The Interdisciplinary Journal of Problem-based Learning

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Lalanthi De Silva (University of Peradeniya)
Chanaka Rabel (University of Illinois)
S. Samita (University of Peradeniya)
Nicola Smith (Massey University)
Lachlan McIntyre (Massey University)
Tim Parkinson (Massey University)
Nayana Wijayawardhane (University of Peradeniya)

IJPBL is Published in Open Access Format through the Generous Support of the School of Education at Indiana University, the Jeannine Rainbolt College of Education at the University of Oklahoma, and the Center for Research on Learning and Technology at Indiana University.

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2023 SUMMER ISSUE

Perceptions of Veterinary Undergraduates on the Novel Use of Problem-Based Learning as a Tool to Develop Their Critical Thinking Skills

Lalanthi De Silva[1], Chanaka Rabel[2], S. Samita[1], Nicola Smith[3], Lachlan McIntyre[3], Tim Parkinson[3], Nayana Wijayawardhane[1]

University of Peradeniya[1], University of Illinois[2], Massey University[3]

ABSTRACT

The recent review of the Veterinary Science degree program of the University of Peradeniya, Sri Lanka, emphasised student-centred learning. Towards this end, courses were introduced throughout the program to integrate concurrent discipline-based material, which were delivered via problem-based learning (PBL) methodology. As PBL was novel to the veterinary education in Sri Lanka, students' perceptions of such learning were evaluated via a questionnaire survey (Likert-scale and open questions) across all four academic-year groups in the program. Most (89.2%, CI: 87.3-91.5) students considered that PBL had been an effective method of learning. Potential to improve critical thinking had the highest score (96.5%, CI: 92.5-98.7). There were significant differences between year groups; which may reflect differences in content or facilitators' experience. Overall, PBL was well-received by students as a learning method per se and as a vehicle for horizontal and vertical integration.

Keywords: Problem-based Learning, PBL, Integration, Veterinary Medicine, Critical thinking, Sri Lanka

Introduction

Effective teaching-learning processes are a rational blend of declarative knowledge which can be defined as content and functional knowledge which can be considered as understanding. Institutions that offer professional degrees are increasingly moving away from a sole emphasis upon the assimilation of content towards a greater emphasis upon the application and use of that information as functional knowledge. Thus, professional workers must be able to operate at the highest levels of Bloom's taxonomy (at least at analysis/synthesis) rather than at its lower levels. The intention of this change of emphasis is to improve graduates' competence in problem solving and decision making in real-life experiences (Biggs & Tang, 2011). This changing emphasis has been underpinned by a redirection of pedagogical approaches towards student-centred learning as a means of facilitating students' acquisition of functional knowledge. Thus, teacher-centred learning, in which the students are dependent upon the teacher for content and understanding, is contrasted with student-centred approaches. This methodology gives students responsibility in learning, understanding, and decision making. The role of the teacher is therefore redirected towards the guidance of learning rather than being the definitive source of all knowledge (Todorovski et al., 2015).

Problem-based learning (PBL) is one vehicle widely used to support student-centred learning, particularly in the development of functional knowledge (Barrows, 1996; Dahle et al., 2002; Vidic & Weitlauf, 2002; Rafique, 2014; Palha et al., 2015). The characteristics of PBL in medical education are small-group, student-centred, teacher-guided learning activities, in which the organizing focus and the stimulus for learning is commonly a clinical or community health problem. In addition, students are guided to improve their critical thinking and problem-solving skills, resulting in the development and assimilation of novel information (Barrows, 1996; Wood, 2003). Critical thinking is defined as "individualistic, cognitive activity with the responsibility placed solely on the individual student" (Thorndahl & Stentoft, 2020, p.10). The discipline may also be described as a higher-order cognitive skill that encompasses the analysing, evaluating, rational and deep thinking that make a person capable of making decisions related to real-world situations (Temel, 2014). Critical thinking is fostered through PBL, inasmuch as PBL places much of the responsibility for the construction and application of understanding upon the individual student.

Many features of the reform of medical pedagogy have also been a model for the reform of veterinary education. Traditionally, curricula in medical/health sciences progress from basic sciences to applied clinical sciences. On the other hand, the clinical diagnostic approach of a medical or veterinary clinician requires the integration of basic sciences, pathobiology, clinical signs, aetiology, animal behaviour, handling and information on the patient's history and environment (Abdisa, 2017). In other words, veterinary and medical curricula need to take a holistic, rather than discipline-based, view to enable students to understand the integration of these different subjects into the diagnostic process. Furthermore, the ability to integrate different subject areas is an important tool in the development of clinical reasoning skills (Dahle et al., 2002; Palha et al., 2015).

Integration of various disciplines can be done either horizontally or vertically. In principle, horizontal integration combines subjects which are delivered simultaneously, whilst vertical integration combines subjects which are delivered in different stages of the curriculum (Dahle et al., 2002). For example, the horizontal integration of basic sciences of anatomy, biochemistry, embryology, histology, and physiology into an organic and functional systems course resulted in a strong impact on students' preparedness of clinical training and long-term retention of knowledge in basic sciences (Palha et al., 2015). Likewise, research on vertical integration of basic sciences with clinical sciences has also been associated with the development of deep understanding and lifelong learning by medical students (Barrows, 1996; Dahle et al., 2002; Rafique, 2014); therefore, this integration is a highly-accepted way of learning (Palha et al., 2015).

Similarly, integration of discipline-based material in veterinary education must provide problems that are qualitatively like those encountered in the clinical workplace. Students are encouraged to gather information from different sources, to find links between different disciplines, and to develop plausible diagnostic hypotheses. They must concurrently improve their communication, interpersonal skills, and deep understanding in a self-directed manner (Adams & Kurtz, 2017). PBL, particularly when based upon case-based scenarios, "improves critical-thinking and problem-solving abilities, promotes independent learning, activates prior knowledge, and encourages a holistic approach to a case" (Lane, 2008, p. 632), whilst also facilitating students' recognition of the relevance of basic scientific content from the beginning of their curriculum. PBL in health-based degrees is often usefully based upon real clinical cases/scenarios, which have the benefit of providing a strong contextual platform as motivation for students' learning. Case-based learning (CBL), in its various formats, is widely used in medical education: the subset of CBL used in medical PBL courses appears to reinforce the principles of PBL through the synthesis of discipline-based knowledge in a context that engages the learners (Patterson et al., 2007; Malher et al., 2009; Stanton et al., 2017). Whilst there is no clear consensus about the depth/breadth of declarative knowledge that students gain through PBL versus traditional teaching methods (e.g., Bokey et al., 2014), PBL has proven to improve engagement (or, at least as importantly, discourage disengagement) and improve students' skills across a panoply of non-declarative domains (Lane, 2008).

Key issues were identified which required remediation during the recent review of the veterinary curriculum at the University of Peradeniya (UoP), Sri Lanka, under the auspices of the World Organization for Animal Health (formerly Office International des Épizooties [OIE]) Veterinary Education Twinning Project (OIE, 2016). The issues that required remediation were the need to reduce the vast amount of information that was being dumped on students without improving the skills to synthesize the information into useful/applied knowledge, a lack of integration between subjects, and the need to develop student's thinking and problem-solving skills.

The approach chosen for integration in the curriculum was based on the correlation and complementary approaches of Harden (2000). These approaches use discipline-based courses with specific emphases upon relevant inter-relationships and run parallel to non-discipline-based courses of which the purpose is to achieve integration between disciplines. The proportion of time devoted to discipline versus integration varies between the two approaches (Parkinson et al., 2017).

In addition, a strong consensus emerged around the use of PBL as the primary means of managing these integration courses. It was determined that that the integration component would receive 20% of curriculum time in each semester and would be delivered by PBL format based on a case of the week. The case of the week would (a) provide integration between parallel subjects, (b) provide clinical context for pre- and para-clinical subjects, (c) contain a significant element of professional/affective domain skills, and (d) not be used as the primary conduit for delivery of new declarative knowledge. As PBL had not been used in the existing curriculum (nor was it used in the preceding secondary education), students' response to it as a mode of teaching was unknown. Hence, the objective of the present study was to evaluate students' perceptions of learning via a PBL mode, including whether the UoP had teaching facilities that were compatible with a PBL methodology. The results of the study were to be used to inform the development of appropriate methods of delivery of PBL within the personnel and physical resources of the faculty and to inform faculty training in PBL delivery.

Method

A survey-based mixed-methods study was conducted to assess the perceptions of students in the UoP veterinary degree program about the pilot PBL sessions which were conducted to evaluate the suitability of PBL as the core teaching method for the newly introduced course, Integrated Veterinary Science. Ethical approval was obtained for the study from the Ethics Review Committee, Faculty of Medicine, UoP (2020/EC/84).

Participants

Participants of this survey were the students in each of the four academic-year groups (Y1, Y2, Y3, Y4) of the BVSc (Bachelor of Veterinary Science) Program who volunteered to participate in this study. The number of participants from each of the four academic-year groups were as follows: Y1, 38; Y2, 37; Y3, 55; and Y4, 40.

Pilot PBL Session

Two different PBL case problems were offered to different groups of students during the study (PBL1 to Y1, Y2, Y4; and PBL2 to Y3). The first case problem (PBL1), based on cardiovascular physiology and companion animal medicine, had been developed by a veteran in PBL from Massey University, New Zealand. The scenario had already been tested on all academic-year groups of veterinary students at that university. The second case problem, PBL2, based on pharmacology, microbiology, and farm animal medicine, was prepared de novo by academics attached to the veterinary faculty of the UoP (also as a means of developing their skills in PBL-case creation). Pilot-study PBL sessions were conducted with each academic-year group over two 2-hour sessions. Each session was conducted in groups of five to eight students, with three (Y2-Y4) or six (Y1) facilitators per year group. Volunteer academic staff members of the UoP veterinary faculty played the roles of facilitators on both occasions. All volunteer facilitators had knowledge in general clinical content and some of them were relevant subject specialists. In addition, all volunteer facilitators had had basic training in facilitating PBL sessions but were not experienced PBL practitioners.

As the student participants had not previously experienced PBL, the structure of the teaching-learning was explained at the beginning of the session (Wood, 2003). The facilitators also explained key features of PBL, such as the nature of student-centred and self-directed approach, small-group activity and the need to have interactive discussions among group members in order to identify issues and to make hypotheses regarding the underlying reasons of the identified issues. Further, the facilitators explained that in the context of integrating parallel discipline-based studies, students would be expected to apply and interlink domain-specific knowledge in problem solving, use of e-learning recourses and text books for verifying contents. In addition, students were encouraged to share their thoughts with peers as well as facilitators. Similarly, most of the facilitators had no prior experience of facilitating PBL; thus, a series of training exercises were held to enable them to learn the basic principles of PBL facilitation.

At the end of the second 2-hour PBL session, each student was asked to complete a questionnaire. The questionnaire consisted of five statements and six open-ended question statements (Appendix 1). Students were instructed to state their level of agreement using a 1-5 Likert scale (1: Strongly agree; 2: Agree; 3: Neither agree or disagree; 4: Disagree; 5: Strongly disagree) on the five statements and to add free-text comments for the open-ended questions if they wished.

Data Analysis

Frequency distributions of student responses were obtained for each statement within each year group. Strongly agree and Agree (SA+A) responses were summed to represent the responses of relative agreements for each statement (Rafique, 2014; Gummery et al., 2018). Furthermore, 95% confidence intervals (CI) were obtained for the true proportion of relative agreement of the population for each statement.

Likert responses were also subjected to Kruskal-Wallis and Mann-Whitney tests. For these two tests, the 1-5 Likert scale was represented as a scale of 1-3, in which SA+A responses were ascribed a value of 1. The Disagree and Strongly disagree (D+SD) responses were given a value of 3. The Neutral response was not included in either relative agreement or relative disagreement. All statistical analyses were performed using SPSS statistical software v26 (IBM, New York). P values <0.05 were considered as statistically significant. Free-text comments from all groups were categorized based on a thematic analysis, and the most frequent type of themes were identified.

Results

Results are summarised in Table 1 and Figure 1. Across all year groups, >85% of students gave Agree or Strongly Agree responses to each statement. Overall mean proportions of SA+A responses across all years to S1 (The class helped to improve thinking skills") was higher (mean SA+A responses: 96.5%, 95% CI: 92.5-98.7) than for other statements (mean SA+A responses of 86.5% to 88.8%). Proportion of SA+A responses for all question statements for Y3 was lower (80.4%) than for Y1, Y2 or Y4 (SA+A responses; 96.3%, 93.0% and 91.0%, respectively). Statistically significant differences were found among the responses of year groups for S3 ("Guidance provided by the facilitators was satisfactory") and S5 ("Overall, I was satisfied with the teaching method") but not for S1 ("The class helped to improve thinking skills"), S2 ("The learning environment was sufficiently comfortable to express/share student's own opinion without hesitation with other group members and facilitators") and S4 ("Online environment enhanced my learning"). Based on mean ranks, Mann-Witney post hoc tests showed that, with respect to both S3 and S5, Y3 had the lowest level of satisfaction compared to all other year groups. Responses of relative agreement to S1 across all year groups were higher than for other statements.

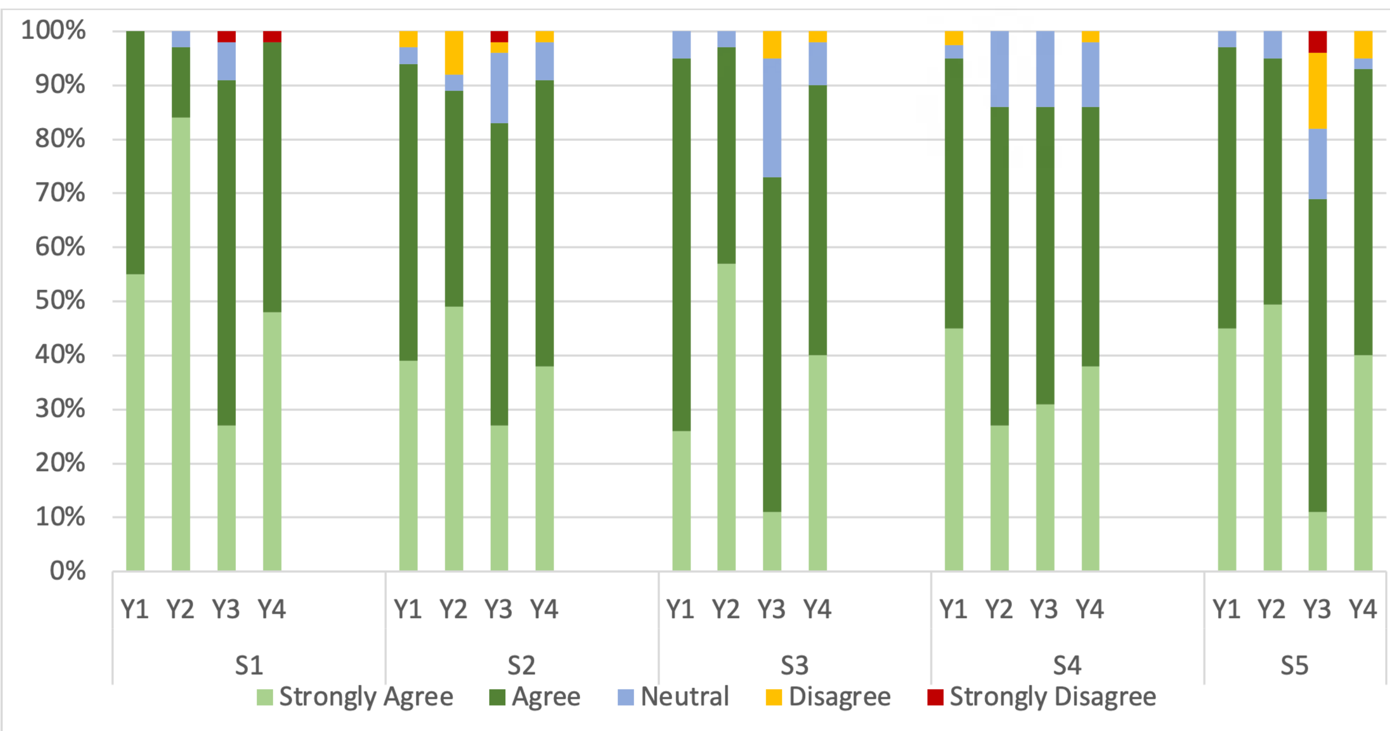

Figure 1. Frequency Distribution of Responses for Each Question Statement

Free text comments were received from 10/38 (Y1), 17/37 (Y2), 49/55 (Y3) and 20/40 (Y4) participants, providing a total of 175 comments. The five most common themes are shown in Table 2. Comments largely reflected the responses to the Likert-scale statements; by far, the most common comments (47%) were of general acceptance of the PBL method. Other comments largely related to areas that participants considered could be improved. For example, facilitator guidance, which had been a strong theme in the Likert responses of Y3 students, was also the subject of free-text responses. Some students felt that a reduction in group size would be beneficial, whilst others noted that improvements to the teaching space would improve the learning outcomes. Some senior students (Y4) believed the PBL and concurrent clinical material should be aligned to ensure they complemented each other.

Discussion

The present study shows that, based upon the high proportion of positive responses to the questionnaire, the use of PBL for the integration of different disciplines was well-accepted by the students. Most students agreed or strongly agreed that they were satisfied with PBL as the learning method (mean SA+A response to S5: 86.5%, 95% CI: 80.4-91.2%), as also confirmed by the free-text comments that affirmed acceptance of the teaching-learning method (Table 2). The responses to S1 ("The class helped to improve thinking skills" [e.g., problem solving, creativity, critical analysis]; mean SA+A response: 96.5%, 95% CI: 92.5-98.7%) indicated that students also considered the method to have enhanced critical thinking and interlinked declarative and functional knowledge in solving real-life problems.

The relationship between the use of PBL and the development of critical thinking in students has been the subject of debate. Most studies reviewed by Thorndahl & Stentoft (2020) of the relationship between the use of PBL and development of critical thinking skills have been based (as was the present study) on participants' perceptions of the benefits on the development of critical thinking rather than of direct observations of improved critical thinking per se. Nonetheless, both responses to the Likert-scale questions (such as the S1: improved problem solving, creativity and critical analysis) and free text comments (e.g., "Rather than learning, remembering and passing exams, this was helpful for improving thinking abilities"; "A very much efficient way to improve our thinking and problem solving skills"; "A good way to improve critical thinking"; and "We solved the problem by discussing what is the best thought from our self-thinking") show that, at least in terms of the perceptions of the participants, their critical thinking skills had been improved by the PBL experience. Furthermore, responses to S2 (The learning environment was sufficiently comfortable to express/share student's own opinion without hesitation with other group members and facilitators) also were largely in agreement (mean SA+A response: 88.8%, 95% CI: 83.1-93.1).

The ability to express one's own thoughts and understandings is a key tenet of student-centred learning and stands in contrast to the key tenet of teacher-centred learning where replication of the accepted (teachers') orthodoxy is expected. In other words, the high level of agreement with S2 infers that not only had the learning environment within the PBL courses been transformed into one that was recognisably student-centred, but it also was not inimical with the development of critical thinking, inasmuch as students were able to express non-orthodox ideas. Thus, as noted by Schmidt (1995), the ability for individuals to express their thinking in a learning environment which is supportive and habilitative, rather than critical or judgmental, empowers students to explore knowledge. Such an atmosphere also allows students to think for themselves, which is likely even more important.

Therefore, the high level of acceptance of the PBL teaching was likely to have been as much as reflection of the teaching method per se as it was a representation of a break from the mould of replicative, teacher-lead learning that otherwise characterised the curriculum at that time (Wijayawardhane et al., 2020). Indeed, similar studies of students who have come through highly teacher-centred educational programs characteristically relish the opportunity to explore their own thinking rather than merely replicating the material that they have been taught. For example, Wong (2004) showed a similar situation among Asian international students of a South Australian University. According to that study, most of those students who studied at a teacher-centred environment at their homelands' colleges preferred to have the new style of student-centred learning to which they were newly exposed at the international university (Wong, 2004).

When the University of Tennessee College of Veterinary Medicine introduced PBL to first-year students, they considered the addition of PBL sessions within the conventional curriculum to be a successful approach for the implementation of self-directed, problem-solving, small-group learning activities (Howell et al., 2002). A study of delivery of physiology in a medical curriculum via PBL has also shown high student acceptance associated with improvement of students' understanding and depth of learning (Rafique, 2014). Similarly, other studies of incorporation of clinical scenarios into basic science courses has had a high level of acceptability by the students accompanied by better understanding of the contribution of basic sciences to clinical medicine (Barrows, 1996; Vidic & Weitlauf, 2002; Malher et al., 2009).

Criterion	Year 1 (n=38)		Year 2 (n=37)		Year 3 (n=55)		Year 4 (n=40)		All responses (n=170)		
	%SA+A*	Mean Likert score +	%SA+A	Mean Likert score +	%SA+A	Mean Likert score +	%SA+A	Mean Likert score +	% SA+A		Mean Likert score +
									Mean	95%CI	
S1: The class helped to improve thinking skills	100	1.00	97.3	1.03	90.9	1.11	97.5	1.05	96.5	92.5-98.7	1.08
S2: Learning environment was comfortable	94.7	1.08	89.2	1.19	83.6	1.20	90.0	1.13	88.8	83.1-93.1	1.15
S3: Guidance provided by the facilitators was satisfactory	94.7	1.05 [a]	97.3	1.02 [a]	72.7	1.33 [b]	90.0	1.13 [a]	87.1	81.1-91.7	1.13
S4: Online environment enhanced my learning	94.7	1.08	86.5	1.14	85.5	1.15	85.0	1.18	87.6	81.7-92.2	1.14
S5: Overall, I was satisfied with the teaching method	97.4	1.03[a]	94.6	1.05[a]	69.1	1.49[b]	92.5	1.13[a]	86.5	80.4-91.2	1.17
All responses for S1-S5	96.3	1.05	93.0	1.08	80.4	1.26	91.0	1.12	89.2	87.3-91.5	1.13

Note. * Proportion of Strongly Agree or Agree responses.

+ Modified Likert score: Relative agreement: 1, Neutral: 2, Relative disagreement: 3.

a, b, c: Based on mean ranks of Kruskal-Wallis and Mann-Whitney tests, responses within a row sharing a common superscript do not differ significantly from each other. Responses in rows that do not include superscripts do not differ significantly from each other.

Table 1. Summary of Likert Scale Responses

Five most common themes	No. of Students commented	% of students commented
General acceptance of the teaching learning method by the students	45	46.9%
Need to provide more facilitator guidance	30	31.3%
Need to improve facilities of the learning environment	14	14.6%
Need to complement with con current clinical exposure	10	10.4%
Need to reduce the group size	9	9.4%

Table 2. Free Text Comments on the PBL Experience

Two PBL cases were used for the present study. PBL1 was designed by an experienced PBL practitioner and was based upon the integration of clinical material with physiology, whilst PBL2 was designed by a less experienced PBL practitioner and was based upon integration of clinical material with microbiology and pharmacology. For PBL1, student acceptance was high across the three year groups (Y1, Y2, Y4) with which it was used and did not differ between those year groups. Thus, students at the start of the BVSc program (i.e., Y1 and Y2, with little to no clinical exposure) and students at the end of the program (i.e., Y4, who had completed their formal physiology lectures three years beforehand) all found the PBL case to be equally valuable. Conversely, for students in Y3 who undertook PBL2, the overall satisfaction was poorer and was significantly lower than the other three year groups (S5 SA+A: 69.1%). However, the responses to the question of whether the teaching had developed the students' thinking skills (S1, SA+A: 90.9%) was only slightly lower than responses of the students who had undertaken PBL1 (100%, 97.3% and 97.5%, respectively for Y1, Y2 and Y4). No significant difference was found among responses of the year groups for this question. This result suggests that, irrespective of the case problems used for the PBL class, the new teaching learning method had contributed to improve thinking skills of the students.

Reasons behind the poorer overall satisfaction of Y3 may be of significance for the future development of PBL scenarios in the veterinary program. First, students found that the guidance provided by the facilitators was not sufficient, in comparison to responses for other year groups (SA+A for S3 for S3: 72.7% versus 94.7%, 97.3% and 90% of Y1, Y2 and Y4). These data were supported by the number of free-text responses from that year group (Y3: 89% of students commented, versus <50% for Y1, Y2 and Y4), in which the consistent theme was the need for more facilitation. Given that there were similar numbers of facilitators across each year groups except Y1, such comments may reflect students' perceptions of the quality of facilitation rather than actual number of facilitators. There is, of course, extensive literature on the role of facilitators in PBL (e.g., Davis et al., 1992; Eagle et al., 1992; as summarised by Jones (2006)) as relating to domain-specific knowledge versus expertise in facilitation without domain-specific knowledge. Jones (2006) concluded that training in facilitation is imperative for either type of facilitator but that the ideal facilitator is "a content area expert, who is fully familiar with the medical curriculum being taught, and has been appropriately trained in facilitation" (p. 488). For senior students undertaking clinically-related PBL, the depth of learning and satisfaction with the process were better when expert, rather than non-expert, facilitators had been present (Davis et al., 1992; Eagle et al., 1992).

Furthermore, whilst all the students who undertook PBL1 had previously studied the relevant physiology via traditional teaching methods, those who undertook PBL2 had not previously studied the relevant pharmacology. In other words, whilst the basis of both cases was the integration of basic and clinical knowledge, the students did not have enough basic knowledge of the basic sciences in PBL2 to effectively integrate it into the clinical scenario. It is, of course, entirely possible to teach such basic science de novo through PBL methods, but that was not the intention of the present cases. Rather, the present results align with the findings of a study on pharmacology-flipped classroom of Khanova et al. (2015), which showed that for effective use of integration in the type of scenario that is reported here, students need to have a sufficient grasp of the basic knowledge to be able to link it to real-world applications.

Consequently, it appears that the students required and expected more guidance from the facilitator in understanding the basic concepts for problem solving and that the absence of either a pre-existing knowledge base or effective facilitation process limited the ability of students to apply their cognitive skills. Therefore, these factors could be reasons why students indicated their relative dissatisfaction. This finding can be further explained with the concept of Zone of Proximal Development (ZPD) (Vygotsky, 1978). According to Vygotsky (1978), the teaching-learning environment should create a motivation in students to actively engage in the learning process which is the ZPD of the students. However, the teaching-learning environment should not be beyond the ZPD, making the curriculum too easy for students leading to boredom or too difficult leading to disappointment, as the problem cannot be solved irrespective of the support given by the facilitator. As the major objective of this study was to evaluate students' perceptions on this novel method, a better approach would have been for each cohort to have the same case problem (allowing for the integration of different disciplines based on the stage of the student) to which a single PBL designer or one group of PBL designers would be involved for all cohorts. Similarly, each cohort could have had the same facilitators. The other limitation was that the students had only one exposure to PBL, so their responses were based on their initial rather than long-term experience.

On the other hand, students across all year groups, including Y3, were satisfied with the online learning environment. This finding was a pleasing result, given the difficulties associated with procuring internet-based materials and access to international journals in a developing country. This result also reflects other studies of students' access to online materials during PBL study: students generally give high scores to facilities that are adequate but are very harsh on facilities they consider inadequate. Resourcing PBL is, of course, by no means limited to internet material: students perform equally well using digital versus print resources, although there is evidence of differences in learning outcomes from digital versus non-digital materials (Strømsø et al., 2004). Conversely, a need also exists for students to move away from simple internet searches to more complex searches across the range of media (Jin et al., 2015). Many of the remaining free-text comments included suggestions for improving the physical infrastructure for PBL classes. Suitable infrastructure has been identified as important to maintain an active learner-friendly environment with appropriate space, adequate number of tables and chairs, small group size, and (as already mentioned) uninterrupted internet access. Comments from senior students indicated that they would prefer to discuss ongoing/actual clinical scenarios which they encounter during their clinical rotations. This finding suggests that the students are motivated to participate actively in the clinical learning process, which is an expected outcome of such teaching-learning methods (Dahle et al., 2002; Malher et al., 2009).

From the perspective of the teaching faculty, the results of this study highlight a number of needs. First, whilst the domain-specific knowledge of the facilitators is undoubtedly of benefit to the PBL process, training in facilitation and the design of teaching material for PBL is also needed. Second, given that a primary purpose of these PBL courses is the horizontal and vertical integration of concurrent and clinical material, it is essential that cases build upon and extend pre-existing knowledge rather than for de novo acquisition of knowledge. Some modification to physical infrastructure would also be needed.

Conclusion

The present study shows veterinary students, who had hitherto experienced a learning environment that was exclusively teacher-centred, expressed a high level of satisfaction with the newly introduced PBL method. Students identified the PBL cases as an effective practice for developing critical thinking and in bridging basic and clinical sciences in real-world problem solving. Some deficiencies were identified, primarily in terms of the training of facilitators and in the development of case problems for the PBL classes. Nonetheless, the study showed the potential value of the use of PBL as a means of accomplishing interdisciplinary horizontal and vertical integration within the curriculum.

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Acknowledgement

The Authors wish to thank the students who volunteered to share their feedback, year coordinators, facilitators and the Dean of the Faculty of Veterinary Medicine and Animal Science, UoP.v

Author Bios

Lalanthi De Silva, BVSc., PG Cert Vet Ed. (UK), is a Lecturer (probationary) at the Veterinary Medical Education Unit (VMEU) at the Faculty of Veterinary Medicine and Animal Science, University of Peradeniya, Sri Lanka. She also serves as the chairperson of the committee for VMEU. Her teaching focuses on Integrated Veterinary Science through PBL and CBL-based approaches. She is a Fellow of the Higher Education Academy (UK) and conducts research in Health Science Education and Antimicrobial Resistance.

Chanaka Rabel, BVSc, PhD, is a Visiting Scientist in Reproductive Biology and Tissue Engineering at the University of Illinois, USA. He previously served as a Senior Lecturer and the Chairperson of the committee for VMEU at the University of Peradeniya, Sri Lanka. His teaching at Peradeniya focused on Farm Animal Production and Health and Integrated Veterinary Science through PBL and CBL-based approaches. He was the deputy chair of the Faculty Curriculum Revision Committee and has experience in curriculum designing in collaboration with international teams.

S. Samita, MSc., MPhil., PhD. is a Senior Professor of the Faculty of Agriculture, University of Peradeniya. His teaching at University of Peradeniya is on Statistics.

Nicola Smith is a Senior Lecturer at Massey University in New Zealand. Her primary role involves developing cases and online learning resources that use and reinforce basic science principles for undergraduate veterinary students.

Lachlan McIntyre, is a Veterinary Epidemiologist in New Zealand. He was the Programme Director, International Veterinary Education Partnerships of the Massey University and played a significant role in the WOAH twinning project, which aimed to enhance the curriculum and teaching at Peradeniya's Faculty of Veterinary Medicine and Animal

Science. In recognition of his contributions, he was awarded an Honorary Fellowship by the Sri Lankan College of Veterinary Surgeons.

Tim Parkinson, FRCVS, formerly Academic Dean of Veterinary Science, Massey University, New Zealand, is presently Emeritus Professor in Veterinary Science. His research interests are animal reproduction and in teaching/learning amongst tertiary students. He recently received an Honorary Fellowship from the Sri Lankan College of Veterinary Surgeons for his work on the WOAH twinning project on renewing the veterinary program at the University of Peradeniya, Sri Lanka.

Nayana Wijayawardhane, BVSc., PhD., is a Professor in Veterinary Clinical Sciences at the University of Peradeniya. Her expertise lies in companion animal medicine, and curriculum pedagogy. She previously chaired the faculty Curriculum Revision Committee during the WOAH twinning project, and played a significant role in successfully revising the BVSc. curriculum as the local coordinator of WOAH twinning project. She is currently a Visiting Scholar at the Royal Veterinary College, University of London, UK and holds an Adjunct Senior Lecturer position at Massey University, New Zealand, and her research interests encompass Veterinary Clinical Sciences and Veterinary Education.

Appendix

Questionnaire to Assess Students' Perception on PBL Classes

The class helped to improve thinking skills (e.g.: Problem solving, creativity, critical analysis) (S1).

Please mention comments, if any.

The learning environment was sufficiently comfortable to express/ share student's own opinion without hesitation with other group members and facilitators (S2).

Please mention comments, if any.

I was satisfied with the guidance provided by the facilitators (S3).

Please mention comments, if any.

The online environment enhanced student's learning (S4).

Please mention comments, if any.

I was overall satisfied with this Teaching-Learning method (S5).

Please mention comments, if any.

Please mention your suggestions to improve this class.