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Health Professions Education xxx (xxxx) xxx

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Utilisation and Evaluation of Cooperative Case-Based Teaching for Integration of Microbiology and Pharmacology in Veterinary Education

Jacqueline Picard [a], Ruth Sutcliffe [a], Robert T. Kinobe [b,*]

[a] College of Public Health, Medical and Veterinary Sciences, James Cook University, Townsville, 4811, Queensland, Australia

[b] College of Public Health, Medical and Veterinary Sciences and Centre for Molecular Therapeutics, Australian Institute of Tropical Health and Medicine, James Cook University, Townsville, 4811, Queensland, Australia

Received 6 May 2019; revised 22 July 2019; accepted 1 September 2019

Abstract

Purpose: Integrating basic sciences with clinical disciplines while fostering clinical reasoning capabilities is difficult. We investigated the utilisation of diagnostic specimens and, a cooperative, case-based learning and teaching model to integrate principles of antimicrobial drug pharmacology and microbiology in the fifth year of a veterinary course.

Methods: In small groups, students were assigned diagnostic specimens from which they isolated and identified clinically relevant microorganisms and then performed antimicrobial susceptibility tests based on a review of pharmacology, microbiology and pathophysiology. Results were recorded and analysed followed by a student-led integrative tutorial. Learning outcomes were assessed via individually written reports discussing the disease process, interpretation of diagnostic results and, recommendations and rationales for therapeutic interventions.

Results: This approach yielded high quality student reports that conformed to antimicrobial prescription guidelines with consistently high summative assessment scores. Mean scores for the final report in this learning activity were: 82 ± 12%, 80 ± 12% and 80 ± 11% for 2015, 2016 and 2017 cohorts respectively; over the same time period, 98 ± 1% of students indicated that these learning activities facilitated the development of confidence, professional knowledge and skills.

Discussion: This was a consistent approach for integrating principles of veterinary pharmacology and microbiology in clinical disciplines. These data illustrate the benefit of a systematic application of a cooperative, case-based learning and teaching model in integrating pre-clinical and clinical disciplines in a bachelor of veterinary science course.

Keywords: Cooperative teaching; Basic and clinical discipline integration; Antimicrobial resistance; Student evaluation; Veterinary education

1. Introduction

The last few decades have witnessed an exponential growth in the knowledge base for basic, paraclinical and clinical veterinary sciences. This presents a challenge in learning and teaching all required

* Corresponding author.
E-mail address: Robert.kinobe@jcu.edu.au (R.T. Kinobe).

Peer review under responsibility of AMEEMR: the Association for Medical Education in the Eastern Mediterranean Region

https://doi.org/10.1016/j.hpe.2019.09.001

disciplines while promoting the development of clinical reasoning skills in undergraduate veterinary students.[1–3] Traditional teacher-centered approaches such as didactic lecturing are not suited to solve this problem because of the emphasis these methods place on learning of facts at the expense of developing high-order reasoning skills and the ability to collate or synthesize, analyse and apply information.[4,5] To address this problem therefore, veterinary schools worldwide are implementing different strategies including, the reduction of lecture content with more time for self-directed learning, incorporating problem- or case-based learning, and designing horizontally as well as vertically integrated curricula.[6–8] In some schools with a five year based veterinary undergraduate course, discipline integration within the first three years has been promoted via intentional curriculum design, carefully planned assessment practices, a personal and professional development program, and use of multidisciplinary case studies, clinical skills, animal-handling opportunities and student involvement in research projects.[8]

In this study, we describe the use of an approach that blends clinical case-based teaching and, small-group cooperative learning and teaching as a strategy for integrating pharmacology of antimicrobial drugs and clinical microbiology for students in the final year of a five year-based bachelor of veterinary science course. Cooperative, case-based learning and teaching (CCBLT) scaffolds specific student-centred learning tasks with clinical cases in an environment that creates opportunities for students to take responsibility for their own learning, engage in discussion and, become critical thinkers and life-long learners.[9–15] CCBLT has been extensively used in health professions education, but its systematic application for integration of clinical microbiology and the therapeutic use of antimicrobial drugs in veterinary medical education has not been reported. Application of this CCBLT paradigm to clinical microbiology and the therapeutic use of antimicrobial drugs was motivated by the need to address the emergence of multidrug resistant bacteria as a compelling challenge to animal care and veterinary professional practice worldwide.[16–18] These problems have led to increased demand for optimization in training on the use of antimicrobial drugs by veterinarians as a measure to mitigate antimicrobial resistance.[17–19]

2. Methods

2.1. Description of the CCBLT target and the final year cohort structure

This study focussed on four, fifth year student cohorts in 2014–2017 academic years of a five year based veterinary undergraduate course. In the veterinary course outlined here, fundamental basic and paraclinical disciplines are covered in the first three years while clinical studies are taught in the last two years. For the period between 2014 and 2017 described herein, the fifth year average cohort size was 61 (3.40), n = 4. Stratification of student numbers by gender, age bracket and socio-economic status at the time of enrolment in the fifth year are summarised in Fig. 1. All four cohorts exhibited similar demographic details with more than 60% of students being female, aged 20–24 years and of a low to medium socio-economic status as defined by the Australian Bureau of Statistics[20] (Fig. 1). All fifth year students had access to

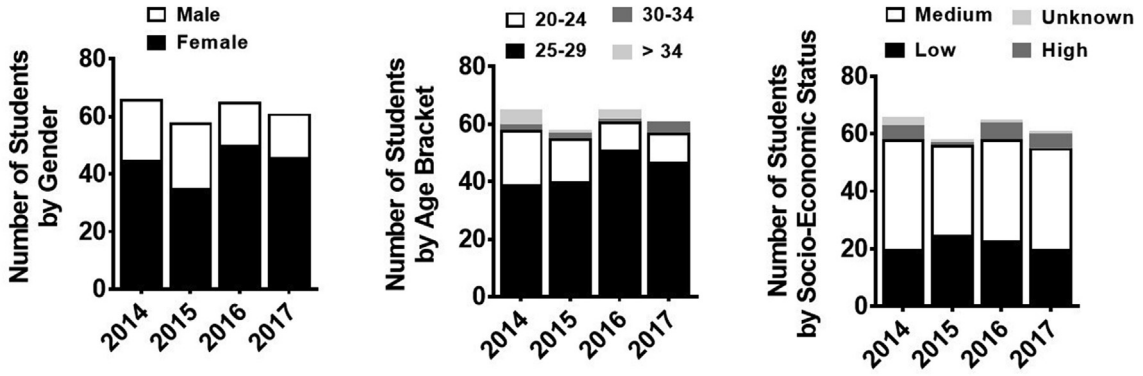

Fig. 1. The 2014 to 2017 student demographic details at the time of enrolment in the fifth year of the bachelor of veterinary science at James Cook University Australia. Across all the four years, 60–78% of students were female, aged between 20 and 24 years, and 88–97% self-identified as belonging to a low to medium socio-economic status as defined by the Australian Bureau of Statistics.[20]

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primary accession clinics for small and large animals, and a veterinary emergency centre and referral hospital for training. The core learning activities in this final year were organised in 12 clinical rotations including a composite rotation in which pharmacology, clinical microbiology and the CCBLT model was implemented. The composite CCBLT rotation comprised of small groups (6−8 student per rotation) and students worked in pairs for each clinical case during the rotation.

2.2. Microbiology and antimicrobial pharmacology learning objectives in CCBLT

The basic principles of formal CCBLT include: positive interactions among students, and between students and instructors, and the utilisation of teaching material that promotes critical thinking and problem solving.[9−15] To incorporate these CCBLT principles in integrating clinical microbiology and the use of antimicrobial drugs in clinical cases, the following learning objectives were established:

(1) Assess the quality of submitted specimen and, discuss and interpret veterinary microbiology diagnostic requests for sample processing.
(2) Perform culture, identification and antimicrobial susceptibility testing of pathogens isolated from diagnostic samples.
(3) Discuss and interpret laboratory results, and develop specific therapeutic objectives based on the clinical history of veterinary patients from which diagnostic samples were submitted.
(4) Recommend appropriate antimicrobial drug(s) and other ancillary treatment options to be applied based on established therapeutic goals, pharmacological features of selected drugs and characteristics of target microbes.
(5) Discuss approaches for evaluation and monitoring of recommended therapeutic options and assess the risks and benefits of selected treatment regimen.
(6) Locate and discuss policies and regulations that apply to selected antimicrobial drugs with respect to withholding periods, export-slaughter intervals and off-label clinical use.

2.3. Design of CCBLT tasks for microbiology and antimicrobial pharmacology

The only essential prerequisite for this task was the successful completion of years 1−4 of our undergraduate veterinary course during which basic aspects of microbiology and pharmacology of antimicrobial drugs are taught albeit mostly as individual entities. To accomplish the learning objectives outlined above, this CCBLT initiative was scheduled for 3× 2 h mandatory sessions over three days while allowing students ample time to carry out independent research and study relating to the assigned clinical case. Authentic diagnostic specimens were acquired from clinical cases in the primary accession clinics as well as the University referral veterinary emergency centre and hospital. Specific tasks were completed in each of the 3 sessions and these are outlined in the proceeding sections below.

2.3.1. Session 1 (day 1 activities)

Each entire group in the composite CCBLT rotation (6−8 students) received a brief instructional overview of safety procedures, standard microbiology practices and diagnostic procedures that are usually employed for isolation and identification of disease causing microbes. A pair of students was then assigned a diagnostic specimen and the relevant clinical information as submitted. Students then assessed the quality of the submitted sample, discussed diagnostic requests for sample processing and initiated their own laboratory work including cytology and preliminary culture. Students were allowed to work with a great deal of autonomy with the instructor providing supervision and guidance where necessary.

2.3.2. Session 2 (day 2 activities)

In this session, each pair of students proceeded to perform Gram staining followed by a wide range of morphological and physical characterisations, and standard biochemical tests such as indole, catalase and haemolysis for the phenotypic identification of pathogenic microbes. For the final full identification of isolated bacteria, students used the API 20 E test system (BioMerieux, Marcy-l'Etoile, France). Students then worked collaboratively to select appropriate culture media and rationalise their choice of antimicrobial drugs for susceptibility testing. Kirby-Bauer disk diffusion and minimum inhibitory concentration methods were used for microbial susceptibility tests according to guidelines established by Clinical and Laboratory Standards Institute.[21]

2.3.3. Session 3 (day 3 activities)

In this session, basic CCBLT principles as previously outlined[(9−15)] were used as a tool to integrate pharmacology, microbiology and clinical medicine in

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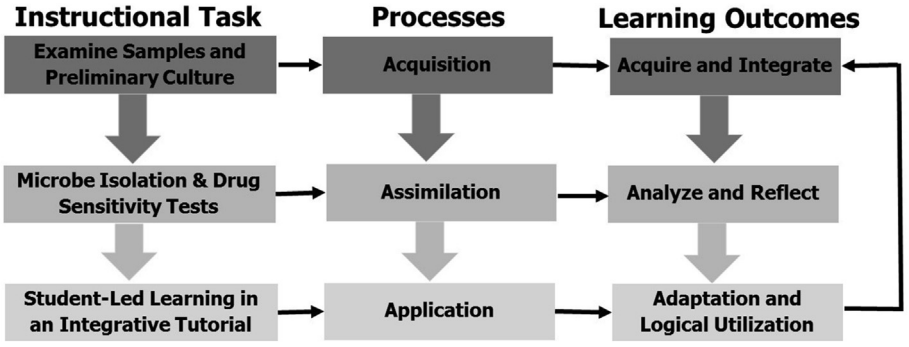

Fig. 2. A schematic illustration of a tiered, three-stage model for the design of learning outcomes that was used to facilitate a shift from didactic teaching to student-led learning in the CCBLT model. Specific instructional tasks were superimposed on this model to promote engagement, discursive and reflective learning, and the logical integration and utilisation of acquired knowledge. (Modified from the work of Marzano and colleagues, 1997).[22]

making therapeutic recommendations for infectious conditions. Briefly, a tutorial for the entire rotation (6−8 students) was convened and each working pair of students assigned to a clinical case used their recorded results to discuss the outlined learning objectives with their colleagues. Academic instructors for clinical microbiology and pharmacology only provided guidance and facilitated the tutorials by challenging students to incorporate basic and para-clinical disciplines in their decisions and recommendations. To emphasise critical learning outcomes and encourage knowledge assimilation and application, a tiered three-stage learning model proposed by Marzano and colleagues[22] was used (Fig. 2). Sessions 1 and 2 presented students with the opportunity to acquire knowledge in a non-didactic manner and, critically analyse and make necessary practical conclusions from their collected data respectively. In session 3, discussions centred on promoting the integration and application of data collated from sessions 1 and 2 with the ultimate goal of identifying and rationalising optimal therapeutic regimen. To encourage the horizontal and vertical integration of knowledge that was pertinent to each assigned clinical case, students were challenged to present and discuss their data, research conclusions and therapeutic recommendations by using a dynamic scaffold considering the fundamental pillars of antimicrobial drug selection for therapeutic use (Fig. 3).

2.4. Student assessments, evaluation of student feedback and data analysis

Students' ability to acquire, assimilate and appropriately apply knowledge in this CCBLT model was

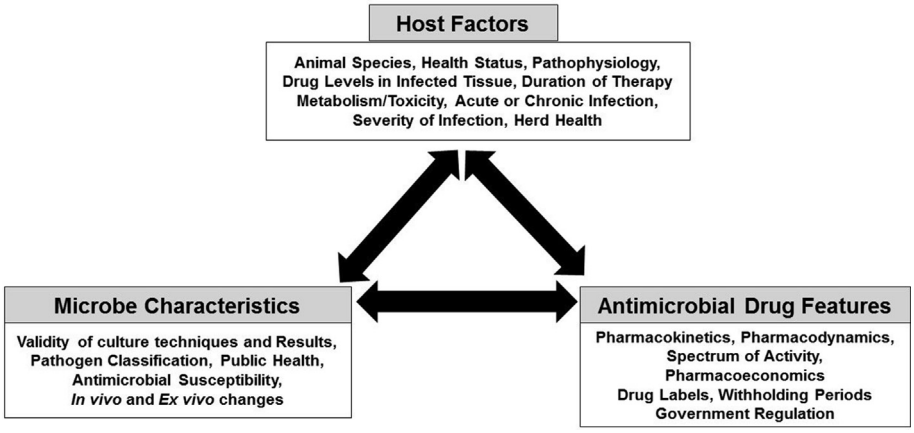

Fig. 3. A theoretical framework of critical elements to consider in recommending appropriate antimicrobial drugs for treating infectious conditions in animals. This model requires the integration of knowledge from basic, para-clinical and clinical veterinary disciplines with specific emphasis on animal host and specific disease factors, pathogen characteristics and antimicrobial drug pharmacology.

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assessed via an individually written comprehensive report relating to the clinical case to which each student was assigned. Students used the acquired data, information from integrative discussions and their own research material to make recommendations for treatment and patient management. Specific details varied with each clinical case but the proposed report format included the following critical elements:

(1) Date, title, author, and clinical case details: patient signalment and a brief case history.
(2) Specimen type: Quality, quantity and appropriateness for the requested test.
(3) Performed tests and acquired results: These data could be tabulated but students were required to provide proof of using appropriate quality controls or brief comments on what remedial actions could be taken if quality controls failed. No detailed discussions of methods was required.
(4) Interpretation of results: Identification criteria of the infectious agents, the clinical relevance of the bacteria or other microbes isolated by students and the presence or absence of any acquired antimicrobial resistance.
(5) Therapeutic recommendations and patient management: Provision of a short background on the disease. Use generated data and results to discuss the best therapeutic options including the administration of topical or systemic antimicrobial drugs, duration of therapy, monitoring approaches, and preventative strategies. Students were also encouraged to discuss whether additional tests could be recommended including follow-up tests and tests for underlying and concurrent conditions and what samples to source. For microbial agents that can be transmitted to humans and other animals, students were expected to discuss appropriate biosafety or infection control measures.
(6) References: Inclusion of any literature sources that were used with emphasis on excluding lecture notes.

This assessment criteria was incorporated in a systematic rubric with higher weighting for higher order reasoning and application of knowledge (Appendix A). Formative feedback during all 3 sessions was provided by the microbiology and pharmacology academic instructors. Active involvement and working collaboratively to accomplish tasks in all sessions was required for students to be allowed to submit a final report. Students failing to attain a 50% score for the final report were required to re-evaluate their data and submit a remedial report. Because the basic concepts of microbiology and antimicrobial drug pharmacology were taught in the third year of our veterinary course, we sought to compare intra-cohort student performance on these topics in a third year theory-based short answer exam, a third year practical multiple station assessment test (MSAT), and the fifth year CCBLT assignment for four cohorts (2014−2017). Mean rank differences across the three assessment modalities and between cohorts were analysed using Kruskal-Wallis test paired with Dunn's post-hoc test for multiple comparisons (GraphPad Prism® version 7.0 software, California USA). Median rank scores were considered significant at $P < 0.05$.

At the end of every fort-nightly rotation in each group, students were requested to fill in a non-mandatory, de-identified questionnaire to provide feedback and comment on the composite rotation and the CCBLT model. The most critical elements of the feedback included evaluation of: learning outcomes, content delivery methods, organisation of the rotation, assessment activities, provision of feedback to students and overall satisfaction with the rotation (Appendix B). Data was incorporated in our analysis only if at least 40% of students in any particular cohort responded and response rates were compared to other year five clinical rotations and university wide subject responses to the same questions. Comparison of response rates was done by analysis of variance with modified Bonferroni adjustments for multiple comparisons using GraphPad Prism® version 7.0 software (California, USA). Differences in mean percent responses were considered significant at $P < 0.01$.

3. Results and discussion

3.1. Assessment in CCBLT and comparison with year three theory and MSAT exams

Socio-economic status and demographic details were similar for all the four cohorts considered and this implies these factors were not confounders for student performance. It is also worth noting that the relatively small cohort sizes suited the implementation of this CCBLT approach as described. This is because much less logistical and technical support

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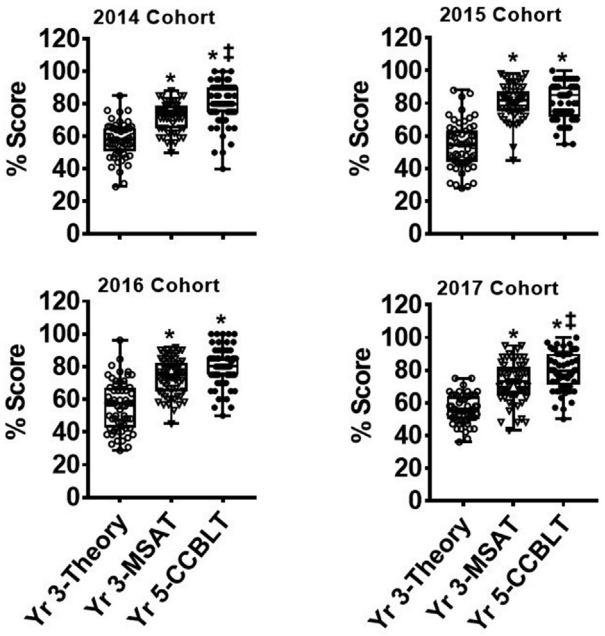

Fig. 4. Intra-cohort (2014–2017) student grades for microbiology and antimicrobial drug pharmacology expressed as percentages from three different exams including, a third year theory exam (open circles), a third year MSAT (open triangles), and fifth year composite CCBLT comprehensive report (closed circles). Collated data represent the median, minimum and maximum scores. Asterisks (*) indicate a significantly higher median score than that attained for the third year theory exam and the double dagger (‡) indicate a significantly higher median score than that attained for year three MSAT exam.

was required compared to what would be needed for larger cohorts. We show that the CCBLT model yielded consistently high student grades according to outlined learning objectives above. The detailed assessment criteria was incorporated in a systematic rubric (Appendix A). For the four cohorts (2014–2017) assessed, the median and range for CCBLT scores were 80 (40–100), 85 (55–100), 80 (50–100) and 79 (50–100) respectively. There were no inter-cohort differences in grade distribution for the CCBLT activity. Student scores for CCBLT were significantly higher than intra-cohort grades from corresponding third year theory-based integrated examination scores for antimicrobial drug pharmacology and microbiology viz. [58 (29–85), 54 (28–88), 58 (29–96) and 55 (36–75)] respectively (Fig. 4).

The typically higher grades attained from MSAT and CCBLT compared to the theory exams may indicate student's preference for a practical exam over a theoretical assessment of knowledge acquisition as the latter may exert higher cognitive demand that is often linked with memorising of facts, rote learning and perhaps, superficial understanding of content.[23–25]

For the four cohorts considered here, the number of students that failed to progress from year three to year five within the same cohort varied from 5% to 16%. While this could imply that year five composite CCBLT activities may have self-selected for success, exclusion of students that failed year three followed by a paired analysis of the same assessment activities yielded similar results. However, it is uncertain whether the higher year five CCBLT scores merely reflected natural progression and academic maturity that is expected with students in senior years of a professional course. In fact, prior knowledge and academic aptitude are well known predictors of student achievement.[26] These putative confounders could not be avoided due to the retrospective nature of this study but do warrant systematic investigation in future studies. Even so, a few salient features of the CCBLT approach as described here are noteworthy. First, the CCBLT model only utilised authentic clinical cases that created a realistic learning experience. Secondly, the CCBLT assignment required full integration of

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knowledge across a number of basic, para-clinical and clinical disciplines such as microbiology, immunology, pharmacology, pathology, epidemiology and medicine. Thirdly, the composite CCBLT assignment tested wider and higher order of learning domains incorporating tasks for creation, evaluation and application as outlined in section 2.3 and Appendix A. These data indicate that the CCBLT approach as applied here, was consistent in yielding high quality written student reports on issues relating to the integration of microbiology and antimicrobial drug pharmacology in clinical disciplines. The assessment tasks in this CCBLT model aligned at least in part, with examining students' ability to execute some of the core day one competences of the veterinary profession including the ability to: (1) collect, preserve and transport specimen correctly, (2) select appropriate microbiological diagnostic tests, interpret and outline the limitations of test results, (3) apply principles for appropriate and responsible prescription and dispensing of antimicrobial drugs in accordance with local and international guidelines, (4) apply principles of biosecurity correctly, including sterilization of equipment and disinfection of clothing, (5) critically review and evaluate literature and data prior to presentation and, apply principles of clinical governance and practice evidence-based veterinary medicine.[27] It is important to note however, that the evaluation of student's performance as outlined above does not ascertain or reflect their actual clinical practices after graduation. Nonetheless, our observations offer the first and critical step in processes that are required to fully evaluate and validate the ability of our final year students to judiciously apply knowledge of clinical microbiology, antimicrobial pharmacology and therapeutics as critical elements for antimicrobial stewardship in clinical practice.

3.2. Student feedback on CCBLT, all clinical rotations and university wide subjects

Over the four years (2014−2017), more than 90% of all respondents in the composite CCBLT group and all other year five clinical rotations agreed that subject delivery methods were adequate with overall approval of learning and teaching activities (Table 1). There were no differences in responses between the composite CCBLT rotation and other clinical rotations but overall satisfaction with university wide subjects was significantly lower (Table 1). In overall subject evaluation by students, the 95% confidence interval differences and adjusted P values in multiple comparisons were: (−1.83 to 5.83, $P = 0.315$) for composite CCBLT versus all other clinical rotations; (18.84−26.49, $P < 0.0001$) for composite CCBLT versus university wide subjects; (16.84−24.49, $P < 0.0001$) for all other clinical rotations versus university wide subjects. For all subject evaluation criteria across all three groups compared here, satisfaction with provision of timely feedback for learning activities registered the lowest response with no significant differences between the groups. In the composite CCBLT model in particular, this may have resulted from the fact that there was a lag in providing written formal feedback as the final written reports required substantial amount of time ranging from fourteen to twenty one days for proper grading.

A qualitative evaluation of student's responses indicated that the most frequent and prominent comments attributed to the CCBLT model included: practical sessions and tutorials being very useful for learning and applying knowledge, the hands-on processing of samples from real cases and the follow up

Table 1
Evaluation of student feedback on teaching activities over four years.

Evaluation Criteria	Composite (Mean (SD)	All Year 5 Rotations (Mean (SD)	University subjects (Mean (SD)	
Clinical rotation/subject learning outcomes were made clear	93 (5.8)	93 (1.7)	82 (1.5)	$P = 0.034$
Delivery methods helped understanding of clinical rotation/subject content	98 (1.0)	92 (1.2)	77 (2.1)[a]	$P < 0.001$
The rotation/subject was well organised	95 (8.1)	89 (5.6)	75 (2.5)	$P = 0.017$
Assessments helped understanding of clinical rotation/subject content	94 (7.4)	92 (1.5)	78 (1.0)	$P = 0.012$
Timely feedback for the rotation/subject was provided	91 (15.0)	84 (4.0)	74 (1.5)	$P = 0.663$
Overall satisfaction with the clinical rotation/subject	99 (0.6)	97 (0.7)	77 (2.5)[a]	$P < 0.001$

Data are presented as means (standard deviations) for four years (2014−2017). Differences were quantified by ANOVA with modified Bonferroni adjustments. Letter superscripts (a) indicate a significantly lower percentage of students agreed to being satisfied as compared to compositae CCBLT or all clinical rotations ($P < 0.0001$). Cited P-values relate to statistical comparisons between compositae CCBLT rotation and university wide subjects.

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discussions on treatment options being helpful for learning, and the organisation of teaching activities in small groups with combined tutorials for the rotation being good for comprehension of concepts. These data collectively indicate that the compositae CCBLT model and all other clinical rotations satisfied student's expectations. The observed significant differences in mean responses to university wide subjects are reasonable since university wide averages are based on many different subjects with varied delivery approaches including didactic teaching. It is also worth noting that our university wide surveys with a 40% response rate compared to over 85% for composite CCBLT rotation may have inherent, unavoidable errors associated with biased sampling and non-response. These factors could be systematically addressed and will be the focus of our future investigations on this topic. Another limitation to this study is that the evaluations outlined above were limited to a few clinical cases that each individual student was exposed to during the composite CCBLT clinical rotation. In addition, only level-one and to a minor extent, level-two of the Kirkpatrick's four-level of training evaluation model was utilised.[28] In Kirkpatrick's model, the four levels of evaluating the successes of training programs include assessments of: reaction to training modalities, actual learning, changes in behaviour as a result of learning and, achievement of intended results. The detailed specific evaluation of behavioural changes in the clinical use of antimicrobial drugs by our veterinary graduates as well as the achievement of increased antimicrobial stewardship and the putative reduction of antimicrobial resistance as a result of this training initiative were beyond the scope of this study. As a result, we are seeking to undertake a prospective study of our graduates to address these issues.

4. Conclusion

We describe the application of a learning and teaching exercise that involved integration of knowledge from basic, para-clinical and clinical veterinary disciplines in the last year of a bachelor of veterinary science course. While these approaches have been extensively used as pedagogical tools in clinical training previously, our experience with the CCBLT model described here seems to be the first documented specific application for integration of microbiology, antimicrobial drug pharmacology and clinical aspects of veterinary medicine. These specific disciplines of veterinary science were targeted for undergraduate training because of the existential threat of increased and newly emerging antimicrobial resistance. This particular problem calls for increased antimicrobial stewardship by veterinarians and their clientele, medical practitioners and the public at large. The utilization of authentic clinical cases and a cooperative model of learning and teaching as described here was limited in scope, but we show that the approach was well received by students and it yielded reproducible high quality student results. The theoretical basis of this particular teaching paradigm could be applied across many different clinical cases that incorporate clinical microbiology, antimicrobial pharmacology and therapeutics to achieve some of the day one competences required for veterinarians.

Acknowledgements

The authors wish to acknowledge Associate Professor Janice Lloyd for her tireless effort in coordinating the composite fifth year rotation, Associate Professor John Cavalieri and Associate Professor Suzy Munns (College of Public Health, Medical and Veterinary Sciences, James Cook University, Townsville, Queensland Australia) for critically reviewing this manuscript, and Associate Professor Leigh Owens (College of Public Health, Medical and Veterinary Sciences, James Cook University, Townsville, Queensland Australia) for statistical advice.

Disclosure

The authors have no declarations of interest. Ethical approval for this study was granted by James Cook University Human Ethics Committee according to the Australian National Health and Medical Research Council guidelines on research involving humans (Approval number H7169).

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit organisations.

Other conflicts of interest

None.

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Appendix A. Rubric for Clinical Microbiology & Antimicrobial Drug Case Report

	Novice	Almost there	Competent	Proficient	Expert
Animal & sample data, tests & results	**0%** No data provided	**8(8%)** Limited patient background and no comment on the sample quality; Some but not all the test results listed or missing. Space given to writing how the test was done. No quality control elements.	**12(12%)** Patient background complete and sample quality accurately accessed. All the results, including QC are listed for each test. Minor errors or omissions noted	**16(16%)** Patient background mentioned, but inaccurate or incomplete comment on sample quality. All the results are listed for each test, but an inaccurate result or missing elements of quality control. Missing complete AMR testing results	**20(20%)** Patient background complete and sample quality accurately accessed. All the results, including QC are listed accurately for each test.
Result interpretation	**0 (0%)** No data or serious misinterpretation of results	**6 (6%)** Mostly correct interpretation of results, but some missing elements or minor misinterpretations, not properly explaining test failures	**9 (9%)** Correct interpretation of results; Not stating how one reached these results. Not properly explaining test failures	**12 (12%)** Correct interpretation of results and explanation provided for any test failures. Clinical relevance not discussed	**15 (15%)** Correct interpretation of results including the clinical relevance/implications of the results and explanation provided for any test failures
Discussion & recommendations	**0 (0%)** No data or serious misinterpretation of results	**20 (20%)** Incomplete discussion recommendations i.e., giving the disease background, but not providing recommendations on treatment.	**30 (30%)** Recommendations are generally correct, but don't necessarily reflect best practice for that disease; provision of too little or too much information Some gaps in the information i.e., suggesting a suitable treatment without motivating the reason	**40 (40%)** Recommendations are generally correct, with minor deficiencies in best practice for that disease; Minor defects in information provision	**50 (50%)** Recommendations reflect best practice for that disease and make take into account the results of the antimicrobial susceptibility tests; alternative diagnostic tests and therapies where available are discussed. Disease monitoring and where appropriate public health implications are also discussed
Language, format, timeliness and referencing	**3 (3%)** No references.Grammar at the level that it is difficult to understand	**6 (6%)** Not given in on time; Verbose, poor report structure; Sentence structure awkward. A large number of serious grammatical mistakes. Overuse of unexplained abbreviations. No references or only public (www) sourced information. References not cited in the body of the report.	**9 (9%)** Timely; Going noticeably over the word limit; some errors in the format of the report; some serious grammatical and spelling errors. Only textbook or public-sourced information	**12 (12%)** Timely; report clarity has a logical progression; adequate references from peer-reviewed sources	**15 (15%)** Timely; good use of English; no spelling errors; report has a logical progression and reads easily; is succinct; appropriate references from peer-reviewed sources

Appendix B. A Confidential Fifth Year Student Rotation Evaluation Form

ROTATION TITLE (*do not indicate dates or student names*).....

	Indicator	Disagree (Dissatisfied)	Agree (Satisfied)
1	Orientation was adequate and clear with respect to rotation objectives and expectations, including assessment criteria and deadlines		
2	The rotation was well organised and structured		
3	Previous years of the BVSc course gave me adequate preparation for this rotation		
4	The learning environment was open and trusting and conducive to learning and developing competency		
5	The pace and amount of work required was appropriate over the fortnight		
6	I felt safe at all times from infectious, chemical and physical hazards and injury		
7	Sufficient additional resources for independent study and research were available e.g.,: textbooks, journals, computers, AV and computer-based aids		
8	Sufficient opportunities and workspace were provided for the completion of tasks		
9	I was given sufficient opportunity for hands-on experience and could practice new skills with appropriate support		
10	The case load/access to hands-on teaching material was adequate and sufficiently varied		
11	Assignments and tasks were relevant and useful in attaining the rotation objectives		
12	Instructors were professional, enthusiastic, skillful and effective teachers		
13	Technical and support staff were professional and helpful		
14	Instructors catered for the different personalities, abilities and needs of group members		
15	I felt comfortable asking instructors for extra help or further clarification without fear or embarrassment		
16	An appropriate amount of timely, specific and constructive verbal feedback was given to me during the rotation		
17	Overall, the rotation experience was valuable for development of my knowledge and skills in this area of veterinary science		

Further comments on the rotation:
The learning activities that were most helpful in developing my competencies were:
Some suggestions for improving the learning experience are:

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Please cite this article as: Picard J et al., Utilisation and Evaluation of Cooperative Case-Based Teaching for Integration of Microbiology and Pharmacology in Veterinary Education, Health Professions Education, https://doi.org/10.1016/j.hpe.2019.09.001

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Please cite this article as: Picard J et al., Utilisation and Evaluation of Cooperative Case-Based Teaching for Integration of Microbiology and Pharmacology in Veterinary Education, Health Professions Education, https://doi.org/10.1016/j.hpe.2019.09.001