Implications for the design of online case based learning activities based on the student blended learning experience

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An evidence based approach was adopted in the redesign of online learning resources for undergraduates in a professional Veterinary Science degree program. Students used online case based resources in blended learning activities to extend and enhance their understanding of the theories underpinning Veterinary Science and to develop their skills in clinical problem solving. This study investigates what the students thought they were learning through the case studies and how the students engaged with the activities. It then discusses the implications of the students' experience of the materials for improving the design of the activities.

Keywords: online, learning resources, case studies, blended learning, veterinary science

Introduction

The Faculty of Veterinary Science at the University of Sydney offers a five year Bachelor degree, with compulsory units in basic animal science, professional practice, paraclinical studies and clinical management of animal disease. Entry is highly competitive (UAI 98.2), with a diverse student intake of recent school leavers, mature students (Government funded and fee paying) and international students. 120 students in year 3 undertake a 5 hour per week compulsory unit in Veterinary Pathology for one semester, managed by two academic staff. Students are assessed for their case studies, a report, practical and written final examinations. The learning context involves lectures, practical laboratory sessions and interactive tutorials based on online case studies. The purpose of the online case based resources was to provide students with an engaging learning experience that promoted deep approaches to learning and development of generic skills in problem solving.

Theoretical background and previous research

This study draws on overlapping and consistent bodies of research to inform the design and evaluation of the student experience of problem based learning. The two areas can be broadly referred to as constructivism and student learning research.

Case based learning and constructivism

Case based learning is a form of problem based learning (Barrows, 1986) and is a favoured approach in the constructivist literature because of its potential to promote active learning. Problem based learning (PBL) evolved from a health science curricula that started in North America over 30 years ago (Boud & Feletti, 1997) designed to develop self directed learning and autonomy through student centred activity. The range of problem based learning strategies used in a subject is typically dependent on the design, delivery and skills of the teaching staff (Barrows, 1986; Savery & Duffy, 1995), and can embody several possible approaches other than case based learning such as project based learning or group based learning (Biggs, 1999).

Key aspects of PBL are summarised in Table 1 (Boud & Feletti, 1997)

Table 1: Characteristics of PBL

Using stimulus material to help students discuss an important problem, question or issue
Presenting the problem as a simulation of professional practice of a 'real life' situation
Appropriately guiding students' critical thinking and providing limited resources to help them learn from defining and attempting to resolve the given problem
Having students work cooperatively as a group, exploring information in and out of class, with access to a tutor (not necessarily a subject specialist) who knows the problem well and can facilitate the group's learning process.
Helping students to identify their own learning needs and appropriate use of available resources
Reapply this new knowledge to the original problem and evaluate their learning processes.

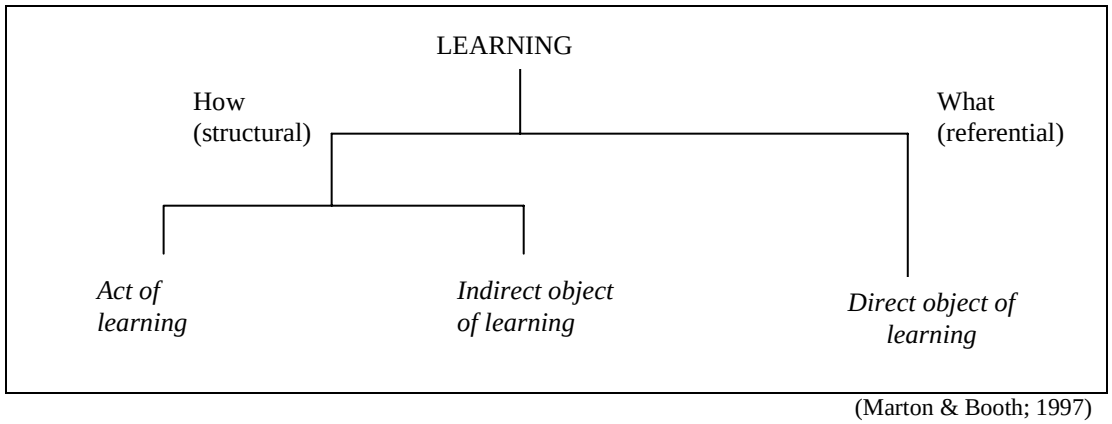
(Boud & Feletti, 1997)

One of the advantages of using PBL learning design is the potential to include real problems from authentic contexts (Jonassen, 1991) Such problems are not only useful learning contexts in which to acquire meaningful knowledge, but they promote activity oriented learning which immerse the learners in a situation that requires use of higher order learning skills. This potential alludes to student learning activities that result in more than just the absorption of information (Neufeld and Barrows, 1974) and promote conceptual change (Biggs, 1999; Prosser and Trigwell, 1999). Key factors that enable conceptual change to take place include clear objectives for both students and teachers, motivation that is intrinsic to the student (but may be generated though effective teaching practice), freedom for the student to engage meaningfully in the task, and collaboration with peers and teaching with dialogue that promotes activities to create deep understanding (Biggs, 1999).

Case based learning and key studies in student learning research

Biggs' factors for conceptual change are consistent with a deep approach to learning (Marton & Säljö, 1976; Entwistle and Ramsden, 1983; Marton and Booth, 1997; Prosser and Trigwell, 1999). A deep approach to learning is one where students focus on the underlying meaning of the task ('What' in figure 1). In PBL it is characterised by active engagement of students who seek to develop and apply knowledge for the purposes of understanding, theorising and reflecting on the learning task ('How' in figure 1). This contrasts with a surface approach which is characterised by low level memorisation, a focus on collection and recall of fact with the aim of finishing the task quickly and meeting assessment requirements (Biggs, 1999; Prosser and Trigwell, 1999; Ramsden 1993). Biggs (1999) unifies constructivism and phenomenographic student learning research to show that meaning is developed through students learning activity, which may be influenced, but not imposed by the structure and design of the teaching tasks.

Figure 1 shows the model of learning from student learning research which is used to evaluate the students' experience of the case based learning in this study. It divides learning into reference (what students think they learn) and structure (how they go about learning).



(Marton & Booth; 1997)

Figure 1: Aspects of learning

Figure 1 shows that learning can be divided into two aspects; the *How* of learning, its structural aspect, and the *What* of learning, its referential aspect. Each of these aspects can be recursively expressed in the

same terms. The *What* of learning identifies its outcome as the direct object of learning. The *How* of learning can be understood as having at least two clear outcomes: the act of learning and the indirect object of learning, the latter referring to the type of capabilities the learner is trying to master (Marton and Booth, 1997). Applying this to case based learning in Veterinary Science, the direct object of learning is an appropriate approach to diagnosing the health problems of animals that draws on both principles of science and the particular clinical signs of the animal; the act of learning involves an interactive problem solving process with colleagues, and indirect objects of learning include communication skills and teamwork.

In terms of case based learning, student concepts can be understood as what the students thought they learnt through the cases, and student approaches can be understood as how the students approached their learning of the cases, both in terms of their interaction with the online resources and colleagues in the face to face learning situations. Outcomes from research based on this model suggest that students' concepts and approaches to learning are relational, that is, if we help students to improve their concepts of what they think they are learning, then their approaches are likely to improve. Equally, if we help students to improve their approaches, then they are likely to better understand what they are supposed to be learning (Prosser and Trigwell, 1999).

There are a number of other important investigations into the usefulness of case based learning in studies consistent with student learning research. Case based learning can be used to promote deeper approaches to learning and reduced reliance on surface approaches in medical students (Newble and Clarke, 1986). In a study investigating how students used case based learning, (Hmelo-Silver, Nagarajan and Day, 2000), the researchers identified differences in the learning activities undertaken in a group problem solving task, with inexperienced students focussed more on detailed data analysis, while experts used flexible, high level reasoning based on application of fundamental principles.

Case based learning in veterinary science

Although case based learning is not discipline specific, its emphasis on authentic cases or problems and its origins in health curricula provide particular relevance to the bachelor degree offered by the Faculty of Veterinary Science which provides a strong basis for its application. In addition, its benefits align with the Faculty's aim to provide students with an engaging learning experience that facilitates deep approaches to learning.

The case studies were designed to develop some key attributes required by the veterinary profession, namely effective clinical investigation, critical evaluation of information, communication and professionalism in veterinary practice. While providing an authentic context for students to expand their understanding of veterinary pathology (point 1,) and stimulate their interest and engagement in animal disease (point 2), the case studies also develop a broader range of clinical problem solving skills. As students undertake new, unfamiliar tasks in investigating animal disease, they receive structured guidance (or scaffolding) in how to approach problems through logical application of scientific concepts and critical evaluation of information derived from the animal, client, clinical tests, colleagues and the literature (point 4). These skills are essential for development of a cohesive and holistic framework for problem solving (deep approaches outlined in point 3) that can be transferred to new and unfamiliar contexts encountered in clinical practice (deep, lasting learning outcomes). The case studies are designed to reward effective communication and reflection on the experience of problem solving (point 5) to consolidate and reinforce behaviour and skills required for professional autonomy.

Consulting the literature referred to above for guidance in the design of the case based learning activities (Barrows, 1986; Savery & Duffy, 1995; Jonassen, 1991; Biggs 1999), educators in the Faculty developed guidelines for case based learning shown in Table 2.

How research supports the design of the case based learning activity and online resources

The Faculty realised that the design of case based activities needed to be practical and feasible within available resources (Ryan, 1997). For its purposes, this resulted in the implementation of a *blended learning* approach that included the use of face to face classes, laboratory sessions, handbooks (to provide

content) and online case based learning resources. The online case based learning resources were part of a blended learning activity that was structured in the learning sequence shown in.

Table 2: Guidelines for the development of case based learning activities in veterinary science

1	Use challenging, authentic problems in a way that places learners at the centre of learning and enables them to take responsibility for their learning.
2	Encourage learners to take ownership of both the problem and their approach to solving the problem in a way that is consistent with professional practices and methodologies.
3	Provide learners with support and guidance that encourages them to move towards coherent, deep approaches (e.g. critical thinking) and away from fragmented, surface approaches (e.g. memorisation of facts).
4	Encourage learners to draw on a wide range of resources in addition to those supplied by the activity (e.g. literature, teaching staff, peers, etc.), to critically evaluate these resources and support them doing this in both independent and group learning situations.
5	Provide learners with an opportunity to reflect on both knowledge, process and approach to learning.

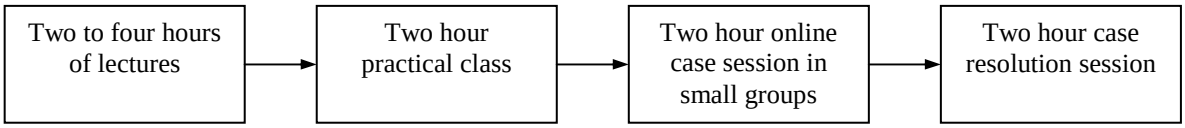


Figure 2: Blended learning sequence involving online learning resources

In the online case based resources, fundamental knowledge was presented through a scenario (see Figure 3) that provided case information drawn from an authentic situation. The objectives of the scenario were to integrate and analyse the knowledge in a way that enabled students to demonstrate their understanding of the problems of an animal by completing a 'case summary form'. Figure 3 is a screen shot of the resources provided for each case study.

Students access the case studies on the Veterinary Pathology subject WebCT site when they commence each case study. Figure 3 shows one scenario which outlines details of the patient (animal) and their problem, followed by a description of the task they need to complete (e.g. filling out a Case Report form) and an explanation of the resources available to help them in this task. The right hand column of the screen shot shows the supporting resources. These provide a clear sequence to guide students in the early stages of working on case studies. The sequence of the resources replicates the way a veterinary practitioner would investigate a case, commencing in the consulting room with a client history, images of the patient and findings from a physical examination of the patient. After reading these materials students develop a list of differential diagnoses for further investigation through diagnostic tests (which may include laboratory reports and radiographs). Students access the test results and review key concepts and information from class to complete the case report form which is submitted online. Learning support is offered to guide students with the approach most appropriate to investigating the problem, topics to guide their thinking (and assist them to critically evaluate both the information and their interpretation of it) and links to further reading on relevant case studies.

Students may work on the case studies using the resources in various different sequences, e.g. 1) reading the scenario, the task, consulting the resources and then completing the case summary form in that order; 2) working through the questions on the case summary form and accessing the case's resources as necessary to answer the questions; and 3) a combination of both methods, according to the students' prior experience, existing knowledge, confidence and familiarity with the tasks.

The key advantage of student control over the content is that it can help to create an environment of ownership on the learner's part enabling students to form their own perspective on the subject (Ramsden, 2003). However this can be a deceptively seductive freedom for the student inexperienced in solving

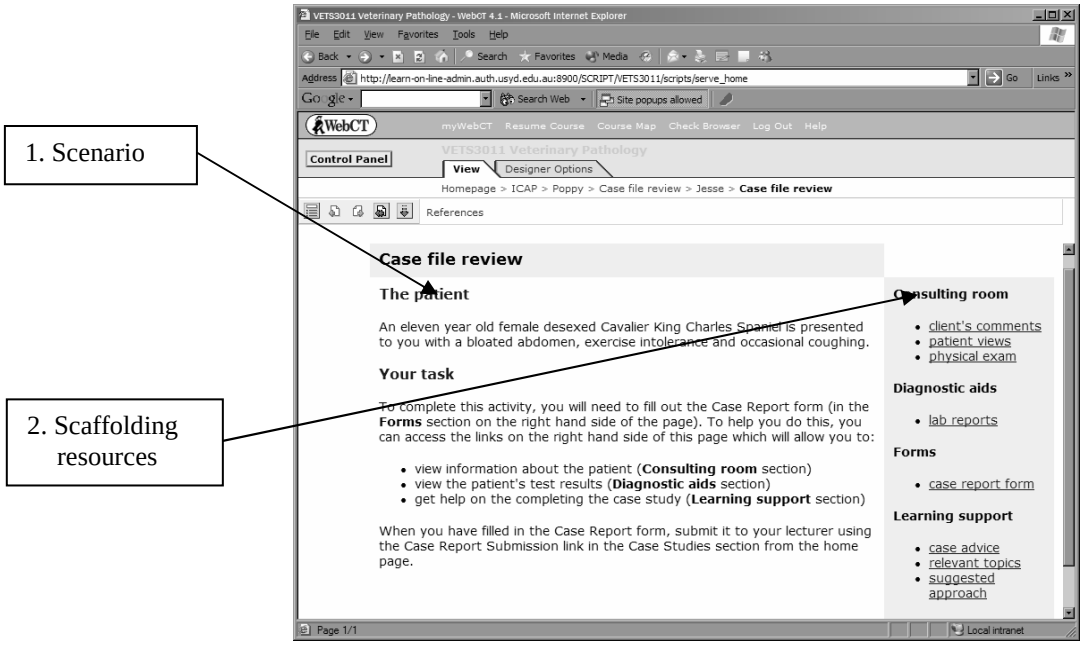


Figure 3 Screen shot of online case based learning resources

clinical problems, as it may encourage 'resource jumping' as students search for hidden answers and clues to the diagnosis, circumventing deep, holistic learning. The learning resources were designed to provide distractions and conflicting possible outcomes that would only be resolved through the final discussion in class, where the importance of a methodical, evidence based approach is reinforced.

The design of the case based learning activities (learning sequence and online case based resources) implemented the guidelines from the previous research in the following way.

Student approaches to learning with the case based learning activities

It was outside the scope of this study to provide an in depth evaluation of the student experience of case based learning. However, to get some idea the researchers interviewed twelve students who were invited to participate based on their academic performance, either in the top 10% of the class of 120 or the lowest 10% of the class (6 students participated from top and lowest groups). The framework for classifying student conceptions and approaches was developed from a larger study of the whole class who completed written questionnaires which were analysed phenomenographically (results not shown here). Key questions used to evaluate the student experience of learning through the case studies were;

1. When you were engaging with the Veterinary Science case studies, what did you think you were learning?
2. When you were engaging with the Veterinary Science case studies, how did you go about it? What sorts of things did you do and why did you do them?
3. When you were engaging with the online resources (activities and materials) of the case studies, how did you use them? What sorts of things did you do and why did you do them?

The first question was designed to probe the students conceptions of learning through case studies, and the second two questions were designed to investigate how they approached their learning through the case studies, including how they used the online resources. By asking them to discuss why did they did certain things in order to learn, the questions elicited the students' intention as well as the strategies they were using. The interviews were transcribed and assessed independently by the three investigators who classified students according to their conception (fragmented or cohesive), approach (surface or deep) and approach to online cases. From an analysis of these transcripts of the interviews interesting and informative trends emerge.

Table 3 Implementation of guidelines for case based learning

The online cases provided in the computer sessions were either actual cases or were based on real cases, providing an authentic and relevant learning experience, supported by quality images and rich clinical context. These cases were the driving force behind the case based learning resources. (Barrows, 1986; Jonassen, 1991; Savery & Duffy, 1995).
Ownership of the problem was reinforced as the group had to manage their own way of solving the problem. Mechanisms for support (e.g. scaffolding and hints) were provided to enable them complete the case in their own way, however they were required to present their answers in a particular format that underpinned an industry accepted methodology. (Barrows, 1986; Savery and Duffy, 1995).
The cases presented provided learners with a range of resources that would be encountered in veterinary practice to complete the problem. They had access to all the information pertinent to the case and some additional distracting material, typical of a real clinical case. However, the key information was presented in a way that didn't signal its importance. The students had to critically evaluate and justify its importance to the case. This required students to apply higher order skills such as critical thinking, analysis and inquiry in a way that would structure their thinking in the context of clinical and professional practice. (Barrows, 1986; Savery & Duffy, 1995).
Students worked through cases in groups (on line) which enabled them to use peers in their own groups as well as other groups for support. Finally, students attended a resolution session for each set of cases to enable them to reflect against what they had submitted in their case reports as well as their approach to completing the case and to learn from the contributions of their peers. The lecturers answered questions in this session and outside to clarify any difficulties students had while completing the cases. (Barrows, 1986; Savery & Duffy, 1995; Biggs, 1999).

What students thought they were learning through the case studies

Some students' conceptions of learning through the case studies separated understanding from the experience. They tended to emphasise the acquisition of 'information' rather the process of investigating animal disease through application of scientific concepts.

Understanding versus acquisition are crucial distinctions in the development of clinical problem solving skills. They are crucial because students who hold fragmented, atomistic conceptions of clinical work are inclined to focus on the details of a problem and to attempt to learn the skills required for making a diagnosis in a very superficial way. Hmelo et al (1997) identified two strategies for clinical problem solving. The first, a data driven approach that relies on decision making based on identifying a series of common elements in the clinical data. The second is a hypothesis driven approach where clinical reasoning is used to develop a long chain of relationships between the elements of a clinical case. Whilst recognition of a pattern in clinical data is an important strategy used by experience doctors for rapid decision making, novices require the need to develop an hypothesis driven approach to resolve complex and novel problems outside of their experience, For example, when encountered with a new case of a disease students try to memorise the exact details of the age, breed, clinical signs and history of the case with the intention of using this pattern of events to identify the next similar case they encounter. While pattern recognition is an element of the diagnostic repertoire of an experienced clinician, enabling rapid identification of common problems, it does not provide the intellectual framework required for logical, rigorous, effective investigation and resolution of the unfamiliar problems which arise in practice.

In the interviews, students with fragmented, atomistic conceptions focussed on specific information provided inonline case studies. Comments suggest they perceived information gathering to be the main feature of clinical problem solving and reflected a very passive approach to using just the information provided through the case study (rather than using it as a springboard for deeper and broader self directed inquiry). For example, when asked what he was learning through the case studies, one student replied:

> … a range of information you investigate when you are presented with a problematic animal. (Student 5)

> … we were learning how to investigate different cases using the information given to us on the computer. (Student 5)

This focus on passive accumulation of information is consistent with a fragmented or atomistic conception of clinical learning. Students focussed on following a set series of steps to gathering the information. This is a recipe for poor quality clinical problem solving as it relies on linking a series of separate, apparently disconnected items of knowledge in order to replicate and use them to identify another similar situation. In fact clinical problems are rarely identical, so this approach short circuits the deeper understanding that should emerge from investigation of each case and leaves students unable to transfer the knowledge and skills gained from a familiar case to a novel context.

Advanced clinical problem solving attributes are underpinned by a holistic conception of clinical knowledge. Experienced, effective clinicians are able to diagnose and treat completely novel problems by applying basic scientific principles to clinical investigation in a logical, evidence based manner. In complex cases this means the diagnosis is constantly reviewed and refined based on the collection, analysis and interpretation of appropriate tests and clinical observations, with cycles of reflection and renewed investigation until the problem is resolved.

The following quotes from learners suggest a cohesive conception of learning through case studies:

> I think the main thing was learning to take a systematic approach to cases and not just look at a list of clinical signs and pick one and go 'there's the diagnosis'. (Student 4)

> … [an understanding of] the tests you might perform and what the results might then lend towards a differential diagnosis, so what kind of diagnoses you might come up with in relation to those tests and the results. (Student 1)

These comments suggest that some learners structured the information in the task in a more cohesive way, linking to an overarching methodology. Students intention was to develop a robust (systematic) and evidence based approach to problem solving (student 4). Student 1 alludes to the importance of interpretation of test information and the way this process contributes to developing and refining the diagnosis, which is consistent with an orientation towards understanding underpinning the learning activity.

There was some variation among the student interviews on the extent to which they perceived that clinical investigation and problem solving could be reduced to a formula of steps to be followed. The following quote shows an intermediate conception of learning:

> … how to develop an approach to solving a problem… the steps you go through when solving a clinical problem. (Student 3)

How students approached learning through the case studies

Some students approached case based learning activities as a set of formula, with steps requiring specific information. They interacted with the case study and the online learning resources in superficial ways. In the interviews they tended to describe their intention to meet the task requirements through reproduction of content provided in lectures. They described how they avoided engaging with the task or its content. In the process of avoiding active engagement with the task they also failed to construct their own personal understanding of the case and missed the opportunity to develop their problem solving skills.

> First of all we didn't use resources, we just used regurgitation of notes that we'd already been given for that week. (Student 6)

Where learning challenges emerged that required more active inquiry to resolve, some students took a superficial approach, focussed on assessment requirements and avoided the opportunity for developing a deeper understanding of the content or their skills in problem solving.

> Often we wouldn't understand something but we'd just gloss over it because we didn't understand it and we'd go, "oh it's only worth 5% or whatever, it's not worth it, it's not worth the time" and we'd just push it aside. (Student 7)

Some students responded to their perception of a high workload and insufficient time for complete investigation by short circuiting the logical approach to problem solving that was intended in the case study design. Instead their strategy was to bypass some resources (that may have developed a more robust

and evidence based understanding of the problem) and to mainly utilise those they believed would provide quick answers. Their focus was on completing the task (the case report) in order to fulfil the assessment requirements set by the teaching staff (student 2), with little concern for the quality of their learning. This is reminiscent of an assessment driven, surface approach to learning.

> … because of time constraints… Mostly we would go straight to the tests. (Student 1)

> … we began with using resources given to us on the screen… then we would talk between us to come up with the things we needed to fill in, in the format given. (Student 9)

The variation in what the students did when they were learning in the case studies was striking, as some students adopted data driven approaches to learning, with the intention of completing the tasks quickly and meeting the assessment requirements (a surface approach). In contrast other students took a theory driven approach to case investigation and focussed on development and testing of hypotheses about the cause of the clinical problems. We draw parallels with the research of Hmelo-Silver et al (2000) who reported that experts working on a PBL tasks were nearly twice as likely to engage in high level interpretation, theorising and to reason based on first principles, compared to novices with a limited background understanding.

Other students thought the case studies were about applying knowledge to real problems in order to fundamentally understand the condition of the animal, rather than looking for a 'textbook' pattern indicating a specific illness. They tended to use the online resources in meaningful ways and to make the learning personal by taking control of the process as they gained experience and confidence (student 2). They described the process of problem solving that an experienced clinician uses, where the diagnosis is progressively refined through cycles of investigation, analysis, interpretation and reflection (student 3). For example:

> … we had a format to follow and we started off really liking that, but in the end we wanted to chuck it out and write it ourselves. (Student 2)

> … if we did it step by step and do a differential list before we look at the test results, that helped us narrow it down a bit more. (Student 3)

There was a range in approach and some learners used an intermediate approach, as suggested by this quote:

> … we looked at the cases individually first and went through them and then when we came together we talked about our ideas about it… we went through it step by step and tried not to jump too far ahead before we answered the questions. (Student 3)

Students held conceptions of learning through the case–studies in Veterinary Pathology that ranged from fragmented to cohesive. The approaches to learning students adopted ranged from surface to deep, a range found in other learning contexts (Prosser and Trigwell, 1999). One of the underlying factors for further investigation is the impact of students' perceptions of the relationship of these case studies to the development of key graduate attributes in clinical problem solving. Those students who reported fragmented conceptions and surface approaches to case studies did not tend to refer to the broader relevance of the learning outcomes, while those students with holistic conceptions who adopted deeper approaches frequently referred to the relevance of the case studies in helping them achieve their career aspirations to become veterinary practitioners. The 'big picture' view is demonstrated in the quote:

> So if you were coming across cases in practice you would certainly have been given a good and thorough way of approaching them or a basis.. (Student 2)

> and

> There is a realism to it; you're presented with a history, a case and you have to use analytic skills and lateral thinking skills which I suppose are very much part of being a vet.. (Student 3)

These findings will inform design of case based activities and resources to move learners from surface towards deep approaches to learning. These changes are crucial to ensure students sequentially build and refine their graduate attributes in clinical problem solving and to prepare them to effectively transfer these

skills to a clinical setting, where they will have far greater autonomy and responsibility for the investigation.

Implications for the design of the online case based learning activities based on students' experience

The aim of developing the case study resources was to encourage students to apply higher order skills such as clinical reasoning, analysis and investigation, consistent with deep approaches to learning in order to develop high quality, clinically relevant learning outcomes. However, their evaluations revealed considerable variation in students conceptions of the learning task, with the disturbing finding that some students held fragmented conceptions and adopted surface approach even in a rich, clinically relevant learning setting. To help the students adopt more effective ways of using the materials for their learning that will enable them to achieve higher order learning and develop effective clinical problem solving strategies, the case based activities and resources will be redesigned with the intention of trying to improve the students' experience of the materials. These recommendations are summarised in as follows:

Table 4: Recommendations for redesign

Provide additional context and support for the first few cases, explaining the case investigation process, its aims and underlining its relevance and value to their career goals. This can be in the form of more fully articulated learning outcomes linked to graduate attributes, additional content to guide the learning process and model answers to support reflection on answers submitted.
Provide clear learning outcomes, descriptions of the learning task, assessment and clear grade descriptors to manage student expectations of what is required and the levels of achievement that will be rewarded.
Provide adjunct resources to enable students to effectively manage their workload in the context of a group learning environment. Recommend a structure for group work, with timelines for task completion for the first few tasks that will enable them to effectively complete the activity in the way it was designed in the timeframe provided.
Ensure the cases are in a sequence that increasingly challenges learners with a subsequent removal of learning support and greater ambiguity and complexity in the later cases to stretch learners.
Provide greater opportunities for reflection on the process and also content covered to allow learners to meet the challenge of subsequent cases and refine their approach. Provide a discussion board activity, with facilitation to focus these reflections and share the learning among the whole community of learners in the unit.
Ensure the output of the activity requires responses reflective of higher order thinking skills through provision of clear grade descriptors, whilst still providing guidelines for best practice methodologies.
Recognise the activity appropriately with allocated marks and timeframe to complete.
Address the perceptions of high workload to reduce the likelihood of students reverting to surface learning approaches based on urgency.

These recommendations are proposed to ensure that students can not successfully complete these tasks using surface approaches that focus on reproduction of information without analysis or application to the problems. They address the context in which the case based activities are conducted by recognising that time constraints and assessment weighting have a profound influence on the approach learners adopt. Our aim is to implement these recommendations in the existing teaching and learning activities as well as to incorporate them in the design process for future case based learning activities.

Conclusion

This paper has discussed the implications on the design of case based learning activities based on the learning experience of students'. Background theory and previous research was chosen to highlight the principles underpinning the design of the activities and show their relevance to the curriculum that is currently being taught in the Faculty of Veterinary Science. Importantly, the paper has presented evidence of how students approached their case based learning activities and based on the students' experience of the materials, guidelines for the redevelopment of the materials have been developed.

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