Learning through inquiry: student difficulties with online course-based Material

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Abstract

This study investigates the case-based learning experience of 133 undergraduate veterinarian science students. Using qualitative methodologies from relational Student Learning Research, variation in the quality of the learning experience was identified, ranging from coherent, deep, quality experiences of the cases, to experiences that separated significant aspects, such as the online case histories, laboratory test results, and annotated images emphasizing symptoms, from the meaning of the experience. A key outcome of this study was that a significant percentage of the students surveyed adopted a poor approach to learning with online resources in a blended experience even when their overall learning experience was related to cohesive conceptions of veterinary science, and that the difference was even more marked for less successful students. The outcomes from the study suggest that many students are unsure of how to approach the use of online resources in ways that are likely to maximise benefits for learning in blended experiences, and that the benefits from case-based learning such as authenticity and active learning can be threatened if issues closely associated with qualitative variation arising from incoherence in the experience are not addressed.

Keywords: blended environments, case-based learning, online resources, qualitative variation, student learning research

Introduction

Learning through inquiry, in its broadest sense, is an important aspect of the student experience in higher education. It is important because it promotes aspects of learning that, when implemented well, are likely to lead to quality learning outcomes: problem-solving (Boud & Feletti 1997) learning in authentic contexts through case-based reasoning (Kolodner & Guzdial 2000), constructing knowledge (Jonassen & Land 2000), active and deep learning (Biggs 1999; Prosser & Trigwell 1999), and reflection (Schön 1990). However, learning through inquiry in and of itself does not necessarily lead to quality learning outcomes. Teachers can spend hours designing and teaching with what they believe to be quality learning activities and environments, but if researchers do not investigate how students conceive of and approach inquiry-based activities, we will not be in a position to evaluate how they can help students to achieve their learning outcomes. Without evidence-based research, attempts at designing and facilitating inquiry-based learning are likely to be guided by guesswork or intuition.

Learning through inquiry in higher education is an increasingly complex part of the student learning experience as new information and communication technologies (ICT) are being used to support it. When
teachers include ICT in the design of inquiry-based learning, it often results in significant portions of the learning experience moving from face-to-face to online environments, increasingly referred to as blended learning experiences (Cox et al. 2004; Ellis & Calvo 2004). If care is not taken to ensure alignment between the face-to-face and online contexts, both of which are supporting the cases being studied, then the students can experience a separation between the two that impedes their ability to engage in holistic meaningful learning. They will not understand how the online activities and materials relate to the face-to-face activities, a situation that would inhibit learning at best, if not lead to learning failure.

This study is a timely and important contribution to our understanding of the student experience of learning through inquiry, as it investigates the coherence of case-based learning from a student perspective in an experience that is dependent on significant online resources. The main research question addressed in this study is whether there are any qualitative differences in the students’ experience of the blended case-based learning experiences. In other words,

To what extent do university students in blended learning contexts, that is contexts involving both face-to-face and online learning, experience the combination coherently? Is there any evidence of qualitatively different experiences of case-based learning in the face-to-face and online contexts?

To investigate the research question, a case-based blended learning experience of 133 second- and third-year veterinary science students is used. The students engaged in learning processes focusing on cases of animals who were suffering from illnesses, diseases, and accidents typical of those that a professional veterinarian would come across in daily practice. The learning processes were dependent upon, and occurred across, face-to-face and online contexts. The students were exposed to theoretical concepts in lectures, which were followed up with case studies of the animals, their history, laboratory test results, annotated images emphasizing symptoms, and relevant research papers, all of which were online. Students then drew on these resources both in and out of tutorials and laboratory sessions as they moved towards the completion of a written report on appropriate diagnoses of the animal and the most appropriate solutions.

This study investigates whether there are qualitative differences in the student case-based learning experience. This main research question includes investigating whether there is any fragmentation in how the students approached their learning in face-to-face or online contexts, how closely their approaches to learning were related to what they thought they were learning through case studies, and how variation in the quality of their approaches and conceptions were related to their performance levels. Qualitative variation in this study refers to discernable shifts in the quality of understanding displayed by the students in relation to their case-based learning (Prosser & Trigwell 1999).

**Previous research and research into case-based learning**

Case-based learning can be defined as learning through being situated in an authentic context that requires the learner to acquire skills and knowledge in order to solve a problem or manipulate a solution (Jonassen 1991). Like problem-based and project-based learning, it emphasises the importance of active, constructive, and authentic learning experiences. Case-based learning encourages the learner to engage with authentic scenarios in order to develop understanding and knowledge and the necessary skills relevant to the context (Jonassen & Land 2000). At its best, it allows students to think and act like practitioners who must come to terms with the issues that a particular case presents to them. The following discusses a number of studies investigating the effectiveness of case-based learning in tertiary contexts.

Research seeking evidence of the effectiveness of case-based learning assisted by computers has been based on the quality of student postings in a Finnish research project (Makitalo et al. 2002). In that study, involving students from Finnish and American universities, 68 pre-service teacher–students were enrolled in an online course. They were expected to interact with the case studies of other students as they developed their own case study. Typical topics of the case studies included fears in the educational environment, dealing with delicate matters in learning situations, learning to learn, becoming a teacher, and developing learning communities. Three hundred and eighty-six postings were analysed for interaction pat-
terns, with an emphasis on the amount of feedback students gave to each other. Broadly speaking, feedback that typically resulted in agreement tended to impede online interaction, while feedback that probed the meaning underlying postings tended to encourage deeper, more meaningful online discussions around the case studies. In terms of qualitative variation of the student experience, this suggests that the quality of feedback provided by tutors to students online is associated with the quality of the online interaction.

Some research has investigated the quality of case-based learning in relation to gender issues supported by video conferencing, with rather curious results. Second-year medical students were encouraged to develop increasingly independent learning skills and a deep understanding of key topics in anatomy at a national university in New Zealand (Peplow 1998). Case histories and discussion of key aspects were conducted via video conferencing with groups of 11 students in separate rooms. This allowed the students to receive the same input, but to work on it separately from the other groups. In the study, 168 students (79 females and 89 males) returned a closed-ended questionnaire that was used to relate their positive or negative views on case-based learning to their performance levels in the final exam. In summary, the study found that female students responded more positively to discussion tasks surrounding the case-based learning than the male students, and tended to perform better in the related section in the final examination. Perhaps, somewhat surprisingly, this outcome from this medical education study may suggest that males may need additional support when engaging in case-based learning.

Important research has investigated student preferences related to case-like problems that were student centred in design and collaborative in nature (Oliver & Omari 2001). Two-hundred and forty students, 220 on campus and 20 off campus, engaged in small group workshops that exploited considerable Web-based resources designed to help them address problems related to their first-year undergraduate subject, ‘Introduction to Multimedia’. The results identified a general level of satisfaction with the Web-based environment as a source of help for solving the problems. The results also showed that while students were satisfied in general with student-centred, problem-orientated, and collaborative activities, nearly half the class reported a preference to work alone with stronger guidance from the teacher. The implication of this for variation in the quality of the student experience is that while there is some evidence of the benefits of active learning brought about by problem-orientated and collaborative activities, students also require some support in order to appreciate the affordances offered by such experiences.

Some studies have focused more on the technological variation that is used to support student case-based learning in higher education. One study (Ward 1998) compared two software systems: ServiceWatch and ServiceWorld. These are large computer-based case studies consisting of text and graphics files delivered over the World Wide Web. Key outcomes from student surveys used in the study included the recognition that neither system had a tutorial-like interactive component, which meant that goals and activities such as report writing and discussion had to be specified separately and related to the software content; that the design of such activities was as important as the design of the software systems themselves; and that the quality of the students’ learning could be related to design aspects of the scenarios such as how realistic, broad, and detailed they were.

Research has also identified some characteristics for technologically based support for case-based learning and reasoning that are likely to promote the benefits of reflection that can arise during the process (Kolodner & Guzdial 2000). These include motivating reflective activities among student users, generating meaningful feedback, and encouraging cyclical reflection without overdoing it. The suggestion underlying this last characteristic is that too much reflection during the learning process could interrupt the students’ train of thought sufficiently to obscure the learning outcomes sought by the activity.

While the studies reported above sought some type of evidence in the research methodologies, none focused on what the students thought they were learning through case-based learning, and how their conceptions were related to their approaches, both in class and online. This study adds to the research by investigating qualitative differences in the students’ conceptions of, and approaches to, case-based learning experiences and whether or not these differences have implications for the students’ performance and the practice of facilitating the cases.
The research framework of this study

In this study, methodologies from relational Student Learning Research (Marton & Säljö 1976a,b; Entwistle & Ramsden 1983; Ramsden 1992; Marton & Booth 1997; Prosser & Trigwell 1999), especially the qualitative branch, phenomenography, have been adopted. They have been adopted because they help the researchers to not only investigate the quality of learning in blended contexts, because they can foreground how students approach their learning both in face-to-face-based and online contexts, but they also seek to relate the levels of performance and the quality of the learning outcomes. Relational Student Learning Research makes a distinction between performance and learning outcomes. The former is the marks awarded to the student. The latter refers to the quality of the outcomes that the students report at the end of the learning experience. For example, quality conceptions of learning are those that involve higher order learning outcomes such as synthesis, analysis, critical evaluation, all which are built on the basis of understanding (Biggs 1999). Research within the model has found close positive relationships between the conceptions and approaches, but not always, as some students can be marks oriented but still have a fragmented conception of learning. Fragmented conceptions of learning are those that reveal little or no awareness of the meaning that underpins learning activities. In such cases, the students tend to retain little of what they have learnt at later stages in their study.

Figure 1 shows the phenomenographic model of the Experience of learning that is used to evaluate the quality of the students’ experience of the case-based learning in this study. It divides learning into reference (what students think they learn, their conceptions) and structure (how they go about learning, their approaches).

The model shown in Fig. 1 divides the experience of learning into two parts: the How of learning, its structural part, and the What of learning, its referential part. Each of these parts 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 & Booth 1997). When we apply this model to case-based learning in Veterinary Science, it is possible to interpret the direct object as being 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, while the act of learning can be interpreted as an interactive problem-solving process with colleagues both face to face and online, and the indirect objects of learning can be understood to include communication skills and teamwork.

Outcomes from previous studies within Student Learning Research (Marton & Säljö 1976a,b; Entwistle & Ramsden 1983; Prosser & Millar 1989; Laurillard 2002) research 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. Similarly, if we help students to improve their approaches, then they are likely to better understand what they are supposed to be learning and more likely to be able to apply that understanding in new contexts (Prosser & Trigwell 1999). While there is a wealth of research in this model that is consistent with this type of interpretation of case-based learning, there is none, to the knowledge of the authors, that has specifically addressed the quality of blended case-based learning experiences. Furthermore, broader issues of how students are starting to use online materials in case-based learning are also becoming increasingly important. In this sense, this study builds on existing research in this model, and on wider research into case-based learning, in important ways that have had comparatively little attention in the past.

Research site

The research site chosen for this study consists of 2 years of a 5-year undergraduate degree in a Faculty of Veterinary Science at a large Australian metropolitan
university. Students in years 2 and 3 of the bachelor degree complete subjects in basic animal science, professional practice, para-clinical studies, and clinical management of animal disease.

In 2003, the faculty introduced a case-based approach to learning across key subjects in years 2 and 3. As such, it is still a relatively new innovation in the student experience and this study is one of the earliest studies evaluating the implementation of the innovation. Students are assessed for their learning of the case studies through the completion of a written report, and the quality of the contributions in class through presentations and discussions. The case-based learning processes involve lectures, practical laboratory sessions, and tutorials that revolve around the cases and rely on the online case study activities and materials. The lecturers involved knew that all students in the study had had some experience of case-based learning in the previous years of their enrolment. To further help their familiarity with both case-based learning and the use of the online resources, at the beginning of the semester, all students were given an introductory orientation session to the learning processes surrounding the case-based learning that are discussed below.

The online case study activities and materials include the following:

- Case scenarios giving authentic situations in which the students can orient their discussions, conceptualisation, and approaches;
- guidelines of how to complete their case-study reports to structure their findings in professionally appropriate ways;
- indicative commentary from personnel in the industry via audio/video clips;
- commentary from experts within the field via audio/video clips;
- annotated images of the animals showing symptoms or clinical signs for discussion;
- laboratory test results of the animals for the purpose of analysis; and
- relevant library reference materials for background information on the theories and illnesses involved.

In essence, case-based learning is a way of learning that has at its core analogy in the context of solving real-world problems and understanding real-world situations (Kolodner & Guzdial 2000). In the context researched here, it was used as a way to expose students to the kinds of issues that they would come up against as practicing veterinarians, with a view to helping them solve problems using authentic or near-authentic resources.

These resources were used to complement the face-to-face classes and laboratory sessions. The online case-based learning resources were part of a blended learning activity that was structured in the learning sequence shown in Fig. 2.

Students were exposed to background knowledge of the case in lectures. They had a practical class that allowed them to relate the ideas of the lecturers to hands-on veterinary activities. After these stages, the students worked on the case studies in small groups and then reflected on conclusions about the case studies in case-resolution sessions.

Considering the online resources more closely, issues that motivated discussion about each case were presented through a scenario. The scenario would provide case information about a sick or injured animal drawn from an authentic situation. The objectives of the case study were to encourage the students to integrate and analyse the knowledge in a way that enabled them to demonstrate their understanding of the problems of an animal by completing a ‘case report form’. The case report form was in essence a decision-making process that they could use to get to the heart of the issues that were behind the illnesses of the animal. Figure 3 shows a screen shot that provides an example of the type of resources supporting each case study.

Students access the case studies on the Veterinary Pathology subject WebCT™ site when they commence each case study. Figure 3 identifies that the resources

![Fig. 2 Blended Learning sequence involving online learning resources.](#)
the students had at their disposal, typical resources that a veterinary practitioner would use to investigate the health of a patient (animal); the client’s comments, views of the patient; and findings from a physical examination of the patient. After reading these materials, students were encouraged to develop a list of differential diagnoses for further investigation through diagnostic tests (which may include laboratory reports and radiographs).

Method

Sample and administration

Students from years 2 and 3 of the veterinary science degree were invited to participate in the study by filling out open-ended questionnaires. Sixty-five second-year students and 77 third-year students completed the open-ended questionnaires during lectures towards the end of the semester, after the entire case-based learning assessment had been completed. As the methodology of learning underpinning the design and intention behind the case studies across years 2 and 3 was the same, that is, the use of authentic data and scenarios to engage in a professional decision-making process leading to appropriate diagnoses, the decision was taken to pool the students’ responses. Future studies would be undertaken to investigate whether there were differences in approaches between years 2 and 3. This study focuses on the similarities of separated or incoherent aspects in the case-based learning experiences of the students across both years.

Some students did not complete the questionnaires in sufficient detail to allow analysis and classification. Consequently, 11 questionnaires were discarded. The final number of students involved in the analysis \( n = 133 \) represents approximately 56\% of the total cohort.

Research questions and analysis

The questions on the open-ended questionnaire were designed to investigate what the students thought they were learning through the cases, how they approached their case-based learning in the tutorials, and how they engaged with the online activities and materials of the case studies. The questions used on the questionnaire were as follows:

1. *When you were engaging with the case studies in your subject, what did you think you were learning?*
2. *When you were engaging with the case studies in your subject, what things did you do? and why did you do the things you did?*
3. *When you were using the case study resources in the subject website, what things did you do? and why did you do the things you did?*

In terms of the model of learning in Fig. 1, question 1 was designed to elicit the students’ conception of what they thought they were learning through the cases in the subject. Questions 2 and 3 were designed to investigate how the students went about engaging with the cases in the face-to-face and online contexts, both what they did (their strategies) and why they used them (their intention).

The above three questions were answered by the 133 students surveyed in this study. Taken together,
their responses provided a rich resource for analysis. The students’ written answers to the questions on the open-ended questionnaires were analysed, and it was found that it was possible to group their responses into four categories for each of the questions. The way this was done is discussed below, and the results are shown in Tables 2 and 4. Tables 3 and 5 discuss the structural and referential aspects of the categories of student conceptions and approaches in ways consistent with the Experience of learning model shown in Fig. 1 and previous research (Prosser & Trigwell 1999; Ellis 2004).

The process of analysing the student responses followed a phenomenographic procedure (Crawford et al. 1994; Cope 2000, Ellis 2004). The process of analysing one of these areas, face-to-face approaches to case-based learning, is taken as an example for the following description.

1. The section of each questionnaire relating to face-to-face approaches was analysed for variation in the response.
2. After reading all of the students’ answers about their face-to-face approaches, there was a sense of qualitative variation in the students’ responses. This variation was evident in the key features of their approaches, some suggesting an awareness of inquiry in order to understand the issues, while others revealed an awareness of more superficial aspects of inquiry, such as a way of collecting information.
3. Student responses with a clear indication of key features of their approaches were identified and used as the beginning of themes (Marton & Booth 1997). The themes were used to orient the classification process as categories of approaches began to appear.
4. The themes were grouped into logically related areas. Some overlapped and these began to form the basis of the outcome space for approaches in the face-to-face context.
5. After re-reading all the student responses in relation to the overlapping draft categories and initial structural relationships, a draft set of categories that revealed meaning and structure was established. This was the initial classification.
6. The initial category descriptions required further development as different aspects of the student experience of learning through inquiry were emphasised by different students.
7. To improve the category of descriptions, representative extracts from the questionnaire were chosen and discussed with supporting researchers. This led to the reconsideration of all of the responses in relation to the redrafted categories. Both the final version of the category descriptions and the re-categorisation of the extracts were agreed upon by all researchers.
8. The redrafted categories became the final version and extracts from student responses that best represented the draft categories were selected. The draft categories and the representative extracts formed the outcome space for this part of the phenomenographic study and drew on the SOLO taxonomy as a way of structuring the hierarchy (Biggs 1999).

This process is used to create the outcome spaces of this study, which are represented as a hierarchy of qualitatively different categories of conceptions and approaches and representative quotations from the questionnaires. While it was possible to categorise all student responses to each question into one of categories shown in Tables 2 (question 1) and 4 (questions 2 and 3), there are a couple of points to note. Firstly, the main qualitative shift in the tables is between categories A/B and C/D. There was between 90% and

<table>
<thead>
<tr>
<th>Table 1. Communicability of the categories of case-based learning</th>
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</thead>
<tbody>
<tr>
<td><strong>Conceptions</strong></td>
</tr>
<tr>
<td>% agreement after initial categorisation</td>
</tr>
<tr>
<td>Researcher 1</td>
</tr>
<tr>
<td>Researcher 2</td>
</tr>
</tbody>
</table>
100% agreement on the classification of the researchers about the final categorisation of the questionnaires. Table 1 shows the percentage agreement between the researchers’ classifications during the process. Secondly, within this division of the four categories, that is, between categories A and B, and between categories C and D, some responses were on the cusp, tending towards a higher or lower category. Notwithstanding these points, the categorisation of the student questionnaires allows us to examine patterns among the approaches and conceptions of the student experience of learning through inquiry, which allows us to discuss the qualitative variation in the population sample.

Results

In this study, the outcome spaces discussed below are a major finding of the study.

Student conceptions of case-based learning

Table 2 shows the categories of conceptions of case-based learning. These are hierarchical and inclusive, that is, the categories are developed from the highest level of learning outcome that can be reasonably reported from the responses given, which, in this case, is category D.

In the first two categories in Table 2, the conceptions of case-based learning emphasise the acquisition and collection of information. Recalling information and collecting bits of information from different areas seem to be the main conceptions underpinning the ways of thinking about the cases. In contrast, categories C and D reveal a close association between the cases and concepts related to quality learning, cases as a way to use theory to solve authentic problems, the adoption of a holistic approach to the cases that requires the perspective of a professional who is able to develop appropriate diagnoses.

The relationships among the categories of conceptions are shown in Table 3. Table 3 identifies the qualitative shift between categories A, B and categories C, D.

<table>
<thead>
<tr>
<th>Category</th>
<th>Descriptions</th>
<th>Representative quotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Case-based learning as a way of recalling information</td>
<td>I thought the lecturers were trying to give us a framework from which we could recall information later. Also I thought they might be trying to make the course more interesting</td>
</tr>
<tr>
<td>B</td>
<td>Case-based learning as a way of collecting information from a variety of sources</td>
<td>Each person collated information from a separate source and then we came together and wrote the report feedback. Trying to get info from different sources helps increase the chances you have gathered all relevant info</td>
</tr>
<tr>
<td>C</td>
<td>Case-based learning as a way of using theoretical knowledge to solve authentic problems</td>
<td>How to approach problems in real life. Applying what we have learnt in the lectures to real life situations. How the things we learnt in lectures relate to clinical cases. How to work in a team and discuss ideas and help each other</td>
</tr>
<tr>
<td>D</td>
<td>Case-based learning as a way of thinking how to think and act like a professional veterinarian</td>
<td>How to diagnose disease and provide treatment in a logical manner. Developing a step-by-step manner to use in practice when presented with patients. Learn how to research information and integrate it with what we already knew. Learning how to work in a group</td>
</tr>
</tbody>
</table>

| Table 3. Referential and structural relationships among the categories of conceptions |
|-----------------------------------------------|-----------------------------------------------|
| Referential – the ‘what’ of the conceptions | Quality of conception                        |
| Cohesive                                    | Fragmented                                   |
| (1) Recalling information                    | Category A                                   |
| (2) As in (1) and from a number of sources   | Category B                                   |
| (3) As in (2) and applying theory to practice| Category C                                   |
| (4) As in (3) and adopting an authentic      | Category D                                   |
| holistic approach                           |                                               |

Referentially, categories A–D are logically inclusive. Category B involves acquiring information, but reveals an awareness that the information is likely to come from a number of sources. Category C involves acquiring information from a number of sources, and reveals an awareness of the importance of applying theoretical aspects to practice. Category D involves applying theory to practices, and shows an awareness of how this relates to the professional practice of a veterinary practitioner. Structurally, conceptions cannot be considered logically inclusive since cohesive and fragmented conceptions are mutually exclusive.

**Student approaches to case-based learning**

Table 4 shows the categories of approaches to case-based learning, both in face-to-face and online contexts. While approaches in the face-to-face and online environments are both captured in Table 4 for the sake of efficacy, it does not mean that adoption of face-to-face approaches in category A was directly correlated with category A online approaches. Relationships among the categories of conceptions and approaches are discussed in Table 7.

In each of the categories A–D, approaches in the face-to-face context are given in the first line, and approaches in the online context are given in italics in the second line.

In the face-to-face context, approach A involved an intention to use the case studies as a way to find and recall information. Likewise, the intention underpinning approach B was similarly superficial in nature, with an emphasis on finding information to answer questions. Categories C and D were qualitatively different, with integration, broader thinking and development of differential diagnosis skills.

<table>
<thead>
<tr>
<th>Category</th>
<th>Descriptions</th>
<th>Representative quotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Engaging in case-based learning in order to find and recall information</td>
<td>Took notes, drew pictures, tried to remember stuff for the exams</td>
</tr>
<tr>
<td></td>
<td>Did not engage with the online case-study resources</td>
<td>Didn’t use anything on the website. Used text books and lecture notes.</td>
</tr>
<tr>
<td>B</td>
<td>Engaging in case-based learning in order to obtain information to answer the questions</td>
<td>Did prac, tutorials and lectures to get all sources of information that we would need to solve problems</td>
</tr>
<tr>
<td></td>
<td>Engaging with the online case-study resources to primarily access information</td>
<td>Accessed the case from the website. Read the case so we know what is was about. Look at all the pictures and read the instructions for that task. Researched using links provided or just databases and search engines. Typed up our answers</td>
</tr>
<tr>
<td>C</td>
<td>Engaging in case-based learning in order to develop integration and understanding of relevant knowledge</td>
<td>Lectures, learn, know about the stuff we need to know. Prac classes, learn what to do in practice. Self-study, reviewing the stuff we learnt in lectures. Reading books, as lectures may not be as detailed. Writing my own notes, I learn better this way. Jotting notes in lectures, helps do revision, integrates individual bits into a bigger picture</td>
</tr>
<tr>
<td></td>
<td>Engaging with the online case-study resources to understand how to develop differential diagnosis skills</td>
<td>I looked at the history, clinical signs, test results and used my knowledge and what I learnt in class to give a differential diagnosis</td>
</tr>
<tr>
<td>D</td>
<td>Engaging in case-based learning in order to develop broader thinking through application and integration of knowledge</td>
<td>Visualise the case, what was happening, what was going on. Consider and think about he case, consider other differentials that could cause a disease. It encouraged broader thinking. Tried to fit this new knowledge and link it to past information to gain a wider picture</td>
</tr>
<tr>
<td></td>
<td>Engaging with the online case-study resources to develop an approach to differential diagnosis appropriate for a practicing veterinarian</td>
<td>We looked at all of the resources/data systematically (as we would have received them in an actual clinical situation) and discussed ideas as we went along. This helped us to develop our hypotheses differential diagnoses logically and ensured we didn’t jump to conclusions</td>
</tr>
</tbody>
</table>
and understanding, and application informing the intention.

In terms of the online materials and activities, approach A revealed an intention to avoid using them and approach B used them in order to access information. In contrast, approaches C and D revealed an intention to use the online resources such as histories, clinical signs, and tests to develop appropriate diagnostic skills and differential diagnoses in ways that promoted suitable approaches for a practicing professional.

The structural relationships among the categories of approaches are displayed in Table 5. Similar to the variation found in the structural relationships among conceptions of case-based learning, a qualitative shift in student approaches to case-based learning was found, both face to face and online. The qualitative shift occurred between categories A, B and categories C, D, with understanding and applying underpinning the latter two categories.

In structural terms, face-to-face approaches in A revealed the strategy of using case studies to memorise information, face-to-face approaches in B revealed a strategy of finding information in order to answer questions, and face-to-face approaches in C and D revealed a strategy of understanding, integrating knowledge for new contexts.

Approach A in the online context avoided use of the resources. Approach B adopted a strategy of using the online resources to access information. Approach C used the online resources to improve diagnoses, and approach D used them to think like a practicing veterinarian.

The categories of approaches are not logically inclusive. For example, an intention to avoid using the online resources cannot simultaneously also reflect an intention to use them to develop differential diagnoses.

### Relationships among aspects of case-based learning

In this section, the relationship among the parts of the experience of case-based learning, the students’ conceptions and approaches, are investigated. First, the distribution of the student responses to the questionnaire is discussed. This distribution is analysed to see whether any patterns exist that may be helpful to understand why students adopt the approaches they do. Patterns found in the data are then related to the students’ achievement as measured by the mark they received for the whole subject. If the distributions in Table 6 were the only indication used to rate the quality of the student learning experience, the results could be quite disappointing. Recalling that case-based learning was a reasonably new part of the student experience in veterinary science, and online case-based learning was a very new part of the experience, the distribution of categories of conceptions and approaches shows some indication of this situation. Seventy-two out of the 133 responses were categorised as cohesive. In other words, the responses revealed an awareness that the purpose of the case studies was to engage with the knowledge in a deep way that would allow the development of differential diagnosis using a decision-making methodology appropriate for in-

### Table 5. The structural relationships among the categories of approaches

<table>
<thead>
<tr>
<th>Structural – the ‘how’ of approaches</th>
<th>Quality of approach</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Deep</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Surface</strong></td>
<td></td>
</tr>
<tr>
<td>(1) Face to face <strong>Memorise information</strong></td>
<td>Category A</td>
</tr>
<tr>
<td>Online</td>
<td></td>
</tr>
<tr>
<td>(2) Face to face <strong>Access information for answers</strong></td>
<td>Category B</td>
</tr>
<tr>
<td>Online</td>
<td></td>
</tr>
<tr>
<td>(3) Face to face <strong>Understand, integrate knowledge</strong></td>
<td>Category C</td>
</tr>
<tr>
<td>Online</td>
<td>Use online resources to improve diagnoses</td>
</tr>
<tr>
<td>(4) Face to face <strong>Apply understanding to new contexts</strong></td>
<td>Category D</td>
</tr>
<tr>
<td>Online</td>
<td>Use online resources to think like a professional</td>
</tr>
</tbody>
</table>
individual differences among patients. Noting the distribution of the categories of approaches likely to be associated with this type of conception, the number drops to 33. This trend is emphasised in the categorisation of approaches in the online environment. Only 15 of the 133 responses reported approaches that used the online activities and materials in ways likely to improve the quality of their learning.

Considering the distributions alone does not reveal the real situation of qualitative differences in the student experience. If we investigate relationships among the categories, and what types of conceptions were likely to lead to better approaches, then the structure of the qualitative variation becomes clearer. Table 7 shows a strong and statistically significant relationship between the conceptions of case-based learning and face-to-face approaches to case-based learning \((\pi = 0.35, P<0.001)\). It also shows a strong and statistically significant relationship between the conceptions of case-based learning and approaches to engaging with online materials and activities \((\pi = 0.23, P<0.01)\). Table 7 suggests that students who adopted a cohesive conception of case-based learning tended to adopt an in-depth approach to case-based learning in face-to-face contexts, and also tended to adopt deep approaches to engaging with the online materials and activities.

Interestingly, the patterns of qualitative variation in the experience of case-based learning were found to be consistent with the performance of the students. To investigate the relationship between the qualitatively different categories of conceptions and student performance, the categories were related to the marks the years 2 and 3 students received as assessment for their subject. In both years, students who held a conception of the case-based learning consistent with a cohesive conception tended to perform at a higher level (year 2: \(M = 73.47, \text{ sd } = 9.77\); year 3: \(M = 65.84, \text{ sd } = 7.6\)) than students holding a conception that was consistent with a fragmented conception (year 2: \(M = 65.23, \text{ sd } = 10.33\); year 3: \(M = 62.13, \text{ sd } = 7.3\)). The t-tests and effect sizes for the mean and standard deviations of years 2 and 3 were \(t = 3.11, 2.15\) and \(\text{es} = 0.82, 0.50\), respectively. These are large and medium effect sizes, similar to the effect sizes found in related studies (Crawford et al. 1994; Ellis et al. 2004).

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**Table 6. Distribution of conceptions and approaches**

<table>
<thead>
<tr>
<th>Conception/approach</th>
<th>N</th>
<th>% of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conception</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fragmented</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>35</td>
<td>26</td>
</tr>
<tr>
<td>B</td>
<td>26</td>
<td>20</td>
</tr>
<tr>
<td>Cohesive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>51</td>
<td>38</td>
</tr>
<tr>
<td>D</td>
<td>21</td>
<td>16</td>
</tr>
<tr>
<td>Total</td>
<td>133</td>
<td>100</td>
</tr>
<tr>
<td>Approach face to face</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>B</td>
<td>91</td>
<td>68</td>
</tr>
<tr>
<td>Deep</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>26</td>
<td>20</td>
</tr>
<tr>
<td>D</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>133</td>
<td>100</td>
</tr>
<tr>
<td>Approach online</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>24</td>
<td>18</td>
</tr>
<tr>
<td>B</td>
<td>94</td>
<td>71</td>
</tr>
<tr>
<td>Deep</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>D</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>133</td>
<td>100</td>
</tr>
</tbody>
</table>

---

**Table 7. Relationships among the parts of the case-based learning experience**

<table>
<thead>
<tr>
<th>Approaches to case-based learning</th>
<th>Conceptions of case-based learning</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face to face</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(A, B)</td>
<td>56 (42%)</td>
<td>44 (33%)</td>
</tr>
<tr>
<td>Deep</td>
<td>5 (4%)</td>
<td>28 (21%)</td>
</tr>
<tr>
<td>Total</td>
<td>61 (46%)</td>
<td>72 (54%)</td>
</tr>
<tr>
<td>Online</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(A, B)</td>
<td>59 (44%)</td>
<td>59 (44%)</td>
</tr>
<tr>
<td>Deep</td>
<td>2 (2%)</td>
<td>13 (10%)</td>
</tr>
<tr>
<td>Total</td>
<td>61 (46%)</td>
<td>72 (54%)</td>
</tr>
</tbody>
</table>

Face to face: \(\chi^2 = 16.7, \pi = 0.35, P<0.001\).
Online: \(\chi^2 = 7.2, \pi = 0.23, P<0.01\).
Discussion

This study has revealed a number of important outcomes for student learning in higher education: the appropriateness of research methodologies from relational Student Learning Research for the investigation of blended learning contexts, variations in the quality of case-based learning for students, and what this suggests about how we teach. This study is, however, not without some limitations. It has a relatively small population sample \( n = 133 \) and has used only one qualitative instrument: an open-ended questionnaire. Its aim has been to evaluate the quality of learning arising from the blended experience that leaves little room for an analysis of skills, rather focusing on the meaning underpinning the approaches to blended learning. Consequently, the findings should be interpreted with caution, perhaps indicating areas suitable for further research using additional research instruments. In future studies, perhaps some quantitative research methodologies such as factor and cluster analyses could be used to investigate some of these findings in an in-depth manner (Prosser & Trigwell 1999). Despite these limitations, the findings are of significant interest and require reflection in what they may suggest for research, student learning, and educational practice.

Implications for research

The outcomes of the analyses in this study have identified qualitatively different experiences of case-based learning in undergraduate veterinary science. Broadly speaking, when students think about case-based learning in fragmented ways, that is, when they conceive of it as unrelated to the development of appropriate diagnoses and the professional practices of veterinarians, then there are significant difficulties in the case-based learning experience: approaches are not closely associated with understanding, and the online part of the experience seems to be marginally related at best. This type of research outcome suggests that the research methodologies adopted from student learning research for this study are appropriate evaluation tools for the evaluation of blended learning environments. More studies investigating variation in the student blended learning experience will help to provide evidence of the quality and issues raised by the combination of face-to-face and online learning environments in higher education.

Implications for the quality of student learning

When the case-based learning experience worked well for students, there are clear indications of quality learning outcomes. Students with conceptions consistent with the cohesive category, that is, those who see a close association between the cases and their thinking and understanding of appropriate diagnostic processes and diagnoses for animals, reveal an approach that was oriented towards engaging with the case resources in a deep way. In contrast, fragmented conceptions tend to be related to approaches that fail to make the most of the experience to improve understanding or integrate relevant knowledge into appropriate practice. Clearly, these outcomes suggest that if we wish to help students who tend to approach case-based learning in a surface way, then, by helping them to better understand the relationship between the cases and authentic ways of practicing and thinking like a veterinarian, their approaches are likely to improve. This is important both for the face-to-face environment, and is especially important for the added demands of approaching the online environment appropriately.

Implications for educational practice

If we accept that cohesive conceptions of case-based learning are closely associated with deep approaches, both in face-to-face and online environments, then this has important implications for educational practice. How can we help students to improve their approaches and conceptions related to case-based learning?

In some ways, helping students to improve their approaches may be more clearcut than improving their conceptions. The approaches of students who use the online resources to engage in a deep way with the decision-making and diagnostic processes of the case studies can be used as examples of sensible approaches to case-based learning. This is an important pedagogical approach to adopt for new aspects of the student learning experience such as the online case-study resources. Teachers could discuss the approaches of the successful students as a way to consider the strategies and skills necessary for suc-
cessful learning. By focusing on how some of the students have interacted with the case-based resources, it may help to reveal the types of strategies that work. How do the successful students develop their response to the case-study report? Do they discuss symptoms visible in the images of the animals with other students? How do they relate the ideas in this discussion with the theories discussed in the lecture? How do they include these ideas in their report? Such explicit guidance would seem to be necessary as it has been clear from this study that there was some misunderstanding among the student population regarding the most appropriate way to use the online resources.

Helping students to develop a cohesive conception of case-based learning may prove more challenging. Perhaps modelling one case more strongly at the beginning of the semester, underlining the professional understanding and engagement with the problem of the animal through the case, may be one way of showing the value of cases for learning to students. Alternatively, perhaps a class debate about how cases can provide an insight into the dilemmas of a practicing veterinarian may be another way of improving the quality of how students think about case-based learning.

In conclusion, while case-based learning potentially provides benefits such as active learning, authentic contexts, problem-solving, and reflection, much of this will be threatened in blended experiences if attention is not paid to issues of cohesion and coherence between the face-to-face and online experiences. This study would suggest that lack of coherence between and within the two contexts from a student’s perspective is likely to result in significant qualitative variation that is adverse for the quality of the student experience. We can spend hours designing and developing blended learning environments, but if we do not understand how students think about and approach their learning in these environments, then much effort and opportunity for quality learning will be wasted.

References


