Educational Research Report

Enhancing Veterinary Education in Cambodia: Evaluation of Web-based Resources in Teaching Herd Health and Epidemiology.

Authors

Arata Hidano[1*], Alison Sewell[2*], Lachlan McIntyre[3], Maggie Hartnett[4], Molly Lee[5], Bunna Chea[6], Timothy Parkinson[3*]

[1] Faculty of Public Health and Policy, London School of Hygiene and Tropical Medicine, United Kingdom

[2]Institute of Education, Massey University, New Zealand

[3]School of Veterinary Science, Massey University, New Zealand

[4]Teaching Academy, Massey University, New Zealand

[5]College of Veterinary Medicine, Iowa State University, United States

[6]Faculty of Veterinary Medicine, Royal University of Agriculture, Cambodia

[*]Contributed equally

Abstract

It can be challenging for veterinary schools in low- and middle-income countries (LMICs) to teach the eleven Competencies identified by the World Organisation for Animal Health (WOAH) due to inadequate faculty and teaching resources. This paper discusses the evaluation of web-based educational resources, to support teaching in the veterinary Faculty at Royal University of Agriculture (RUA) in Cambodia. Content- and pedagogy-based materials addressing herd health, and epidemiology/disease investigation, their most urgent needs, were developed via a collaboration between Iowa State University (ISU) and Ohio State University (OSU) and Massey University (New Zealand). Content-based resources were developed as a *Moodle*-based, server-mounted series of PowerPoint presentations, supported by a wide range of learning and assessment activities that Faculty could draw on in their teaching. Pedagogical resources were directed at strategic alignment between intended learning outcomes, teaching methods and assessment. The use of these resources at RUA was evaluated by questionnaires, focus group discussions and classroom observations. Results showed that the resources had been well received by Faculty, who drew on them to augment their own (Khmer-language) teaching materials, and to maintain teaching quality especially during Covid lockdowns. To a lesser degree, faculty used the pedagogical materials and made modest shifts towards student-centred methods, which were observed to promote student engagement in their learning. The general agreement among faculty on the overall benefits gained, supports the development of future digital content and pedagogical materials to address the remaining nine Competencies.

Keyword: Veterinary curriculum; Day 1 Competencies; Student-centred methods; On-line resources; low- and middle-income countries, Herd-health, Outbreak investigation

Introduction

The needs for public health education in veterinary professional curriculum have been well attested in the veterinary educational literature.[1,2] Standards of veterinary education have been identified as a key determinant of the quality of veterinary services,[3] particularly in low- and middle-income countries (LMICs) where poor communities often lack access to adequate public and veterinary health services.[4] Further, standards of veterinary education impact the capacity of the veterinary profession to manage endemic and transboundary animal disease,[5] with their attendant risks of food insecurity and zoonotic disease.[6] In 2012, the Office International des Epizooties: WOAH (World Organisation for Animal Health) published Recommendations on the Competencies of Graduating Veterinarians (OIE Competencies [7]) which encouraged strengthening veterinary curricula on the management of infectious diseases of animals in particular, and the management of livestock in general. These guidelines have been used widely across LMICs to guide curriculum reform,[8,9] particularly via 'twinning' programs [10–16] between veterinary schools in developed countries and LMICs.

Twinning programs have clearly contributed to the advancement of veterinary curricula in those countries in which they have taken place. Indeed, in some LMICs that have more than one veterinary school the twinning partners have disseminated their learnings widely across the national veterinary schools.[10,15] However, notwithstanding the benefits that have accrued from these programs, there remain significant limitations to implementation of curricular improvements in the veterinary schools of many LMICs. Indeed, Seddon *et al.*[15] noted that, in the context of south-east Asia, '*ongoing resource issues, including teaching staff's very heavy workloads, limited facilities for practical classes and clinical teaching, and limited access to animals*' (p. 89) combine to pose significant challenges to further development of veterinary programs. Similar factors pertain in sub-Saharan Africa, where de Deken *et al.*[17] recognised that most veterinary schools '*face serious shortages, both in their budgets and of qualified personnel*' (p. 383).

These resource constraints, particularly including the breadth of faculty qualification, are indeed a significant barrier to the advancement of veterinary educational programs. These barriers pertained strongly at the veterinary school in the Royal University of Agriculture (RUA), Cambodia (see [18] for a historical account of the development of the University over the post-colonial and Khmer Rouge periods). Veterinary students at the RUA firstly undertake a four-year program to become a veterinary para-professional (Bachelor of Science in Veterinary Science: BSc), after which some progress for a further two years of study to complete a six-year veterinary program (Doctor of Veterinary Medicine: DVM). In the beginning of this study (2019), there were 100 students per year of the BSc program (although the University is in the process of increasing this intake to 200), and around 30 students per year in the DVM. The cadre of the RUA Faculty is 13 members of academic staff, all of whom teach into the program. Some have primary degrees in veterinary science, whilst others have degrees in animal science. Half of the faculty have higher degrees (Masters, PhD), with the remaining having only a primary degree. Hence, there are too few fully qualified faculty members to fully deliver the WOAH Day 1 competencies to the cohorts of students who are studying veterinary science.

Specifically, and as described below, the faculty at RUA identified two-fold needs: firstly, they needed resources for technical content and, secondly, they needed new pedagogical methods that were

compatible with the high student to staff ratios. Similarly, these two key needs also aligned with the findings of Seddon *et al*. [15] In order to develop materials that would address both these technical and pedagogical needs at RUA, a collaborative project was developed between them and Iowa State University (ISU) Center for Food Security and Public Health, in partnership with the veterinary schools at Ohio State University (OSU), Massey University (New Zealand: MU), and the University of Gondar (Ethiopia). These partner universities had prior experience of OIE twinning projects between high-income and low- and middle-income partners.

Two domains of veterinary knowledge included within the OIE (WOAH) Day 1 Competencies (as outlined in the WOAH Competencies of Graduating Veterinarians and Model Core Curriculum [7]) were initially selected to be the focus of online resource material (referred to as digital materials or platforms hereafter) development: (i) Herd Health Management and Nutrition and (ii) Infectious Disease Epidemiology. [19] These outcomes were supported by two more generic goals (iii) Best Practices in Teaching and (iv) Reducing Impacts of Gender Inequalities in Veterinary Medicine. The first two selections were made on the basis of the preferences of faculty at RUA that were expressed in Stage 1 of the study, as described below. In the long term, it was intended to use the perceptions of the faculty towards these initial materials to inform the development of future resources to support the teaching of all 11 of the WOAH Day 1 Competencies in LMICs. This paper only describes the outcomes of the use of these initial online materials, to support the teaching of veterinary undergraduates at the RUA.

Methods

The project was undertaken in four stages: (1) a pre-evaluation of the teaching needs of the faculty at RUA; (2) the development of online materials for use by those faculty; (3) faculty training, familiarisation and utilisation of the digital materials in teaching; and, (4) a post-evaluation of the perceived value of the materials by faculty and of any pedagogical changes that might have occurred. This paper reports Stages 1 and 4 only - the pre-evaluation of needs (Stage 1) and post evaluation of how the digital materials had been incorporated into faculty programs; the benefits and challenges (Stage 2).

The intention of Stage 1 was to explore the teaching needs in terms of content knowledge and pedagogical knowledge of faculty. Three primary methods of data collection were used: questionnaires, focus group discussions, and classroom observations. Firstly, we used the evaluation tool developed between OSU and the University of Gondar [10] in a face-to-face interview format (all faculty n = 13) to evaluate the extent to which the curriculum at RUA develops the competency of graduates in each of the WOAH Day Competencies . Thereafter, all faculty completed a second questionnaire that was designed to generate data about current levels of resourcing and expertise, how the digital materials might support teaching and learning, their perceived utility/value for teaching, and perceived challenges/benefits of using a digital platform. A second component of this questionnaire was based on the Theory of Planned Behaviour[20] to assess shifts in faculty attitudes towards using the digital platform, their perceived control of it, and their expectations of its efficacy. The questionnaires took approximately 30 minutes to complete. Likert scale responses were summarised, but not subject to further statistical analysis (in part because of the small sample size.) We met with faculty across two focus groups to discuss the nature of their current curriculum, teaching practices, and resourcing. In addition, we held three focus group discussions with students (n = 10), however the data from these

was not used due to the language barrier which failed to generate rich data. Finally, five classroom observations were conducted including faculty teaching the following topics: i) principles of veterinary surgery, ii) biochemistry and molecular biology, iii) communication, iv) digital imaging and practical diagnostic imaging. These were the only classes available to us at the time of our visit, but they provided a good sense of the teaching styles and resource constraints. Data from these four qualitative methods were analysed using thematic coding.

In Stages 2 and 3, delivery of the materials was undertaken via a bespoke, *Moodle*-based, online platform with which the ISU developers of the program were very familiar. It was determined that the digital platform would firstly be available to the faculty of RUA in Cambodia and the faculty of the University of Gondar in Ethiopia and potentially, later, to be made universally available. The intended audience for the materials was to be faculty facing, rather than provided to the students themselves. Given the dearth of discipline-specialists in the veterinary public health/disease control domains at RUA, material was developed that could be used by non-specialists such as faculty members who had backgrounds in pathology or microbiology. Precedents for this online emphasis have been extant for some time,[21] as has the notion of international collaboration to create internet-based learning materials.[22] These two stages are not reported on here.

In Stage 4 of the project, the responses of RUA faculty to the digital teaching materials were assessed, including the nature of how they made use of these materials over the ensuing three years 2019-2022, their challenges and the perceived benefits. Four data collection methods were used: document analysis of the digital materials, questionnaires, focus group discussions with faculty, and classroom observations. We conducted a systematic document analysis in 2022 to evaluate the suitability, completeness, and alignment of the technical content of the digital materials and the pedagogical guidance for faculty. Using a structured assessment Tool, drawing on the work of Dalglish *et al.* [25], we also examined the cultural relevance of materials to the Cambodian context, as well as the degree to which it was seen to represent gender inclusivity.

Secondly, the questionnaire 4 (see Appendix 1) was expanded from that used in Stage 1, designed to generate data about the material's perceived utility/value for teaching and the challenges/benefits of using them. Nine faulty completed this questionnaire. The questionnaire also returned to the Theory of Planned Behaviour[20] to assess shifts in faculty attitudes towards the use of the digital platform, their perceived control of it, and their expectations of its efficacy. The questionnaires in Stage 1 and 4 were implemented anonymously, so individual responses over the course of the research could not be tracked at an individual level. Thirdly, eight faculty who taught in the third and fourth year of the veterinary program, participated in two focus group discussions (see Appendix 2). These discussions were facilitated by a researcher who was fluent in both English and Khmer because the original research team was unable to be in Cambodia due to pandemic restrictions. These audio-taped discussions lasting 45 minutes enabled faculty to elaborate on their questionnaire responses, especially their reflections on how they had used the digital materials, their perceived value to support students' learning, challenges, as well as any pedagogical shifts they had made. The responses of one of the faculty members (who agreed to his identity being revealed by contributing to the manuscript as a co-author) was extracted from focus group transcript and are directly presented in the Results section below.

Finally, three classroom observations of Year 3 students (Microbiology, Immunology, and Parasitology) were videoed to provide further understanding of how teaching about infectious diseases at RUA had changed, if at all, and the challenges of teaching large student numbers in small flat floor classrooms. We were unable to observe a class in Epidemiology and Herd Health - the focus of the digital materials – because these classes were not taught as standalone subjects for the BSc programme, rather they were included within other subjects. Classroom teaching was also observed to see whether (or to what extent) constructive alignment [23], and student-centred learning [24] principles (part of the digital materials) had been incorporated into faculty praxis.

All data collected in Stage 4 were analysed thematically as in Stage 1.

A self-test was completed to determine whether ethical approval was required by the Institutional Review Board (IRB) of Iowa State University – who held overall responsibility for the project. This test determined that our research was IRB exempt, because the outcomes were to remain specific to RUA and its programmes, although other organisations may use the results for their own programmes. Approval was then granted by the Dean of Veterinary Science at RUA. Having gained her consent, Information sheets and Consent forms were distributed to all faculty members, to invite participation and to ensure they were well informed of the research aims and their rights in the data collection process.

Results

Findings are presented in three sections: (i) the initial evaluation of faculty needs; (ii) post-implementation study of the quality, use and implementation of the teaching materials; and (iii) the narrative of one member of the RUA veterinary teaching faculty.

Stage 1: Initial evaluation of faculty needs prior to development of digital materials

The pre-evaluation phase of the project in 2019, including two site visits to the RUA Veterinary Faculty, identified the faculty's curriculum and teaching needs. Also identified were the challenges faced by the faculty that had the potential to limit the use and value of the proposed digital platform. For instance, the faculty was small, consisting of only 13 academic staff, many of whom were expected to cover wider disciplines than their own specialty area. Not all students had access to a computer, there was no computer lab, internet access on campus and in students' homes were unreliable, digital literacy using a learning management system such as *Moodle* was low and technical support staff were few. These resourcing challenges were compounded by high faculty workloads, lack of specialty teaching equipment, high student to teacher ratios, and small teaching spaces that necessitated the same lesson to be repeated up to four times.

The Theory of Planned Behaviour survey indicated that faculty held positive attitudes towards the concept of a digital platform, with mixed responses in their intention to use it. The faculty worked collaboratively, sharing a desire to support each other in its use. Faculty believed they would have autonomy over its use, and were passionate, committed in their support of students' learning. Traditional didactic approaches were most commonly used in their teaching; however, some faculty

members, who had been exposed to alternative teaching methods, were starting to experiment with more student-centred teaching approaches. Examples included collaborative, dialogic and shared-inquiry learning methods, which were used to vary the lecture style. Importantly, the majority of faculty expressed a willingness to learn about new pedagogical approaches to improve their teaching and students' learning outcomes. Teacher-student relationships were very respectful, and students appeared highly motivated to learn in the program, despite the observed challenges, especially their limited English comprehension.

The stated preferences of faculty for new digital content were in areas such as Epidemiology, Disease Outbreak Investigation and Management, and Veterinary Public Health. Another preference was that examples in the materials reflect a Cambodian context, including the roles undertaken by smallholder farmers in remote villages. Faculty also requested that the digital platform allow both upload and download capability. Furthermore, faculty wanted more than *PowerPoint* slides; requesting also teaching resources in the form of images, short video clips demonstrating practical skills and scenarios that they could adapt into their existing materials. Thirteen recommendations (Appendix 3) from these key findings were sent to ISU and OSU for their consideration as they developed the digital materials.

Stage 4: Post-implementation assessment of the digital teaching materials

Description of materials

Extensive digital materials were developed for faculty use related to two WOAH 'model core courses' of (i) Herd Health Management and Nutrition and (ii) Infectious Disease Epidemiology (see Table 1a), which were mapped to four Day 1 Competencies—Epidemiology, Zoonoses, Disease Prevention and Control Programs, and Emerging and Re-emerging Diseases. Comprehensive and well-researched content to meet the relevant learning outcomes was provided for each competency. The materials were pitched at a level that was deemed to be appropriate for faculty (1) who had adequate to good fluency in English, (2) who were teaching into the BSc/DVM programs and (3) who had advanced general veterinary knowledge, whilst potentially lacking domain-specific content knowledge. All digital teaching materials produced in this project, including *Powerpoint* slides, notes, images, tables, figures and quizzes, were produced under a Creative Commons license so that RUA faculty could use all or part of the materials without copyright restriction or infringements.

Materials were uploaded on the *Moodle* platform, which was maintained entirely by ISU. RUA Faculty were able to download the resource materials onto their computers, and either use them directly or incorporate them into their course materials. The technical content was provided primarily via *PowerPoint* presentations, with speaker notes and Facilitator Guides. Additional resources included relevant research-based literature, optional readings, glossaries, fact sheets and handouts. Many sections were well-illustrated with photos, charts and tables that could be adapted for teaching purposes and student activities. One section of the digital platform was dedicated to a species-by-species account of important infectious diseases.

A stand-alone module dealt with pedagogical concepts related to strategic alignment of outcomes, content and assessment. Additionally, a range of pedagogical techniques were embedded in the

content-based material, covering areas such as: problem-orientated, or collaborative learning; and including activities such as student exercises and quizzes. Material related to gender (in)equity was embedded in some of the technical content, and three modules on reducing impacts of gender inequalities in veterinary medicine were also included (See Table 1b, c).

INSERT TABLE 1A, B, C NEAR HERE

Quality, relevance and use of the materials

Document analysis showed strong alignment with the relevant WOAH Day 1 competencies, and a broad range of materials that might support teaching in those disciplines (Table 2).

Faculty's declared intention to use the platform, as assessed in Stage 1, aligned closely with actual use as assessed in Stage 4 (Figure 1). Nine of the 13 (69%) RUA Faculty completed the questionnaire and eight (61%) participated in the focus group discussion during the review phase of the research in 2022. Of these eight participants, five had used the materials to a moderate degree [P2-6] and one participant [P1] had drawn on them heavily (Table 3), attributing his use to the strong alignment of one of the developed modules to his teaching specialism. Users P1-P6 had read/used materials, even if they did not directly relate to their disciplines, as a means to learn about how their subject connected to broader veterinarian concepts, and to deepen their students' learning. For instance, P1 commented that '*I go through all the content, I do not care [if] it related to my subject or not, but some parts that I can pick up on, I have shared to our students*'. Only two of the eight participants [P7 and 8] did not use the digital materials at all in their teaching '*because materials are not related to my subject*' [P7] and '*because of language* [P8].

[Insert Table 2 here]

[Insert Table 3 here]

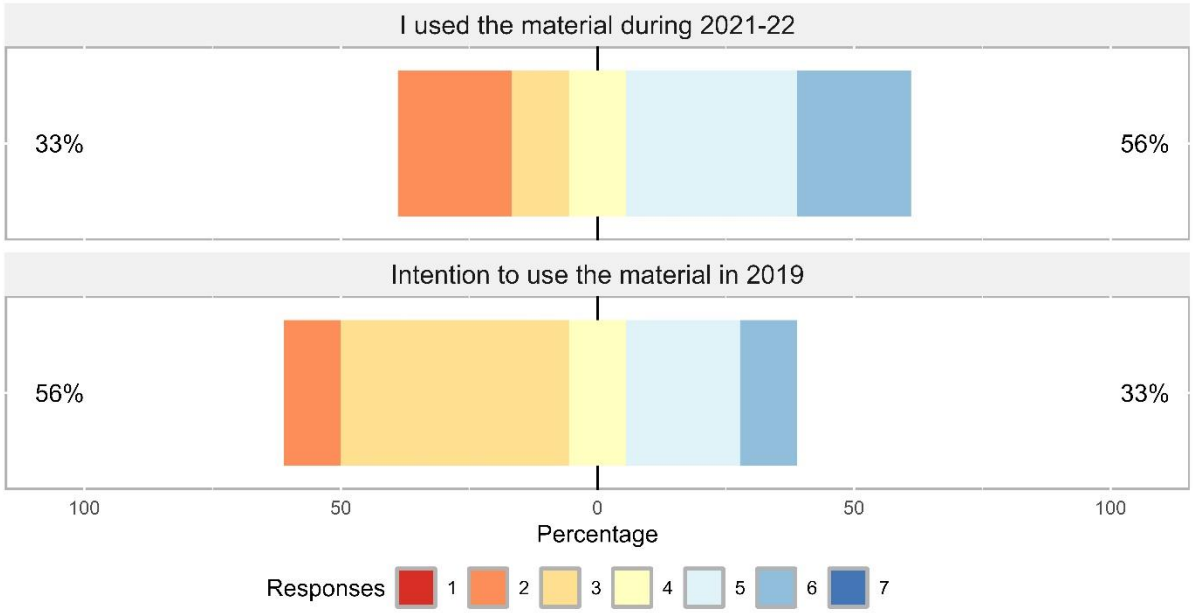


Figure 1: Comparison of intention to use the digital materials as perceived in 2019 (pre-development) and as enacted in 2022 (post-development). Responses were given on a 7-point Likert scale (1= did not/not intend to use at all, 4 = neutral, 7 = used a lot/intend to use heavily). N=9. Percentages of participants who gave higher or lower scores than neutral are shown.

P1-6 adopted and/or adapted the digital materials in various ways. These faculty especially noted the value of the speaker notes (footnotes) on the *PowerPoint* slides, which enabled them to gain a much deeper understanding of the concepts presented on the slides, equipping them with background understanding to provide richer explanations to students' questions. The Facilitator Guides also provided valuable exemplars of ways to structure a learning experience so that the learning outcomes were well aligned to the content. The quizzes were popular tools which the six participants adopted as a means of reviewing the key points at the end of a lecture, and/or enabling students to self-monitor their individual learning progress. Likewise, the questions posed on *PowerPoint* slides were useful to challenge students' thinking. P 1-6 embedded material directly into their own slides – particularly valuing the photos/pictures/ diagrams/charts, and their ability to freely use them without risk of contravening copyright restrictions. The only drawback with these photos was that most did not relate directly to their Cambodian cultural context.

Factual accuracy and relevance (to Cambodia, to smallholder farmers and to women in agriculture) were assessed by participants using 7-point Likert-scale scores (Figure 2). All responses (with one exception) to questions related to the content of the platform were neutral (4/7) or better. However, for all categories except 'relevance to small holders', the mode response was neutral. For 'relevance to small holders', the mode response was high (6/7), although almost as many respondents gave neutral scores. Only two respondents considered that the material relating to the support of women in agriculture was better than neutral. No respondents gave scores of 7/7 for any category.

Pedagogical changes

A summary of the changes that respondents made to their teaching methods is shown in Figure 3. While P1-6 attributed small changes in their teaching to exemplars in the digital materials, most agreed that their teaching styles had been shaped by a wide range of other influences – both local and international. Evident in the post-review data sets were the same teaching approaches that had been observed during the preliminary study in 2019. Pedagogical styles that were more traditional in nature (*PowerPoint* and teacher talk with a few questions or filling in missing words in a booklet) continued to dominate their teaching. P2 experimented with a flipped classroom style by giving his students a handout of the class content prior to classroom so that it could be the focus of a discussion in class-time; however, he found that the students were no more attentive and not taking notes ... so *'I just give them [the handout] after I finish the lecture and I ask them to take notes '.*

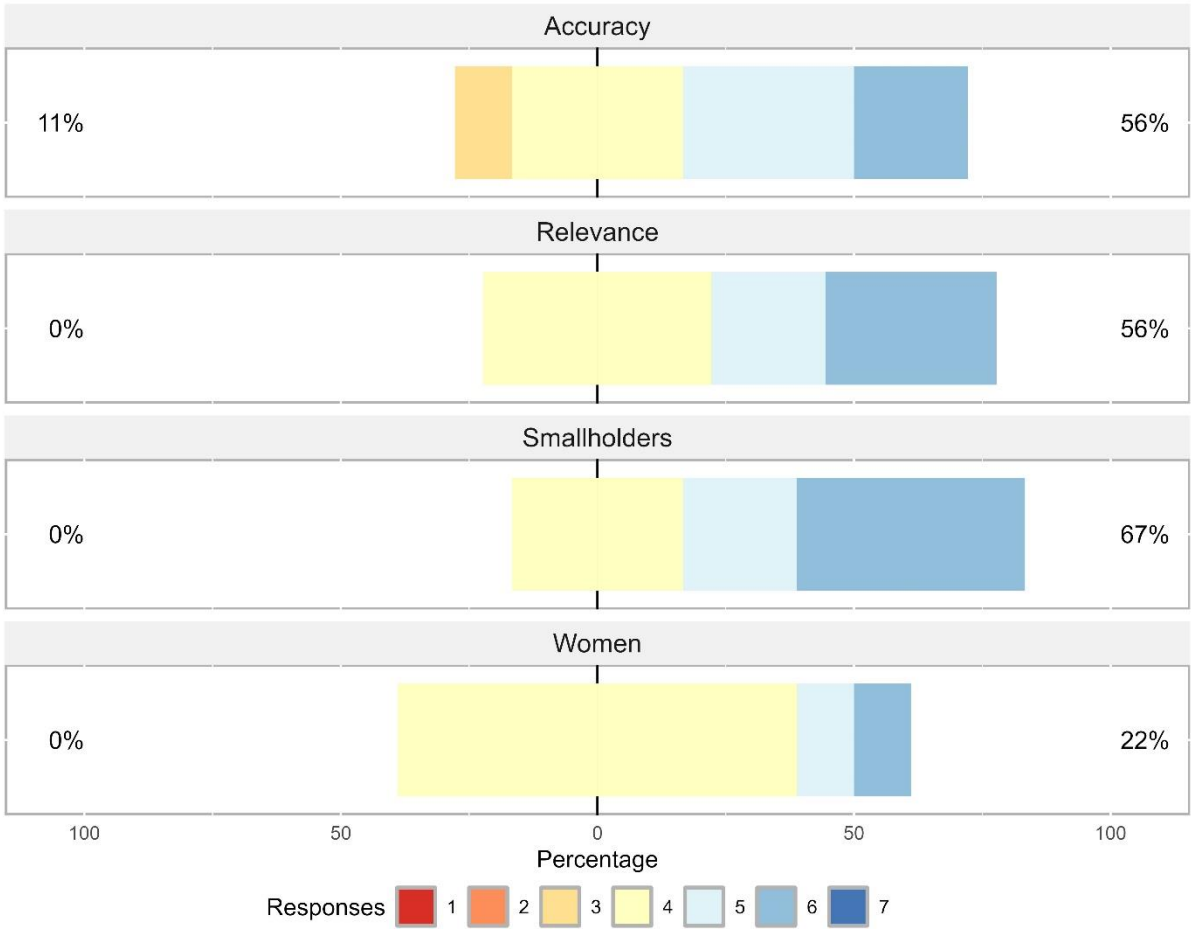
Most faculty asked to be sent material about pedagogy or to visit ISU, OSU or indeed other overseas universities to observe teachers using innovative teaching approaches. P2 expressed this point very clearly when he said that, '*many lecturers come to RUA to sit in and see our teaching, but we do not*

have a chance to go back to that country to see teaching so please invite us to see their teaching.' P1 added that *' I really like to see how they engage the students into group discussion… [and] see how [they] teach in large groups of students. …It is so hard to encourage 200 students into group discussion*'.

The participants who, in 2019, had used more innovative student-centred approaches, were still using these interactive approaches (such as small group discussion, role playing scenarios, inquiry learning, and collaborative tasks) in 2022. As P1 said, *'we still encourage students to talk or discuss rather than sitting and listen'.* Some lecturers asked their students to summarise sections of material and present these to the class, using this as an opportunity to fill in gaps or to make further comments.

P5 reflected on his use of repeated exposure to materials and explicit teaching methods involving a sequence of reviewing, presenting new content (aligned to learning outcomes) and summarising… a sequence he had learned when visiting another university; explaining that: '*before I have lecture, I take 20 minutes for review, and then I teach them and after [I] finish lecture, I have summary [of] key points and I always check my students' summary'.* P5's account varies from P7 who did not use the materials, and continued to use a traditional lecture style talking to key points on his *PowerPoints*, and posing only a few questions to students whose role it was to take notes. An account from one faculty member is relayed in the next section to highlight his reflections of using the digital materials.

Figure 2: Responses to the questions: 'was the content factually accurate to disease/disease



management in Cambodia? (Accuracy); was the content relevant to disease/disease management in Cambodia (Relevance); was the content relevant … to enable … support small-holder farmers? (Smallholders); was the content relevant to support women in agriculture? (Women). Responses were given on a 7-point Likert scale (1= of no use, 4 = neutral, 7 = ideal). N=9. Percentages of participants who gave higher or lower scores than neutral are shown.

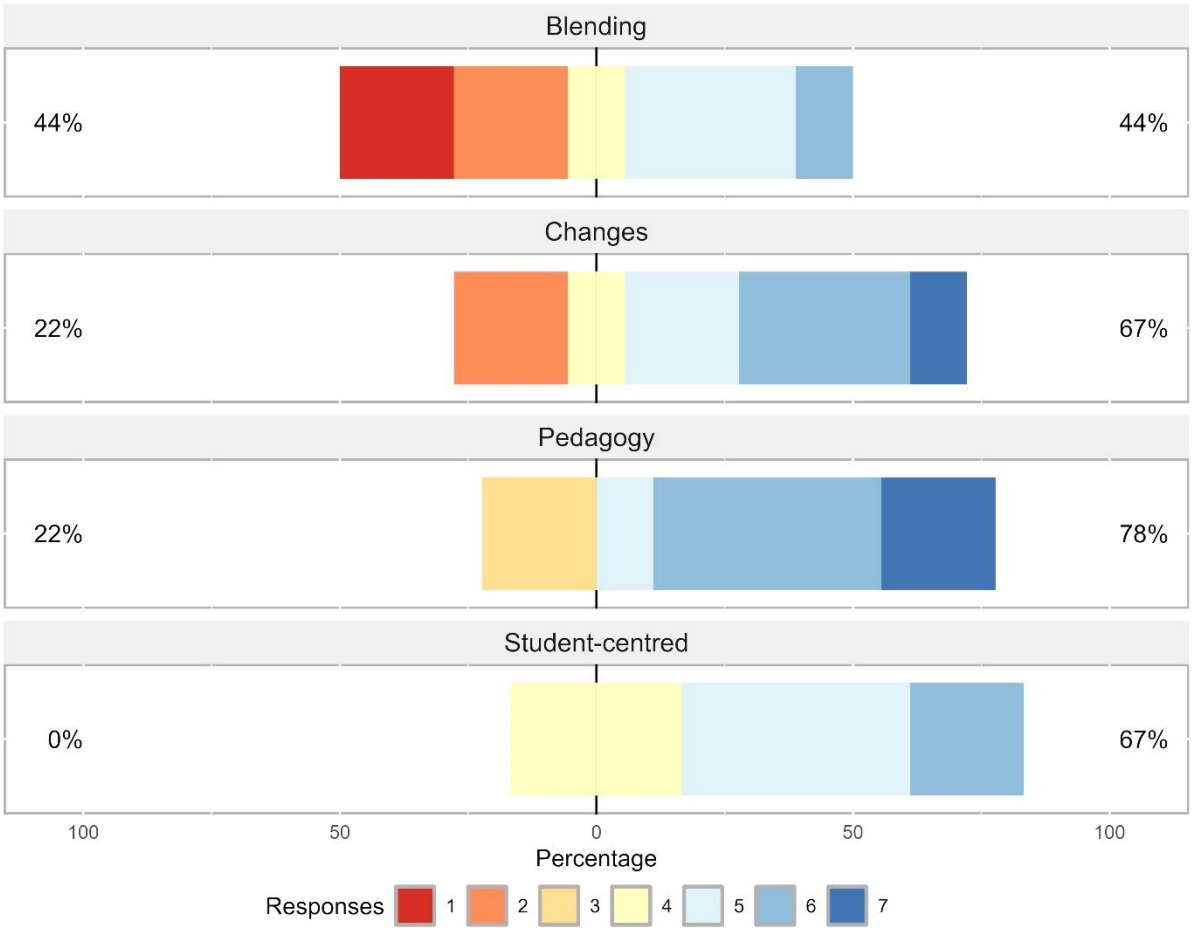


Figure 3: Responses to the questions: 'were you able to reduce the number of repeated classes by using a blended approach' (Blending); 'did you make any changes to your teaching methods as a result?' (Changes); 'did you find the material on pedagogy useful? (Pedagogy); 'did… you develop student-centred innovations?' (Student-centred). Responses were given on a 7-point Likert scale (1= of no use, 4 = neutral, 7 = ideal). N=9. Percentages of participants who gave higher or lower scores than neutral are shown.

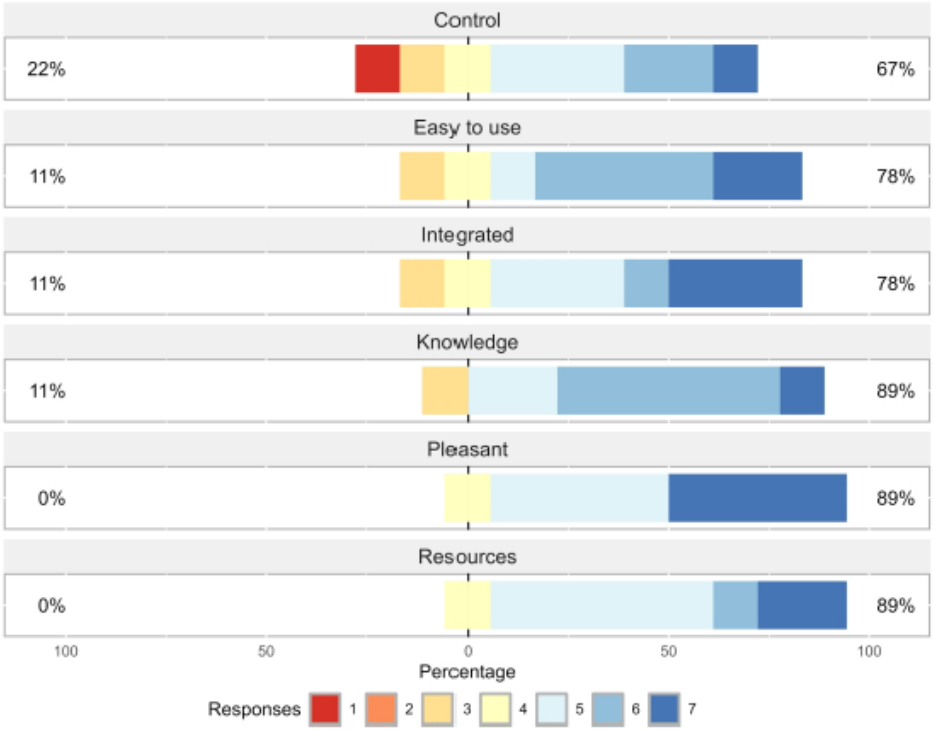


Figure 4: Responses to the statements: 'I had control over using the system to improve my teaching' (Control); '… it was easy for me to use the system' (Easy to use); 'the system was not compatible with other systems I use' (Integrated); 'I had the knowledge necessary to use the system' (Knowledge); 'using the system was pleasant' (Pleasant); 'I had the resources necessary to use the system' (Resources). Responses were given on a 7-point Likert scale (1= of no use, 4 = neutral, 7 = ideal). N = 9. Percentages of participants who gave higher or lower scores than neutral are shown.

Case study: reflections of one RUA veterinary teacher.

Bunna, a microbiologist, described himself as a 'moderate adopter' of the digital materials. He had had prior teacher training in Thailand and was observed by the authors, prior to the introduction of the digital materials as an innovative teacher, whose teacher presence and collaborative learning designs, motivated high student engagement in learning.

Bunna found that the Facilitator Guides, provided as part of the digital materials, served as examples of ways to structure and guide his classes so that all learning outcomes were addressed in a timely fashion. He commented that *'I usually go to Facilitator Guide because it will guide how to use power point ... so I am ready to speak with that power point.'* Bunna also pointed out that the material in the Guides provided him with a greater depth of knowledge enabling him to elaborate on the PowerPoints which were only written in brief bullet points. The materials that were outside of his teaching area were particularly useful for him. For example, in relation to swine biosecurity, Bunna commented that: '*I can read it and summarize the basic concept for bringing to the students when we discuss about diseases in [my] microbiology course*'.

The Disease Information section of the digital platform was perceived as particularly relevant to support his students' assignments as well as the collaborative classroom activities that he designed in class for problem-based (inquiry) learning. He reported that, '*I found the disease information [useful], so I gave them to the students and asked them what did you see? What is the clinical sign that you found? What is suitable for treatment or prevention?*' *... so I put this to the students and the students gave me their ideas. It became like a river of ideas flowing between the teacher and the groups of students.*'

In addition, Bunna reflected that the materials provided on the digital platform had helped him to think about and change his teaching approach *'... previously I just gave a little opportunity for students to speak, [but] when I visit this digital platform it [reflects] student-centered learning... ... now I try to adopt and change a bit on my lecture*'. Another teaching innovation that Bunna used was to successfully provide digital materials prior to his face-to-face class, with the expectation that his students would engage with them in class via a collaborative assignment or class activity. He reflected that: '*I think that [with] the student learning-centre[d] approach, the students feel ... confident to share ideas rather than only listen to the teacher in the class...so it is a good learning environment*'.

Further, Bunna was observed using another collaborative teaching method where he divided his class into four groups and gave each group a handout of different relevant subtopics related to rabies. Each group read, discussed and used smartphones and noted the key points, which each group in turn presenting back to the class, with Bunna elaborating to ensure key concepts were explained clearly. This collaborative approach to learning was highly engaging for students' learning.

Challenges

Perceptions of the usability of the digital platform within the context of the RUA's communication technology structure and the abilities of faculty are shown in Figure 4. Most responses amongst this group of faculty were positive, but with no clear patterns within those positive responses. The response to the question '*I had control over using the system to improve my teaching'* was poorer than other questions.

[Insert Figure 4 here]

Five key challenges were identified by staff in their accessing and/or use of the digital materials: i) difficulty of language; ii) poor internet connectivity; iii) lack of time to access materials; iv) lack of pedagogical materials to support their teaching, and in some cases; v) lack of relevance of materials to a Cambodian cultural context. Language difficulties were mentioned by all six participants (whose levels of English competence varied, ranging from very poor to reasonably competent). The main challenge lay in the use of technical words in English which were difficult to translate into the Khmer language. With 80% of their students coming to the university from rural areas, their English language was poor and it was difficult for them to learn the technical veterinary medicine vocabulary. P6 reinforced this challenge by reflecting: *'we share the materials...to students..., but it is a limitation for them because [the materials are] mostly in English'*. P1 explained that even the technical words sometimes interfered with his own comprehension.

Poor internet connectivity was the second major challenge for both staff and students; particularly when off-campus. The digital materials were in large-sized files, which were only suitable for downloading at the university campus where internet connections were relatively stable. Whilst it was not the primary intention of the project that students would directly access the platform, even disseminating derived materials to students during Covid lockdowns (i.e. when most students had to return to their rural homes where internet access was either non-existent or was slow and intermittent) was difficult for both faculty and students. P1 shared his frustration trying to help his students during his online teaching during Covid lockdowns: *'I face [an]other problem I think we all face ... I teach through the online system [Telegram, which is] sometimes very hard because some students cannot listen. I call them many times but they do not respond to me, so it is very hard when we want to get the students to attend my teaching'.*

The third challenge was the heavy workloads of faculty, leaving less time to explore the materials and decide how to incorporate them into their own PowerPoints. P2 reflected that: '*we are quite busy so it is the time challenge for us*'. The fourth challenge was the lack of pedagogical support materials within the digital platform. Faculty had large classes with little space for active learning activities: although, in one classroom observation conducted in Stage 4, students were able to break out into the wide vestibule spaces to do their small group task and then return to the classroom to report back, indicating that some staff were overcoming the small classroom problem. Most faculty were motivated to learn about student- centred learning experiences, but they lacked the pedagogical understanding to do this successfully. As P1 said: *'I think it really good to help students [to] engage to discussion, but sometime we found that is difficult … we just encourage them to talk but probably everything not so clear'*.

The final challenge, that faculty shared was an overall lack of relevance to their Cambodian cultural context and smallholder farm conditions. For example, P7 noted that they wanted '*more about parasite subject[s] because we cannot explain about the pathogen[s] in USA or pathogen[s] in Europe. We focus on pathogen[s] in Asia*'. Furthermore, some of the digital materials explained disease diagnostic tools that were beyond the capabilities of Cambodian technologies and were unfamiliar to faculty.

Discussion

The concept of collaboration between veterinary schools from high income countries (HIC) and low to middle-income countries (LMICs) in order to develop shared research is well established and, more recently, collaborations to develop standards of teaching have emerged in both the medical [26,27] and veterinary domains. [8] The WOAH twinning program [16] between veterinary schools in HICs and LMICs has added formality to these relationships, by creating a framework for the development of curriculum pedagogy. Several projects that were undertaken under the aegis of the WOAH twinning program broadly advanced curriculum and pedagogy across the veterinary institutions in the relevant LMICs, [8-15] although the WOAH Day 1 Competencies [7] were generally not the primary focus of those programs. In the collaboration reported here, Faculty at RUA were asked to reflect upon their ability to deliver the WOAH competencies, in terms of their academic personnel and teaching resources and their

pedagogical repertoire. The present work therefore extends the twinning concept, by focusing specifically on the materials needed to fully address WOAH Day 1 competencies in the veterinary curriculum in LMICs.

Once faculty at RUA had taken a holistic overview of their ability to deliver the WOAH Day 1 Competencies, they were asked to consider the areas in which they most needed support. The preferred content areas of Epidemiology, Herd Health and Veterinary Public Health were clearly areas that were under-represented in the cadre of faculty, so, to that extent their identification of those areas was relatively unsurprising. On the other hand, faculty placed a strong emphasis on improving their pedagogical understanding, identifying the need for a broader repertoire of teaching methods that would be suited to their particular circumstances.

The technical content (including the embedded teaching and learning activities) met two different, although related, needs of the faculty: firstly, of providing a 'continuing education' (CE) platform for their own learning, and, secondly, of 'up-skilling' them in the Day 1 Competencies that they felt under-equipped to teach. This pairing has also been recognised in the medical literature from LMICs: Al-Worafi noted that *'engaging in continuous learning and staying updated with the latest advancements in medical knowledge and teaching methodologies is essential for their* medical educators' *professional growth and effectiveness in their role to deliver a curriculum* (p. 4). [28] Similarly, as Hill et al. (2021) note: *'If staff can use their skills, and be employed in new roles, they have greater job satisfaction'* (p. 1236). [26] In the context of LMICs, where opportunities for veterinary CE may be scant, [29] digital materials are a critical source of learning development amongst educators. [30]

The digital platform was created as a repository of information, illustrations, teaching aids and student activities. In terms of improving the curriculum, it provided resources on which the faculty could draw to develop factually-correct and well-illustrated teaching materials. By intention, it was not designed for use directly by students; not least because the materials were in English, a language of which most students had only a rudimentary knowledge. Rather, it was intended that faculty would draw on its content to populate their own teaching notes and learning activities. The choice of Epidemiology as the first requirement of the faculty reflects the intrinsic importance of this subject itself, as well as, perhaps, some of the difficulties non-specialists might encounter in teaching it. The attention paid to Epidemiology in the WOAH Day 1 Competencies has also been extended by other organisations. For example, the Food and Agriculture Organisation (FAO) considered that *'veterinary epidemiology skills are essential for the animal health workforce to prevent, detect and control infectious diseases'* (p. 1), [31] so developed a program of competencies [32] and training for graduated veterinarians to ensure that they developed these skills for a quality veterinary service. One such FAO initiative, also in South East Asia (Thailand), is building post-graduate educational programs on the foundation of the WOAH Day 1 Competencies program, to provide '*a useful platform for ... strengthening regional disease surveillance and improving response to both public and animal health problems of international concern'*. [33] Important though these post-graduate initiatives are, they are all predicated upon an adequate teaching program in veterinary primary degrees: which in turn are predicated upon a cadre of Faculty with the necessary content-knowledge and teaching skills.

The Herd Health component of the digital platform addressed basic aspects of Herd Management such as animal nutrition and welfare, but its main foci returned to the symptoms, diagnosis, epidemiology and management of infectious diseases at the herd level. Nutrition and welfare are important *per se*, but also, alongside the control of infectious diseases, are critical components of food security in LMICs. [34] Food security remains tenuous in much of Cambodia, with affordable protein sources being at a premium, [35] so maintenance of healthy livestock, particularly in the smallholder sector, is important to mitigating the risk of malnutrition. There is clearly potential for quality veterinary services to mitigate these problems, at least at the level of disease control, and preferably at the levels of managing nutrition and welfare. Targeting these aspects of the WOAH Day 1 Competencies should, as with the aforegoing consideration of epidemiology teaching, ensure that veterinary graduates have at least entry level skills in these areas.

However, all these desirable outcomes are constrained by the number of faculty at RUA and the physical and educational resources available to them. This is a ubiquitous problem across all health sectors in LMICs: '*in low- and middle-income countries, many educational institutions have insufficient infrastructure and equipment .... and shortages of teaching staff severe'* (p. 672). [36] In the present study, faculty included internet access amongst the areas of insufficient infrastructure, noting that, whilst internet access within the RUA Faculty was generally adequate, outside of Phnom Penh (and especially in rural areas), internet access was insufficient for its routine use in teaching students. This challenge was a further reason that the digital resources were developed to be faculty- (rather than student-) facing. Further, IT support in RUA was also limited, so the use of a complex platform was deemed inappropriate. Hence, the resources were designed to use an internet platform (*Moodle*) that is freely and widely accessible, which requires only limited competence in IT, and which is reasonably compatible with the under-resourced hardware and internet connectivity constraints of LMICs. Rajapakse et al. described *Moodle* in the context of medical education in Sri Lanka as being '*open source, its features suit our needs, it is relatively simple to learn and configure yet extremely flexible and powerful'* (p. 452) [37]*:* features that were also recognized in the present work. However, the use of an internet-based resource as primarily faculty-facing is relatively unusual, as, in most cases, they are used to address Faculty shortages and/or supplement faculty instruction directly to students. [38] Creating all the digital resources under a 'creative commons' license enabled faculty to make full use of them without the copyright issues that constrain most material derived from the internet. Thus, most faculty used the materials as resources for creating their own *PowerPoint* presentations in the Khmer language (i.e. to circumvent students' lack of English language skills).

There was a broad consensus of the value of the pedagogical materials. The section of the digital platform that formally dealt with pedagogical matters was focused upon strategic alignment of teaching, learning and assessment. Less formal material, which was embedded in the declarative content, provided a broad range of teaching activities, student exercises, and exemplars of classroom activities to support each topic. So, whilst a traditional didactic approach was the most generally adopted teaching method at RUA, all of the respondents used various aspects of the teaching/pedagogical components of the platform to some extent. The small size of the faculty cadre inhibited wide-scale pedagogical

innovation, as did the inadequate teaching spaces which necessitated even didactic activities being repeated three or four times per class. Hence, whilst interested in the pedagogical resources *per se*, faculty were more focused upon whether their use could reduce their teaching workload. Interestingly, the faculty who received these digital materials 'switched roles' between being didactic teachers and digital learners: so that the faculty themselves had become the learners. Thus, constraints such as user friendly learning management systems, internet services and digital tools to support the online learning, and the need for a supportive communication technology team pertained. [39] It was perhaps for these reasons, that the pedagogical materials did not fully support transition from a traditional didactic teaching approach to a blended learning approach. [40] On the other hand, faculty commentary was that they aspired to a broader range of pedagogical materials to support innovations in their teaching. It therefore seems likely that when these resources can be expanded into additional areas, faculty would adopt them.

Faculty feedback on the accessibility of the digital platform (Figure 4) showed that the aspirations for accessibility and ease of use had largely been met. However, faculty were keen to be able to add their own material (notably images) to the platform: largely as many of the images were acquired in East Africa, and, whilst the scientific content is ubiquitous, relevance would be improved if Cambodian students were able to place them in the local context. The hope was that illustrating content (e.g. diseases) with material derived from East Africa, would enable students from different geographical circumstances to engage with that material; but the feedback seemed to indicate that it was necessary to illustrate the content in a local context in order to improve student engagement.

The extent to whether the digital platform and its implementation and use is sustainable in the long-term is an important consideration. The academic environment is a key determinant of the persistence of such initiatives. Hu et al. found that '*change in medical education practice will falter in contexts that lack supporting discursive, material-economic, and socio-political arrangements*' (p. 323).[41] On the other hand, many such initiatives are successful, [36] particularly where collaborations between HICs and LMICs involve the exchange of skills and sharing of expertise. The faculty at RUA clearly perceived this need for two-way sharing, inasmuch as most faculty members asked to visit the HIC partners in this project to observe teachers using innovative teaching approaches. The WOAH's twinning projects, as originally envisaged, expect such reciprocal visits to be an integral part of the program. It is therefore interesting that, whilst the focus of the present project was primarily upon the provision of digital teaching materials, the need to 'go and see' how good pedagogy is implemented in high-income countries remains a significant and substantial concern to the participants at RUA.

The limitations of a project such as this, are primarily that it was undertaken with a small group of faculty (n=13 total; n=6 active participants with the digital platform). However, when this small group represents the total cadre of faculty who teach the veterinary program, questions of the size of the sample group become less relevant. Rather, the present work would appear to represent the universal insufficient numbers of staff among medical schools in LMICs,[42] a situation that is generally worse in veterinary schools than medical schools. Secondly, the covid pandemic interrupted the implementation and data collection processes, so (apart from faculty statements that having the digital materials facilitated their urgent transition to online teaching), it is not possible to determine how, or to what

extent, this disruption perturbed the present results. Thirdly, our evaluation of the curriculum would have benefited from incorporating stronger student voices, which should be explored as the next step of the evaluation.

Conclusions

Taken together, these findings support the intention of the project as a pilot for the development of teaching resources for all 11 Day 1 Competencies (i.e. the WOAH specific Day 1 Competencies), and to provide online access to these to veterinary faculty in LMICs in order to enhance veterinary students' learning, and to advance the quality of veterinary services available in Cambodia. The use of an open-source educational platform (*Moodle*) appears to have been well-regarded by those faculty who chose to use them, and enabling them to readily access materials, despite the internet connectivity barriers. Further, the use of a creative commons license appears to have facilitated the ability of faculty to circumvent the most difficult issues of image copyright. The need for more extensive materials supporting pedagogical expertise was not an expected outcome, but it is very clear that pedagogical support is a co-equal need with that of developing discipline content. Providing pedagogical materials in a form that will usefully help to transform the teaching repertoire of the faculty is likely to prove a significant challenge. On the other hand, expanding the existing two WOAH competencies into the full 11 is less philosophically challenging, but becomes a technically challenging task when the needs of students to have exemplars, designed in their local language and context, is recognized.

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Table 1

a: Some examples of platform content in the domains of Epidemiology and Herd Health

Descriptive, analytic, and applied principles of epidemiology
Concepts of the epidemiology of infectious disease
Methods for description and analysis of disease events
Use of epidemiological concepts to investigate and manage animal disease events
zoonotic, emerging, re-emerging, and transboundary diseases
Application of epidemiological information to help smallholder producers of poultry, small ruminants, and swine
Use of herd health concepts to manage and improve animal production

b: Some examples of platform content in the domains of teaching and learning

Important principles in teaching practices, including their benefit for students and teachers
Guidance on implementing these practices in veterinary coursework.
Alignment between learning objectives, content and activities, and testing.
Case-Based Teaching and Learning

c: Some examples of platform content in the domain of gender equality in veterinary medicine

Reducing gender inequality by using and teaching a gender-conscious curriculum
Health risks and differences in disease outcomes related to gender
Gender inclusion related to infectious disease prevention and response
Gender inequalities in livestock production
Benefits of women's empowerment and strategies to empower women in livestock production

Table 2: Outline document analysis for the material on the digital platform, according to the criteria of Dalglish *et al.* (2020)

	Criterion	Fulfillment
1	Is the target audience identified?	Academic staff.
2	Is the content suitable for this audience with respect to African or Asian developing country focus, technical accuracy, completeness, referenced to current knowledge?	The style and content is commensurate with an audience, which has advanced veterinary knowledge and education, whilst potentially lacking domain-specific knowledge
3	What is the purpose/intent/intended use?	To educate staff and to provide them with the understanding of the subject necessary to teach OIE D1C
4	Is there any guiding statement at the start?	The home page of the Platform provides a brief, but adequate, overview of the material
5	Are there any noticeable underlying assumptions or biases?	No untoward biases or inappropriate underlying assumptions were noted. Illustrations from SE Asia would be preferable to those from East Africa
6	Is there a consistency of style, length, format, technical language within the content components?	All materials are provided as powerpoint presentations, on a common template, and generally with additional information in the 'notes' pane of powerpoint.
7	Completeness of the component section(s) and as a whole?	Technical content was very thorough and complete, and appropriate for an audience of academic staff. Material went beyond the needs of graduates for OIE D1Cs, but would be appropriate as CE/upskilling for staff
8	Completeness of the component section(s) and as a whole?	Thorough and complete
9	Are there references and internal cross references?	Material was thoroughly referenced and supported by extensive reading materials
10	Is there relevant and useful visual information?	Yes: line art, figures and photographs
11	How well do the topics align with OIE Day 1 Competencies?	The materials are strongly aligned with the relevant OIE D1Cs
12	How well does the material align with the needs identified in the first visit to RUA in 2019 (Annex 3)?	Content-focus was strong. Use of a readily accessible IT platform, that was compatible with IT support and internet bandwith at RUA was appropriate
13	Is the material easily incorporated or modified for teaching undergraduate students?	Staff report that the material is readily usable for teaching students

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705 **Table 3:** Summary of responses of RUA veterinary Faculty to the digital resources for teaching WOAH
706 Day 1 competencies.

Participant #	Specialism	Degree of use	Used material beyond specialism
P1	Ruminant medicine and bio-security	Heavy	Yes
P2	Immunology	Moderate	Yes
P3	Pharmacology	Moderate	Yes
P4	Microbiology	Moderate	Yes
P5	Poultry medicine	Moderate	Yes
P6	Public health and risk communication	Moderate	Yes
P7	Parasitology	Not used	No
P8	Pig medicine	Not used	No

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Appendix 1

Questionnaire

Questionnaire

World Organisation for Animal Health (OIE) Digital Learning Platform for the Faculty of Veterinary Medicine, Royal University of Agriculture, Cambodia.

The purpose of this questionnaire is to evaluate the use and impact of the digital materials developed by Ohio State University to assist your teaching of the OIE Day 1 competencies.

There are four sections: Content, Digital Platform, Teaching/Learning, Planned Behaviour. For each statement, please circle the number that most accurately reflects your perspective. The answers are on a continuous scale. The middle point is neutral. There is an opportunity to explain your responses in more detail after each group of questions. If there are additional comments that you would like to make, please use another sheet or raise them in the Focus Group Discussion. Depending on your use of the digital materials, this questionnaire will take approximately 10 to 40 minutes to complete.

Your name is: _____

(optional, but it will help us to compare your previous answers in section 4)

You are:

¨ **Male**

¨ **Female**

Your age is_____ Years

Your job title is

¨ **Dean/Vice Dean**

¨ **Professor/Associate Professor**

¨ **Senior lecturer**

¨ **Lecturer**

¨ **Other (please specify) _____**

Your highest Education level is:

¨ **Bachelor of Science/Bachelor of Animal Production and Health**

¨ **Master of Science/Master of Animal Science**

¨ **PhD**

¨ **Other (please specify) _____**

How many years have you taught Veterinary Science at University level? _____ Years

Please rate your expertise using digital technology for teaching.

Poor	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Excellent**

Please rate how much you engaged with the digital materials.

Did not engage	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Engaged extensively**

If you did not engage with the digital materials, can you tell us why?

If you did not engage with the digital materials, what might the developers have done differently to encourage you to engage more?

If you <u>did not</u> engage with the materials at all, you have completed the questionnaire. Thank you.

If you <u>did</u> engage with the materials, even a little bit, please continue with the following questions.

1. **Content:** ***We're interested to find out about your perceptions of the content intended to support the teaching of OIE D1Cs in epidemiology, herd health and nutrition, zoonoses and disease prevention and control programs.***

1.1: Was the content factually accurate to disease/disease management in Cambodia?

Little accuracy	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Very accurate**

1.2: Was the content relevant to disease/disease management in Cambodia?

Little relevance	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Very relevant**

1.3: Was the content relevant to supporting small-holder farming?

Little relevance	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Very relevant**

1.4: Was the content relevant to supporting women in agriculture?

Little relevance	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Very relevant**

1.5: Can you give examples of content that was very good in meeting the OIE objectives, or was very poor? Why were these poor/good?

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2. **Digital platform:** ***We're interested to know how easy the platform was to access, and whether the content was useful to develop your own teaching materials.***

2.1: Was the Digital Platform readily accessible to you (e.g. computer hardware, software, internet)?

Difficult to access	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Easy to access**

2.2: Was the Digital Platform 'user friendly' to use and to find what you wanted?

Difficult to use	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**User friendly**

2.3: Was the content useful for your teaching?

Not useful	**1**	**2**	**3**	**Perfect**	**5**	**6**	**7**	**Very useful**

2.4: Were you able to easily incorporate the content into your teaching?

Difficult to incorporate	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Easy to incorporate**

2.5 What kind of resource was most valuable? Text? PowerPoint? Images? Scenarios? Quizzes? Other? Please explain why you think this?

_____

2.6: Were there challenges to use English-based resources for instructing in Khmer?

Many challenges	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Few challenges**

2.7: Please explain any other challenged you experienced?

_____

3. **Teaching and Learning:** ***We're interested to find out how you incorporated the digital resources into your teaching, and how they have supported changes in your teaching methods and students' learning?***

3.1: Did you find the material on teaching methods (pedagogy) useful?

Little or no use	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Very useful**

3.2: Did you make any changes to your teaching methods as a result?

None	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Major revisions**

3.3: Were you able to reduce the number of repeated classes by using a blended approach (i.e. combining face-to-face and online learning in ways that complement and supplement each other)? ***Examples might include videoing the lecture of one class and uploading it to the OIE Digital Platform for students; use of online tutorials, hardcopy teaching notes, vs. online resource material;***

Little blending	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**A lot of blending**

3.4: Did the OIE digital Platform support you to develop student-centred innovations?

No OR I didn't do that	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Yes, very helpful**

3.5: Did using the Digital Platform help your students to develop deeper understandings of the content, or to make better use of their knowledge?

Not really	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Yes very much**

3.6: Do you think your students are better prepared to help small-holder farmers because of the digital resources you incorporated into your teaching?

Not really	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Yes very much**

3.7: What evidence do you have for any improvements in your students' learning and preparation for work?

_____

4. **Planned behaviour:** ***We're interested to compare attitudes and expectations to use the digital resources, that were identified in 2019.***

4.1: Having had access to the system during 2021-22, I did use it.

Did not use it	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Used it a lot**

4.2: In 2019, I predicted that I would use it.

Did not intend to use it	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Intending to use it**

4.3: Using the system was a (bad/good) idea.

Bad idea	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Good idea**

821

822 **4.4: Using the system was a (foolish/wise) idea.**

Foolish idea	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Wise idea**

823

824 **4.5: I (disliked/liked) the idea of using the system.**

Disliked	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Liked**

825

826 **4.6: Using the system was (1=unpleasant/7=pleasant).**

Unpleasant	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Pleasant**

827

828 **4.7: People who influence my teaching thought that I should use the system.**

Should not use	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Should use**

829

830 **4.8: People who are important to me thought that I should use the system.**

Should not use	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Should use**

831

832 **4.9: I had control over using the system to improve my teaching.**

No control at all	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Strong control**

833

834 **4.10: I had the resources (IT, wi-fi, time etc) necessary to use the system.**

No control at all	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Strong control**

835

4.11: I had the knowledge necessary to use the system.

No knowledge	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Excellent knowledge**

4.12: Given the resources, opportunities and knowledge it took to use the system, it was easy for me to use the system.

Very difficult	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Very easy**

4.13: The system was not compatible with other systems I use.

Not compatible	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Integrated well**

If you have any additional comments, please write them here, or bring them to the Focus Group Discussion.

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Thank you very much for your time.

Appendix 2

Focus Group Discussion questions

Focus Group Discussion (FGD)

Faculty of Veterinary Medicine, Royal University of Agriculture, Cambodia.

The purpose of this FGD is to build on some of your responses to the questionnaire to assist our evaluation of your engagement with and impact of the digital materials developed by Ohio State University in your teaching of the OIE Day 1 competencies.

There are no right or wrong responses. We are interested in knowing **your** perspective. There are **two** sub sections: Teaching/Learning and Challenges. We anticipate this will take 45 minutes. Are you happy that the discussion be audio-taped, for later analysis by the Massey University team in New Zealand. I will pause the tape at any time if there is anything you do not wish to be recorded.

1. **Teaching/Learning:** *We're interested to find out how you used the digital resources in your teaching, and how they have supported changes in your teaching methods, and in students' learning?*

1.1: What were the key benefits for using/adapting these materials in your teaching?

1.2: Can you provide an example of how you used/adapted any of the teaching materials?

1.3: Can you talk a little about any changes you made in your teaching methods as a result of the guidance provided about teaching methods?

1.4: Were you able to develop a **blended approach** in your teaching? (i.e. combining face-to-face and online learning in ways that complement and supplement each other)? Can you talk a little about how you did this such as: videoing the lecture of one class and uploading it to the OIE Digital Platform for students; use of online tutorials, development of textbook, hardcopy teaching notes, vs. online readings and digital OIE resources; in-class vs. online quiz.

1.5: What kinds of **student-centred approaches** were you able to develop with the use of the online materials? Please give examples. How did students react to that change in teaching

1.6: Do you think that the material added value to your students' learning in terms of deeper content knowledge or ability to apply their knowledge? If so, how did you see these improvements in your students' learning?

2. **Challenges:** *We're interested to find out about the challenges you experienced using the digital materials and how you overcame these?*

2.1: What main challenges did you face when accessing/using these materials? (e.g. IT, internet, access, not relevant, too complex, not motivated….)

2.2: How did you overcome these challenges?

2.3: Do you need more professional learning opportunities that might help to overcome these challenges and or/to develop new learning-centred pedagogical approaches?

2.4 What advice might you give to the ISU/OSU developers of future materials to overcome any of these challenges and to inspire greater engagement?

2.5: Is there anything else you'd like to tell us about your engagement with the OIE digital materials?

Thank you for your participation in this Focus group Discussion.

Appendix 3 Outcomes from Stage 1 consultation between faculty at RUA and Massey University

1. To be staff (rather than student) facing
2. To be compatible with the unstable wifi/internet capability of RUA
3. To be stand-alone and require no maintenance from RUA
4. To avoid increasing, and eventually decrease, staff workloads
5. To have on-going in-country support for use of the Platform
6. To be primarily focused upon epidemiology, disease outbreak investigation and management, and veterinary public health
7. To effectively liaise with the OIE twinning project between RUA and {redacted} University
8. To enable, and provide training to RUA staff to customise the Platform to Cambodian contexts
9. To facilitate the development of student-centred and blended approaches to teaching
10. To provide on-site support for pedagogical upskilling
11. To be compatible with staff capabilities in using Moodle
12. To present a broad range of materials, not confined to PowerPoints
13. To be designed to assist staff who are not discipline specialists to fill gaps in their knowledge