

The learning of veterinary students during practical ultrasound exercises

Anna Müller

Department of Veterinary Clinical Sciences
University of Copenhagen

Introduction

This report concerns a part of the course Veterinary Imaging¹, which a mandatory course in the Master of Veterinary Medicine curriculum. First, the course is briefly introduced. Then a background for the project is given, based on current literature, qualitative interviews and previous student evaluations. This information forms the basis of a number of interventions that have been introduced in the course. Finally, qualitative feedback from students who took the course, and a discussion with the course responsible are used to evaluate and discuss the effect of the implemented interventions.

Overall description of the course

In the course Veterinary Imaging, students are taught how veterinary medical images are acquired and interpreted. Such medical images are typically used to assess whether disease is present in different anatomical regions. The course covers radiology, ultrasound, computed tomography, magnetic resonance imaging, scintigraphy and radiation safety. It runs over 5 weeks during the Master of Veterinary Medicine. The first week consists of half-day lectures. One of these lectures covers the basic physical principles of ultrasound. The following 4 weeks contain a few days of theoretical group teaching and then have a more practical approach with mandatory group exercises, case-exercises and e-learning. Finally, students take a practical

¹ <http://kurser.ku.dk/course/SVEK13043U>, last visited 04.12.2018

test in radiography and a test covering theory from the whole course. These tests must be passed in order to receive a course certificate.

Ultrasound exercises

Part of the mandatory *practical* exercises in this course covers ultrasound scanning of the abdomen. Ultrasound scanning is a skill that requires a lot of individual practice. Approximately 12 students at a time have two ultrasound machines at their disposal for two full days. They are given a 30-minute introduction to these machines by a teacher on the first day. After the introduction, the students are expected to practice scanning on healthy dogs. In several previous evaluations of the course, students describes deep frustration about these exercises, for reasons described below. It is frustrating for the teacher to leave the students with these frustrations. Our section does not have resources to let a teacher stand by the students one-on-one for those two days. Although we try to help the students in between other tasks such as clinical work, the given time varies from day to day, which causes further frustrations when students compare their exercises with one another.

Definition of the problem

The introduction above raises the question: How can the course be adapted, so that students become better prepared for two days of independent group work in ultrasound?

Resume of selected literature

Ultrasound is an important diagnostic tool for many veterinarians in practice, and is a skill that many veterinary students rate as important (Rösch et al., 2014). For an unexperienced operator, it can be hard to contextualize the resulting cross sectional images. Hands-on practice in the safe environment, such as clinical skills labs, can motivate veterinary students, reduce their anxiety in clinical situations later and reduce gaps between theory and practice (Rösch et al., 2014; Langebæk et al., 2012). Our practical ultrasound exercises have one thing in common with such skills labs: they involve independent training on healthy animals, as opposed to real patients. However, using live animals for practice can be considered controversial,

and a different way of practicing ultrasound scanning is to use phantoms. Phantoms allows principles to be demonstrated, knowledge to be gained and invasive techniques such as biopsies can be practiced safely (Carrig et al., 2001; Yoo et al., 2004). The feeling of *making progress* has been shown to positively affect the emotions, motivation and perceptions that people experience in relation to their work - as long as the work is considered meaningful to the person. Even small progresses can have an impact. On the other hand, setbacks have a negative impact, which is even stronger than that of progression. The feeling of progress is usually followed by a better performance (Amabile et al., 2011). If this principle is translated to teaching of veterinary students, it seems important to set aside time and attention for noticing and collecting evidence of progress among the students. For this reason, focus on expectations and progress were addressed in the interventions presented below. It has been shown that verbal and non-verbal information have equal importance for human cognition (Clark et al., 1991). Therefore, in teaching situations, it is beneficial to use a mix of speech, discussions and non-verbal information such as images, videos and variation in body language (Ulriksen, 2016).

Description of documentation

For the purpose of this report, I read the qualitative and quantitative results of the course evaluations as of autumn 2017 and spring 2018. These evaluations were anonymized with regard to personal comments on teachers. I also interviewed associate professor Lene Buelund, who is course responsible, as well as a student who took the course before the interventions were introduced.

Later, the introduced interventions were assessed based on personal experience, a second interview with course responsible and written interviews with two students who took the course after the interventions had been implemented. The focus of these interviews were the students' opinions about their learning on the described course. Finally, the 1-minute evaluations written on the ultrasound checklists (introduced below) were also included in the assessment. In total, 10 checklists had been handed in.

Results

The course evaluations showed that students in general were positive about the Veterinary Imaging Course. However, as given in the introduction, there were many frustrations related to teaching and learning ultrasound. The main causes of frustration were:

- i. A general wish to learn more ultrasound than the course offers.
- ii. A need for theoretical preparation, such as a lecture introducing ultrasound images, machine settings etc. before practical exercises.
- iii. A need for more guidance when moving from theory to practice - there is a big difference in assessing images acquired by a skilled ultrasonographer versus producing and interpreting images on your own.
- iv. Difficulties setting the ultrasound machine correctly.
- v. Lack of structure during the practical exercises. Many students describe good teamwork, but issues using time efficiently. They have troubles planning their own time, such as splitting up in teams and mix theory and practice. Many students leave early.
- vi. Questions arise during scanning, but there is no teacher available to ask for help.
- vii. Observing teachers being busy with clinical work and writing reports makes some students feel less important. For example, one student wrote *“It seemed like there was very little time to explain things to us, because patients arrived. Then we were left on our own to just watch and try things on the dog we had brought”*.

The student who took the course the previous year also described frustration with the ultrasound exercises. Although she had tried to prepare well, she was in doubt about *how* to prepare and *what* to read. This student expressed an ambitious wish to learn ultrasound, but theory was overwhelming to her, and the gap between theory and practice felt huge. As a possible improvement she suggested that some kind of practical guide might help reduce this gap. Dr. Buelund confirmed many of the issues mentioned above. She said: *“There is a need for a theoretical introduction to ultrasound in the course and development of teaching material”*. Dr. Buelund had observed that many students came poorly prepared, and that students had difficulties working independently. *“However”*, she said, *“our students do learn a lot during the exercises, but unfortunately, they do not seem to be aware of their own progress”*.

To summarize, the student evaluations, the qualitative interviews and my own experience showed a strong agreement: There was a lack of theoretical introduction to ultrasound and difficult for students to perform independent practice. The students needed help to become better prepared, and more guidance to get going with the practical exercises. Equally important, there was a need to adjust the level of expectations before our students arrive to the exercises. Lastly the students need to be able to recognize their own progression along the course.

Description of interventions

A number of interventions were introduced in the course. The overall aim of these interventions was to cover the need for a theoretical introduction and to guide students when they move from theory to practice. Other aims were to help students prioritize their time during the exercises, monitor their own progress, and to encourage students to take responsibility for their own learning. Hopefully that can reduce the idea that they must have teacher to guide them.

Lecture covering ultrasound

The aim was to introduce ultrasound theoretically and prepare students for the practical exercises. The lecture covers 6 hours of teaching radiology and ultrasound of the abdomen. There are approximately 25 students at a time and the lecture is repeated eight times a year. The lecture includes learning goals, terminology and machine settings, followed by a section with case based teaching including a large number of normal and abnormal radiographs and ultrasound images. It also allows presentations of ultrasound videos mimicking real-time ultrasound scans. Moreover, the practical exercises are introduced and students are encouraged to prepare by reading the presented teaching material before and during the exercises. To stimulate learning, the lecture is organized with an overlap of constructivist and psychodynamic approaches (Dolin, 2013; Bada et al., 2015). To foster student activation and participation, a large number of case-based discussions are included during the day (Clark et al., 1991; Dolin, 2013; Wang et al., 2013). These cases encourage dialogue among students as well as between teacher and students.

Ultrasound teaching material

Lecture handouts: Most of the slides from the lecture are handed out in advance, so that machine settings, terminology and many examples of normal and abnormal ultrasound images are available to the students. However, most slides with cases does not show written image descriptions, to promote student discussions during class.

Compendium: A guide of 23 pages is handed out to the students before the lecture and practical exercises. This guide introduces the relevance of clinical ultrasound, describes machine settings and transducer manipulations. Relevant organs are described and normal ultrasound appearance of these organs are illustrated. This level of detail is in agreement with our interpretation of the expected day 1 competences for a Danish veterinarian according to the European Association of Establishment for Veterinary Education (EAEVE) (ECCVT, 2015).

Checklist: A checklist (Appendix A) with different tasks is handed out during the introduction to the practical ultrasound exercises. The purpose of this list is to clearly state what we expect from the students during the exercises, and to guide them through relevant teaching material, such as the compendium mentioned above. The list is also meant to help students prioritize their time, and to increase their feeling of being responsible for their own learning. Furthermore, the list is a way of monitoring progress at a personal level. Finally, in the checklist, students are asked to reflect on their own effort during exercises, and there is a 1-minute evaluation for students to fill in. Then the checklist is asked to be handed in to anyone in our staff.

Quick guide: A pictogram instruction (Appendix B) on how to prepare the patient, instructions on how to select a transducer, find relevant buttons on the ultrasound machine and show how to set these buttons.

Analysis and discussion of the raised question

During the time span of this project, I held the lecture three times and six groups of students had the practical ultrasound exercises. The checklist was only available to one of these groups, so the value of the checklist remains to be assessed. My personal experience was that the students participated actively in the case discussions and seemed engaged during the lecture and exercises. They also seemed to appreciate the new teaching material.

“It is now clear what our students can expect from the ultrasound teaching, what we as teachers expect from the students and what they achieve during the practical exercises”, Dr. Buelund said. To improve teaching further, Dr. Buelund mentions that we need to explore how additional ultrasound teaching can be added. *“But that is a complex matter, because it requires coordination with other courses that run parallel with ours”*, she says.

The two interviews showed that both students had markedly improved their knowledge and skills in the field of ultrasound. They both found the available teaching material useful, and both said that their own effort in the course had contributed a lot to their learning. Nevertheless, both students wished they had had a teacher available at least some of the time. This was also a wish among most of the checklist evaluations. One interview student said that although she was well prepared and had read all of the available material prior to class, she found it hard to move from theory to practice. Both students expressed that further training is needed for them to use ultrasound as a diagnostic tool. This is in line with our expectations as teachers – but obviously not the expectations of the students. Thus for future teaching, it seems relevant to highlight the *level of expectations*, for example by discussing expectations in the beginning of the group teaching (Horst et al., 2013). It has become clear that our students seem to expect to gain way better skills than the teachers expect them to have after only two days of training. As a comparison, many students accept that they cannot perform advanced surgery on their first day as a vet. However, many seem to expect that they can perform a diagnostic abdominal scan on day one.

From a practical point of view, the implementation of the described interventions was fairly straight forward. One challenge occurred when one group of students were re-scheduled, so that they had the ultrasound exercises *before* the ultrasound lecture. That was frustrating for them and for me as a teacher. But our discussions in class later showed that they had gained basic knowledge about ultrasound. Furthermore, the teaching material described in this report needs to be familiar to all of my colleagues in the section, because we may all engage with the students during their ultrasound exercises.

I was glad to experience that some students actually prepared for the lecture and the exercises. It is not my general impression that students come well prepared. My colleagues and I have even considered if it would be better to only teach ultrasound in theory, because unfortunately the frustrations that grow from the practical exercises often obscure the realization that stu-

dents actually do learn much. If we simply shortened the time available for scanning, I think frustrations would decrease. But so would the scanning skills of the students and that would contradict the EAEVE Day one competencies (ECCVT, 2015).

The independent format means that students gain ultrasound skills more or less on their own during the ultrasound exercises. We can see that our students gain a basic knowledge about ultrasound, and that their scanning skills are markedly improved after two days of practice and active learning. Despite this, the students are disappointed and want more guidance. This contradiction might partly express that they are not used to constructive teaching and independent work (Bada et al., 2015).

This report covers a limited time span for implementation of a re-organized lecture and new teaching material. But there are of course many possibilities for improvement in the future. A few alternative examples are Flipped Classroom, where lectures are given online in advance, and confrontation time is spent on problem solving activities (McLaughlin et al., 2014), or a mix of clinical demonstrations and online resources (Roshier et al., 2011).

This project shows that there is a continuous need to set the level of expectation among students before practical ultrasound exercises. The new lecture format and the new teaching material are valuable and useful, and can be improved continuously. But it has also become clear that some issues cannot be solved by simply improving the quality of teaching. The work load of the teachers as well as the students, is already high. More manpower would be needed to satisfy the students wish for one-on-one teaching. In this case, although the level of learning might be acceptable already, I think students are right: the two days of ultrasound exercises would be even better if a teacher was present to a greater extent.

Perspectivation

There is a clear interest for the topic of ultrasound among veterinary students. This can be considered a luxury in an academic education with an extensive curriculum (Hashizume et al., 2016). There might be a great potential in this interest if it can be allowed to flourish and lead to improved learning of ultrasound. It would be ideal to create a diagnostic imaging skills lab where phantoms and interactive video material are used as part of the ultrasound teaching. Other than reducing the time where live animals

must participate, practice in skills labs can improve skills and reduce anxiety among students prior to practice on live animals (Rösch et al., 2014; Langebæk et al., 2012; Carrig et al., 2001). For this to happen, however, more staff resources and funding would be required. Furthermore, the use of ultrasound already during practical anatomy lessons can be beneficial for learning, and might prime students for experience with ultrasound later on (Swamy et al., 2012).

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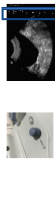


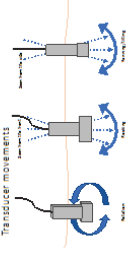




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A Ultrasound exercise checklist

<p>UNIVERSITY OF COPENHAGEN FACULTY OF HEALTH AND MEDICAL SCIENCES</p>  <h2 style="text-align: center;">Veterinary Imaging Ultrasound Exercises</h2>  <p>Name of student: _____</p> <p>Group number: _____</p> <p>Date and year: _____</p> <p>Attendance (full days): Day 1 <input type="checkbox"/> Day 2 <input type="checkbox"/></p>	<h3>Introduction</h3> <p>Welcome to Ultrasound! The aim of the ultrasound exercises is to strengthen your day 1 skills in veterinary diagnostic imaging. To perform ultrasound scans, you need knowledge both in <i>theory</i> and <i>practice</i>. During these two days you get a chance to practice both. To help you get through a mix of theory and practice, try to fulfil each of the bullet-points listed in this folder and check them off. The order of performance is irrelevant.</p> <h3>Day 1 competences</h3> <p>Read the Day 1 skills for veterinary imaging according to The European Association of establishments for Veterinary Education of Europe (EAEVE):</p> <ul style="list-style-type: none"> <input type="checkbox"/> <i>"Understand the contribution that imaging and other diagnostic techniques can make in achieving a diagnosis. Use basic imaging equipment and carry out an examination effectively as appropriate to the case, in accordance with good health and safety practice and current regulations."</i> <p>EAEVE states that you should be able to use "basic equipment". For ultrasound, it often takes a few years to learn how to scan well. In the beginning, it is difficult. But you can learn a lot in two days, if you spend your time well.</p> <h3>Theory</h3> <ul style="list-style-type: none"> <input type="checkbox"/> Read the compendium "Get going with abdominal ultrasound" (available on Absalon).
<h3>Knobology</h3> <p>The machine does not know which patient, organ, or area of interest you want to scan. Therefore, it cannot adjust the settings for you. In order to acquire images that are diagnostically useful, you need to adjust the basic settings of the ultrasound machine. And this goes for every single organ or region of interest! So, make sure you know <i>why</i> and <i>how</i> to adjust the following:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Frequency <input type="checkbox"/> Depth <input type="checkbox"/> Focus <input type="checkbox"/> Gain <input type="checkbox"/> Time Gain Compensation (TGC) <h3>Prepare the patient</h3> <p>Before scanning, you need to clip the coat. For a full abdominal scan, this means clipping from the xiphoid process, along the rib cage, along the lateral aspects of the abdomen and the inguinal region. If you are not allowed to clip the dog this much it is ok, but you then have to accept that it will be harder to perform the scan. This is because ultrasound beams usually cannot penetrate thick coat.</p> <h3>Transducer movements</h3> <p>When you scan, make sure you practice transducer movements. Identify any anatomical structure in the abdomen. As you scan, explore what happens when you perform:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Sliding <input type="checkbox"/> Compression <input type="checkbox"/> Rotation <input type="checkbox"/> Rocking <input type="checkbox"/> Fanning 	<h3>Practice scanning</h3> <p>Use the compendium "Get going with abdominal ultrasound" and the text books in the reference list, as you work your way through the following organs. Only tick of organs that you have found!</p> <ul style="list-style-type: none"> <input type="checkbox"/> Liver <input type="checkbox"/> Gallbladder <input type="checkbox"/> Spleen <input type="checkbox"/> Left kidney <input type="checkbox"/> Urinary bladder <input type="checkbox"/> Right kidney <input type="checkbox"/> Stomach <input type="checkbox"/> Duodenum <input type="checkbox"/> Jejunum <input type="checkbox"/> Ileum <input type="checkbox"/> Colon <h3>1 minute-evaluation</h3> <p>Spend 1 minute on writing your thoughts about ultrasound exercises, and submit this folder to the staff in the radiology section.</p> <ul style="list-style-type: none"> <input type="checkbox"/> Grade your own effort during the exercises on a scale from 1-10: _____ <input type="checkbox"/> How can we make the exercises better?

B Quick guide to practical ultrasound exercises

<p>Practical ultrasound exercises</p> <p>Gain practical ultrasound technology and diagnostic medicine information on the course</p> <p>Addressed to students in the 1st and 2nd years</p>	<p>Frequency range</p> <p>Each transducer has a range of frequencies. Select the frequency by clicking on the touch screen.</p> 	<p>Prepare the patient</p> <ol style="list-style-type: none"> 1. Clip the coat 2. Clean the skin with 70% alcohol 3. Gel! <p>Remember to wear gloves after gel!</p> 	<p>Depth</p> <p>When scanning, adjust the depth. The origin of interest should occupy about 2/3 of the screen. Depth is indicated by a red line on the right side of the screen.</p> 	<p>The ultrasound machine</p> <p>The machine screen is controlled by the touch screen with the set function.</p> <p>The lower screen is a touch screen.</p> 	<p>Focus</p> <p>Adjust focus number and position the blue correspond to your number. The focus number is indicated by a blue circle on the screen.</p> 	<p>Transducer movements</p> 	<p>Select a transducer</p> <p>Can be continued or linear transducers have different frequencies. Select the frequency that suits on the touch screen.</p> 	<p>Gain</p> <p>The gain will adjust the brightness of the image. The gain is indicated by a blue circle on the right side of the screen.</p> 	<p>Now practice your ultrasound skills!</p> <p>Before, in following, correct the focus, select the frequency, adjust the gain, and position the blue circle on the right side of the screen.</p> <p>Adjust setting depending on the organ of interest.</p> <p>The set number is given a number. The set number is indicated by a blue circle on the screen.</p> 	<p>When you are done for the day</p> <ul style="list-style-type: none"> ✓ Turn off the machine on the floor ✓ Wipe gel of the transducer with 70% alcohol ✓ Clean the gel with 70% alcohol ✓ Wipe gel of the skin with 70% alcohol ✓ Put gel and alcohol back in place 
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