students identified other courses that could be suited to BL approaches, particularly those that taught core principles and moved on to real-life application of the content. Yet in our survey, students had a mixed response to TEL activities that built on background knowledge, particularly when learning built on content from previous studies in their degree course. Getting students to revisit previously learned material can be a challenge and partly depends on how well they learned it the first time. Students who are less familiar with the background knowledge may feel they spend longer than expected on these activities, leading to demotivation and failure to meet learning outcomes.[46] Students commented that being unable to predict the time an activity would take made it difficult to prioritize their learning, particularly TEL activities that required students to research topics beyond core course materials. As previously mentioned, signposting could be a potential solution to this and has been shown to increase students' awareness of what a TEL activity involves. For example, signposting has been shown to be useful with flipped classroom techniques[47] and in large online learning environments.[48,49] Annotating TEL activities with the expected level of background knowledge, associated course resources, and expected time to complete the activity could improve student motivation and engagement with stand-alone TEL activities.

Preserving lecturer interaction is very important in BL courses, because interaction between students and the lecturer can increase the quality and effectiveness of F2F sessions.[50] F2F activities encourage lecturer interaction, whereas TEL activities emphasize learner–material interactions.[24] We found that students missed interacting with teaching staff and student peers, especially for stand-alone TEL activities. Students requested more guidance to support their learning in TEL activities that were predominately self-directed. Students felt that, in isolation, TEL interaction with teachers was not as productive as F2F interaction. Positive interactions with lecturers can improve student learning because one-on-one direction can assist individual students with learning needs, such as help in prioritizing and clarifying course content.[51,52]

Students also value being part of a learning community, and F2F sessions in BL courses can foster a community spirit that encourages students to learn through supported interaction with teachers and their peers.[43] VLEs' design can maximize student–teacher interaction through discussion boards and email. For example, a study by Beer et al. demonstrated that the more teachers communicate via VLE platforms, the more students will engage with the content.[53] A study looking at veterinary student engagement with an online-only course highlighted that even though automated feedback was provided online, students missed personal interaction with their teachers.[54] In that study, students particularly missed F2F teacher assistance with their approach to online case-based problem-solving activities. When designing courses around BL principles, F2F and TEL activities should be synergistic to support student engagement and academic achievement as part of a learning community.[55] Complementary F2F feedback sessions with teaching staff at the end of the course can provide students with the opportunity to interact with teaching staff directly about TEL resources used in the course.

The online learning environment had an impact on how students engaged and perceived their learning experience. Students were generally able to navigate TEL resources hosted by the university's main VLE (Moodle); however, students were frustrated when they could not find activities hosted on another VLE (Mahara). Students also described software problems as a barrier to their learning. Students' perception of the format and design of online learning environment content can make a difference in how students engage with TEL resources.[56] There is a complex relationship among emotions, motivation, cognition, metacognition, and academic achievements. Thus, when using BL methodology, an individual's emotions, such as frustration, may demotivate and hinder cogitative processes.[57] A large survey of more than 500,000 biological science students undertaking BL courses found that highly frustrated students review less online course content and attain lower grades than those with low levels of frustration.[58]

It was clear in our study that, on occasion, frustrations related to the online learning environment were perceived to have hindered student learning. Despite these frustrations, students continued to try to complete aspects of the course that had software problems. For example, the pharmaceutical prescription, farm calendar activities, and end-of-module quiz were most accessed multiple times by individual students. Other studies have highlighted that software problems led to a drop-off in student access, with students becoming demotivated and disengaged with TEL activities.[59–61]

It is important to understand the nature of the frequency of interaction in TEL activities and to establish whether the frequency of interaction is productive. Although we did not ask specifically why students accessed some TEL activities more than others, some of the TEL activities with the highest frequency of access had a grade associated with completion of the activity but also had the most negative feedback from students (pharmaceutical prescription and end-of-module quiz activities). Drive to achieve higher grades may have led to students attempting the activity multiple times. The use of grading to encourage students to complete TEL activities has been demonstrated over a variety of formats.[49,62,63] In addition, veterinary students are regarded as highly motivated to succeed in their studies due to their passion for their chosen career, which might partly explain their persistence with faulty activities,[64] because students perceived completing these activities as an important part of their professional training. However, software frustrations may have had a negative impact on the quality of their learning strategies. Parkinson et al. highlighted that although veterinary students are generally motivated, frustration and work overload might encourage them to use superficial rather than deep learning approaches.[42] Students who use superficial approaches retain knowledge for short-term recall, whereas those who use a deep learning approach are able to apply knowledge in different contexts.[21] In veterinary training, deep learning is integral to developing clinical problem-solving skills.[65]

Like F2F activities, TEL activities should be aligned with ILOs, and software problems should be mitigated to minimize student frustration. The majority of the frustrations with software problems were related to automated feedback in TEL activities that marked correct answers as incorrect. Veterinary students appreciate sequential feedback with relevance to their future career,[54] and inappropriate feedback could be detrimental to their learning experience. Troubleshooting TEL activities by piloting new activities and appropriate staff training in using software to design activities is important to limit the likelihood of software issues.[66,67] Because this was the first run of the module, problems

were likely and highlight why troubleshooting is particularly important for newly developed TEL activities.

In addition, previous experiences with TEL can influence future engagement with it.[68] In the UK, veterinary surgeons are required to conduct regular continuing professional development throughout their career.[69] In recent years, there has been an increase in distance online-based platforms for post-graduate education of veterinary surgeons.[9] Thus, it is important that TEL activities in undergraduate veterinary BL courses do not discourage future engagement with TEL.

This study had various limitations that should be considered when planning future research. We examined only a relatively small number of students for a snapshot in time of a single course. End-of-course feedback is often given by students who have grievances about a course and, because the course feedback questionnaire was optional, this may have biased our results.[70] However, end-of-course surveys and log data are useful for understanding an individual's engagement and perceptions of a course,[71] and TEL platforms offer opportunities to monitor trends in student learning. Conducting interviews or focus groups might have provided further depth to students' perceptions of BL methods,[72] but the online questionnaire did facilitate sampling a larger cohort of students. Our approach has been helpful in identifying factors to consider when using BL principles to design undergraduate courses as part of routine course feedback. Few studies take advantage of such audit tools to research the use of BL principles in the training of veterinary surgeons.[73] Despite the module design's being focused around BL principles, the students who participated in our study had been taught using BL methods for 2 years. Students with little experience of BL courses may have different perceptions and encounter additional challenges when participating in these courses for the first time.

We did not assess access to online TEL resources from the module as part of pre-exam preparation (4 months after the end of the course). Also, we could not investigate the nature of interaction with TEL activities (e.g., depth of engagement) because of limitations in the data provided by the VLE software. Other studies of online courses have identified that students may more often use TEL material before exams.[74] However, it is unclear whether such behaviors improve academic outcomes or, in the case of veterinary training, alignment with professional competencies. Further research should focus on improving academic staff's ability to estimate and allocate adequate independent study time for students. For veterinary students, in particular, how the design of BL courses affect students' own allocation of study time may relate to their professional development, their well-being, and their mental health. For this reason, future studies could consider whether TEL activity guidance (signposting) assists students in managing their study time and further prepares them for future independent study.

Assessing student perception and engagement with a BL course has highlighted the benefits and challenges of using BL principles in the undergraduate education of veterinary students. Our findings support other work recognizing the importance of considering course context, organization, and student time allocation skills; troubleshooting software errors; and developing synergistic resources when developing a blended course. Veterinary educators who want to incorporate BL methods in professional degree teaching should consider these factors to improve application of course content and support students to become independent learners. Although it is clear that a BL approach can be effective in training the next generation of veterinary surgeons, there is considerable scope for additional research to establish the most effective techniques for implementing BL in veterinary and medical education.

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APPENDIX 1

Table A1: Summary of the F2F and TEL Activities in the Module

Type and 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 theater with clinical experts on various subjects.	30 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.	3 1-case stations of 30 minutes each with 6–7 students; 1 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.	3 30-minute stations with 6–7 students; 1 clinical teacher per station
Parasitology practical	Students work through 12 diagnostic stations to identify parasites of farm animals and answer questions on treatment protocols.	1 1-hour class with 11–12 students; 1 parasitology teacher per group of students
CBL		
Anthelmintic and antibiotic selection	Students work on, present, and discuss 3 case scenarios on selection of diagnostics and pharmaceuticals. Case scenarios are provided online before the class to prepare for discussions.	2 1-hour classes with 22–23 students
Type and name of activity and VLE hosting the activity		
Complementary resources for F2F teaching		
Module organization (Moodle)	Various guidance documents with additional reading references for lectures, practical, and CBL classes 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 CBL		
Farm animal calendar (Moodle)	Students are required to create a calendar, for example for 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, and extended matching questions on various topics covered in the module.	Available throughout the module
End-of-module summative assessment (Moodle)†	Submission of case-based assessment of a disease investigation report, farmer fact sheet, and revision poster.	Available throughout the module

F2F = face to face; VLE = virtual learning environment; CBL = case-based learning

* Attendance recorded by a register

† The end-of-module summative assessment was an obligatory activity

APPENDIX 2

Table A2: Overall Structure of the Online Student Feedback Questionnaire for the Module

Question no. and question	No. of responses
Agreement (Likert scale) questions: State how much you agree with the following statements:	
1. Overall, I was satisfied with this module.	55
2. The module was well organized.	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
Free-text questions	
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

Note: Agreement questions were responded to on a Likert scale, categorized as *strongly disagree, agree, neutral, agree,* and *strongly agree*
CBLs = case-based learnings; IT = information technology