Prepublication Manuscript: Equine Veterinary Education

Creating the Consummate Professional: Historical and Contemporary Perspectives

Stephen May, Royal Veterinary College, Hawkshead Lane, North Mymms, Hatfield, Hertfordshire, AL9 7TA

(Based on the BEVA John Hickman Memorial Lecture 2014)

The Fundamentals of a Profession

At the start we are faced with a perplexing paradox. All of Society and the profession itself have an interest in the well-being of the veterinary profession for the quality of our food, the disease status of this country and dealing with serious outbreaks of disease, as well as the health and welfare of our own livestock and the companion animals with which we share our lives. However, we should be under no illusions. It is highly unlikely that the veterinary profession would be created in its current form if it did not already exist. In our modern market economy it has been pointed out that "the acceptance of the authority of professional knowledge is a hard won cultural and political achievement, and one that is threatened in contemporary society" (Edgar 2011). And yet, the founders of our profession and their successors progressively accrued privileges to the veterinary profession, and latterly the veterinary nursing profession, based on the public good that we offered and that we continue to offer.

Fundamental to the arguments from the start have been the six key elements that together make a profession stand out from other lines of work (Thistlethwaite and Spencer 2008). These are: the presence of a skill based on specialist knowledge, the provision of specific education and training, the assessment of competence before entry to a profession, a register of members, adherence to a code of conduct, and, last but not least, the provision of a service for which the veterinary surgeon and veterinary nurse has a right to be paid but which is not focused on financial reward nor, in particular, on extracting the maximum fee possible from the client. As for medicine, arguments based solely on technical expertise are weak when it comes to any defence our privileged monopoly on animal care (Sullivan 2000). However, a broader focus on our services to and protection of the public, and their animals, has been recognised in achieving the recognition and reputation that the profession has earned, and we must all understand and be capable of arguing this if our profession is not just to survive, but thrive as we move forward. A central feature of this is all veterinarians being competent and up-to-date in their chosen area of activity, and fundamental to this is our initial clinical education and our continuing professional development (RCVS 2014).

Educational Expertise

One of the problems with education is that we all think we are experts and in many ways we are. However, often our "expertise" is heavily biased by our own experience. We have often rationalised after the event and we can easily mislead ourselves into drawing outrageous conclusions about education with no sound evidence base, a process that we would be ashamed to use if we were working on a clinical problem. We are also easily seduced by popular myths promoted through the media (see box 1). Therefore, recognising the importance of the quality of veterinary education for us all, and the requirement for an evidence-based approach, we need to

establish valid criteria for judging what constitutes good educational design for taught programmes and what constitutes effective and efficient teaching. However, in order to create these criteria we also need to understand what is required of the modern veterinarian and how we learn as human beings. What do the public and our clients expect? What do we, as veterinarians, think we should be providing, and what about the nature of the learning process can be used to help achieve these goals?

Requirements of the Veterinarian

The legitimacy of the veterinary profession depends on a balance between a societal need - a public good - and a service, that is met by our profession and its members. This is a "social contract" in the Hobbesian sense (May 2013a), where we collectively give up some of our freedoms to have anyone treat animals, and in particular if you are not a vet, to treat them yourself, for the guarantee that we can have a quality service from those whom we give the powers to treat. However, this is not a static relationship; it is dynamic, with society's needs and expectations changing as it evolves and our knowledge and skill increase, and it is important for the profession to adapt in response to this (Enticott et al 2011). At the outset of the veterinary profession, 250 years ago, our founders were exercised by the quality of care they received for their horses (Mitsuda 2007). Various gentlemen who started to collect and publish what was known about the diagnosis and treatment of diseases in the horse recognised a huge variation between the farriers of the time which included those who tried to apply the most up-to-date knowledge and empirically improve on their approaches based on response to treatment, and those who were charlatans engaged in quackery (eg Smith 1917). Progress was individual where it occurred, and not easily communicated, so those who founded the first veterinary schools were keen that up-to-date knowledge should be learned and used by graduates of early courses to assure a common standard of care for their horses. There were debates from time to time about student selection and who made the best candidates to receive veterinary education (eg Veritas 1828), but essentially for the first 200 years of the profession, education was about the transmission of the most up-to-date knowledge of veterinary science and medicine, and its sale to clients keen to receive the latest treatments for their animals' ailments.

The focus on the professional as the repository of specialised knowledge, changed dramatically in the 1990s with the development of the internet and dramatic change in knowledge availability (Tan 2000). For over a millennium, university libraries had been the repositories of knowledge and universities the disseminators, with their graduates selling knowledge as a commodity. With the internet, knowledge was accessible by all, with increasing ease, so the professional role has increasingly shifted to us acting as guides to a better educated and knowledgeable public wanting help in discriminating between the good material and the quackery. We who were once mini-repositories for remembering and accessing "the truth" for dissemination now much more play the roles of judges – the arbiters of the quality of the many different approaches that are advocated. In IT and software development, a "killer application" is one that beats all its competition, and judgement has been described as the killer application of the human brain (Tulgan 2001). Computers can store more information and undertake mathematical calculations more rapidly than our brains, but uniquely we can assemble pieces of information from a current case, our past experience, our reading and our discussions with colleagues, and reach decisions based on sound judgements in the interests of our clients (Proctor et al 2011).

Clinical Reasoning

Central to our capacity to make sound judgements is clinical reasoning. It is core to everything we do; the multiplicity of problems that we face on a daily basis. And yet until recently it has been poorly understood, and not specifically taught. We have assumed that it is a skill that our students pick up as they go through their clinical programmes but horrifyingly many have not (May 2013b). Clinical reasoning is not classical hypothetico-deductive scientific reasoning. Scientific reasoning starts with an hypothesis, and works backward from the solution to see if based on the solution predicted elements are present. Clinical reasoning is an inductive process, and works forward from a problem to see if the elements that the clinician identifies can be combined to obtain an answer. From the signs of the disease, you work out the probability of the cause. Scientific reasoning focuses on areas that can be researched with current research methods. Clinical reasoning deals with problems as they present, which as we know may be atypical presentations or in some cases new diseases for which there may not be tests or if there are these may be uneconomical for us to use. A source of confusion over what constitutes good clinical reasoning has been an association between "pattern recognition" and forward reasoning, and analytical approaches and backward reasoning (May 2013b). It is important that all clinicians are analytical when they need to be, particularly when faced with difficult and important decisions. Therefore, a better distinction is between pattern recognition and analytical reasoning which can either use forward reasoning when we are in clinical mode or backward reasoning on occasions when we are conducting a scientific study.

The logical approach to clinical reasoning involves a systematic move from the observations to the cause, at the same time as controlling the amount of information with which the clinician has to deal, through "clustering" of related signs. The ability to understand the meaning of clinical signs, to cluster related signs into mental representations, and to link these to systems and the associated pathology, is the hallmark of the successful clinician. In contrast those with diagnostic difficulties, both students and qualified doctors, were stuck with the details, the facts of the case, and struggled to relate these (Auclair 2007, Bordage 2007). Crucially this type of forward analysis leads to the development of so-called illness scripts (Schmidt et al 1990, Custers 2014) which we then use for future pattern recognition and comparisons, in contrast to scientific reasoning that does not (Sweller 1988). Pattern recognition is our memory of a problem already solved (Croskerry and Norman 2008). It is accurate and gets us through our busy work days, but there is just one problem. When we see a pattern that we think fits, we tend not to check because we are "cognitive misers" (Stanovich 2009). We like to achieve solutions with the least effort, so once we think we have the solution we stop.

This problem with applying patterns where they do not completely fit also exercised the Scottish physician Sir Arthur Conan-Doyle, and he built it into his famous character Sherlock Holmes. One example is the dog that did not bark, in the short story Silver Blaze. The authorities think they have solved the case, but "the curious incident of the dog in the night time" meant that for Sherlock Holmes the pieces did not fit. As "the dog did nothing in the night time", the case must have been an inside job, by someone that the dog knew; the man the police had identified could not have been the culprit. That should lead us to the conclusion that when we use expert pattern recognition, which can be "more accurate than novice first principles approaches", we must be alert to "the dog that did not bark". We need to overcome our cognitive miserliness and engage in first principles, analytical approaches, in complicated problems (Coderre 2003, Norman 2009). We know that, even for students, this type of "combined reasoning", used to "triangulate" our first impression based on the pattern, is more accurate than the use of one or the other reasoning method by itself (Ark et al 2006, 2007).

The Nature of Learning

Having recognised the requirement for the modern, consummate professional to be adept at reasoning and decision-making, alongside their technical and non-technical skills, we need to consider the type of learning that can best achieve this. For students to really understand and practically apply what they are being taught, it is important to actively engage them in thinking about their subject, and this can happen if there is space in a curriculum for active learning, with students working individually in their own time and in groups on solving problems and taking appropriate actions (Biggs 1999, Prince 2004). However, the enemy to all this is content, and in particular content overload (Ramsden 2003, Parsell and Bligh 1995). In 2013 it was estimated that there were 672 Exabytes of information on the internet, equivalent to more than 12 million times the information in all the books that have ever been written. It was possible, in the 17th and 18th centuries, for men like Athanasius Kirchner (Findlen 2004) and Thomas Young (Robinson 2006) to be described as men "who knew everything". But there is no way that a human being can achieve anything like this in the modern era. We are saturated with information from all directions so that, if we are not careful, we are so overloaded that our ability to make sound judgements is compromised (Naish 2009). More information is not always better. We struggle with multiple alternatives, whether it is a decision over the purchase of a car (Rey et al 2009) or a decision about the initiation of treatment before referral (Redelmeier and Shafir 1995). You need enough information about a problem to be able to come to the best answer (Norman 2009). However, too much information, far from improving your answer, is more likely to lead to "paralysis by analysis" (Gladwell 2006, Croskerry et al 2014). Too much information also means that we give up on understanding what we are hearing or reading and struggle just to remember it (Perkins 1995, Ruohoniemi and Lindblom-Ylanne 2009), so even our most interested and motivated students can be crushed into submission and resort to rote learning for exams, if they can succeed through this route.

Criteria for Good Educational Design and Effective Teaching

Greater understanding of the process of learning means that a fundamental principle of veterinary course design must be that we go way beyond a narrow focus on content. In the past, this was decided by individual teachers ("the experts"), or departments, who filled "lecture slots" on a "just-in-case" basis! A student might one day need to know about a virus that only affects one species of zebras. The main planning issue for those who once engaged in this type of curriculum design was how to fit more in (Halliwell 2006). It is essential that room is made for thinking time and space for the development of non-technical skills, such as reasoning and communication, and technical skills that are so essential for the modern graduate (Nelson 1999). A key preliminary stage for medical and veterinary schools was to move to a culture where the curriculum was owned, and a much more restricted core of knowledge agreed, by representatives of the whole school, so that a skills development orientation could be taken, and the whole programme managed in a co-ordinated and integrated way (Harden 2000). This was important for four key reasons: firstly, because we all know that there is very little time for learning at first degree level and subsequently in our careers. Secondly, because the content focus tended to lead to the very mistaken view that teaching is equivalent to learning; only a fraction of what is taught in a traditional curriculum is learned and remembered (Nelson 1999, Custers 2010)). Thirdly, because this content and teaching focus tended to lead to assessment as an afterthought, making it often inappropriate for the required skills and driving students to libraries and rote-memorisation to the exclusion of all the practical skills that we want them to master (Heath 2006). And fourthly, because leaving decisions up to experts reveals two blind spots in their thinking. The first relates to the difficulty that an expert has deciding what is appropriate for an undergraduate curriculum, and the way they confuse day one

with more advanced knowledge and skills (Welsh et al 2009), and the second expert blindness is that although eventually most content focused teachers can be persuaded that we teach too much, their thinking is sometimes not consistent. At a workshop linked to the development of the RVC 2007 curriculum, academic staff were asked two questions: whether overall we taught too much and whether they themselves taught too much. Helpfully, 76% of those present thought we taught too much, but only 38% agreed that they taught too much. This expert focus on detail, together with their confusion over skills levels, means that no-one can have a veto on decisions in their own area.

Outcomes Based Curricula

The essential place to start to discuss and agree content for a modern curriculum and appropriate modes of its delivery is not by thinking about inputs but rather thinking about what comes out, by defining learning outcomes – the skills that we expect a student to achieve on graduation, including so-called Day 1 Skills, and map classes to these. Crucially, this requires input from all quarters – generalists, specialists, recent graduates and animal interest groups to ensure an appropriate balance. Even feedback from recent graduates is quickly affected by their practice destinations, with those in small animal practice forming the view that the old RVC curriculum devoted too much time to equine practice and not enough to small animals, and those in equine practice the view that too little time was spent on equine matters and that there was no need for more small animal teaching (Kinnison and May 2013).

In addition, a powerful way of driving appropriate student activity and learning for the good is to ensure we employ valid and reliable assessments linked to our learning outcomes. There is a truth in the aphorism “they do not respect what you expect, they respect what you inspect”, which is demonstrated in the way in which assessment drives student learning (van Mook et al 2009). As we have seen, in previous generations, veterinary educators focused on content and assessments were almost an afterthought based on written and traditional examinations that had poor validity for reasoning and practical skills, and in the case of orals in particular, very poor reliability (Wakeford et al 1995). Therefore, the modern curriculum needs to be designed backwards. Collectively, society, and we in particular, need to define the important learning outcomes, core and elective in different species, choose valid and reliable assessments for each outcome, and design active learning experiences that support students in achieving these outcomes (Taylor 2009).

Vertical and Horizontal Integration

Once the content has been defined around the skills required, a big question then is how it is organised. Traditionally, in the so-called Flexnerian curriculum with its preclinical/clinical divide (Parsell and Bligh 1995), the “ologies” dominated the early years, looking at, for instance, an infective organism and its consequences rather than a clinical disease and its causes. This led to a “pivot point” in the middle of the course where instead of learning that, say, Salmonella made an animal sick and caused enteritis, students had to be able to view an animal with enteritis and work forwards to a cause. For many students this was a huge challenge, literally turning their knowledge and notes around to approach everything from the opposite direction. Students were further challenged by the need for them to integrate anatomy, physiology, biochemistry, pathology and pharmacology.

A typical modern programme picks up on this and either through PBL or more traditional approaches establishes major themes around the individual and groups of animals that are revisited on a spiral basis (Harden 1999). Traditional disciplines are integrated horizontally on a systems basis, and, through vertical integration, science is placed in a clinical context to help students build mental frameworks that carry right through from first to final year. In parallel the curriculum develops and distinguishes between scientific, clinical and ethical reasoning skills, supported by appropriate learning skills where these are necessary. At an early stage leadership and teamworking skills are introduced to support interprofessionalism and underpin later business content. And last but not least communication is developed from basic to advanced levels (Radford et al 2003, 2006).

Classroom to Clinic Bridges

Increasingly, with the development of busier clinics filled with complex technologies, the clinical environment has become potentially challenging and intimidating for many students (Baillie et al 2010). The transition directly from the theory of the classroom to the practice of the clinic, with the outdated notion that students should immediately be able to apply what they had learned, had become stressful, an enormous challenge for many, and so more and more students failed to take advantage of the multiple opportunities for learning offered by authentic cases and case material. Modern curriculum design has allowed educators to provide classroom to clinic bridges in the form of clinical skills classes, using models and simulations, for technical skills such as rectal examination for colic diagnosis (Baillie and Rendle 2008), and observation and technical skills in lameness diagnosis (Starke et al, in preparation), and case-based reasoning classes to develop a logical approach to clinical problem solving (May 2013b).

With the recognition of the importance of bridging classes, the modern integrated curriculum has allowed, for the first time, a much more structured approach to sequential skills development. Over hundreds of years in music, and similarly in other areas, such as sport, systems were developed to take the novice, such as a violin player, from a fumbling student to an accomplished solo performer (Ericsson 2009). Working back from learning outcomes involving whole cases, as curriculum designers we can take a reductionist approach to the level of a core procedure and the individual techniques that contribute to that procedure. We can then teach from the techniques in the clinical skills laboratory, through the procedure back to the full case management across the years of the integrated curriculum (May and Head 2010).

As well as technical skills, this works well in the crucial area of communication (Latham and Morris 2007). None of us any longer expects a professional adviser to tell us what they are going to do or what we should do with the expectation that we will take that on trust. We want to understand their judgements and advice, and consent to any actions in an informed way. This means that our communication skills, which experienced practitioners have always recognised are one of the main ways in which our clients judge us as veterinarians, are of even more crucial importance than they were in the past. We need to be able to speak the language of medicine to colleagues and clients from the health professions, the language of science to many of our well-educated clientele, and simpler forms of language to children about their small pets and adults with special needs about their animals. Veterinarians and veterinary nurses need to judge the level and check that their communications are intelligible to the client; they need to recognise that certain contexts, such as high stakes encounters involving the breaking of bad news, can mean that nothing is taken in by a client; they need to understand that if an owner does not understand why a course of action has been chosen, that person is much less likely to give the treatment, particularly if it is difficult to administer.

John Hickman was responsible for the only explicit teaching on this that I remember receiving in my veterinary programme. He told us in a lecture on lameness: "If it looks complicated, do not rush in and imply to an owner that you can cure their animal. If you fail they will judge you a failure. Tell them that it is 'a cripple', and that you might be able to help. Then if you fail, well, it was 'a cripple', but if you succeed, they will consider you a remarkable person!"

Professional Responsibility

So far, we have focused on direct reasoning about problems and taking action. However, more and more, with increasing varieties of options for treatment, from gold standard through silver to bronze, there is a division between what technically can be done, what economically may be achievable and what should be done. The resolution of this requires skills of synthesis of competing priorities and metacognitive skills – the ability to think about your thinking, and whether your conclusions are reasonable in all the circumstances - and also the ability to recognise our own limitations and if we can not handle a particular case who is best able to deal with it on behalf of our client.

A clinical case may not respond and may even die despite treatment for all sorts of reasons. Yet some graduates believe that they should have known all the answers, and if a case goes badly, it is somehow a failure on their part. If, after four, five or six years of education, our students still see all problems as black and white, and if an animal dies, or if a client decides against the gold standard treatment they advise, they have failed, then their teachers have done them a large disservice. In particular, they will struggle to negotiate their early years in practice and may ultimately leave the profession or take it out on themselves in terrible ways. In so many areas it is easy to fall into the trap of judging the quality of a decision by the outcome. If this is poor, we assume the decision must have been at fault. Therefore, alongside their veterinary care knowledge and technical and non-technical skills, one aspect of professional education in the modern curriculum must be about the reasonable expectations our clients can have of us, our colleagues can have of us and we can have of ourselves, in terms of how good is "good enough" when it comes to our practice and how many hours we need to devote to our professional lives in the day. Once more, we know that older curricula missed this, with a terrible cost to some. There is a balance that must be achieved in terms of altruism and service.

The Learning Environment and the Teacher

Although for veterinary schools, and universities in general, the teacher is frequently the last piece of the jigsaw to be considered in the complex, modern learning environment, the teacher, their training and their understanding of their role, should really be the first. Here we have another paradox that despite the most important factor in what the student learns being what they do, consistently the individual teacher comes out as the most important source of variance in student achievement (Rowe 2002). The teacher is key to ensuring effective and efficient educational delivery, and yet we know that teachers can drive poor learning practices. The reason for this is that best laid plans can be undermined sometimes deliberately but often unknowingly by those tasked with their delivery. This has come to be known as the hidden curriculum (Hafferty and Franks 1994, Whitcomb 2014). We can have our intended outcomes for the consummate professional that we have discussed, and we can create our intended curriculum. However we then depend on its correct interpretation and delivery by the teacher, in an environment that is conducive to the type of learning that we want, and its appropriate receipt by our engaged student. If this goes wrong the received curriculum is not what was originally conceived, and our intended outcomes are replaced by unintended outcomes. For instance, despite research demonstrating that a combined reasoning approach is best for students, some clinicians told RVC students that pattern recognition was dangerous and only experts should use it. Sadly, as a

consequence, finding themselves using it automatically, which we all do, some students were in denial and desperately trying to teach themselves not to do it (Tomlin et al 2008).

So, as a synthesis of over 800 meta-analyses has shown (Hattie 2009), it is important that we impress upon teachers that it is the way in which the teacher supports effective learning through problem solving teaching, the sequencing and deliberate practice of the well-designed curriculum, as well as feedback and formative evaluation, and the encouragement of students to reflect and think about their own learning that leads to the best outcomes. Teaching is the most demanding of all the roles of the academic. It requires a form of dual processing that means as well as being focussed on the task we need to be paying attention to student performance and the characteristics of the student as a learner. This allows the teacher to decide on the appropriate way of instructing a particular learner and also when they should intervene (Wood et al 1976, Dolmans et al 2005).

Teachers who are student focused and keen to impart concepts and develop their students thinking will have an impact on those who are prone to memorisation and reduce their tendency to this superficial approach. In contrast teachers focused on teaching and information transmission will negatively impact deep learning for understanding and drive students to memorisation whatever the structure of the curriculum (Trigwell et al 1999). This student centred approach fostering deep learning for understanding as opposed to memorisation of facts, which has also been called a preference for complexity, is important not only for the quality of veterinary graduates, but also their continued engagement in learning (Dale et al 2010). We all expect and want to be confident that the doctors teaching us are up-to-date, and similarly our clients expect the veterinary professionals to be equally up-to-date in areas where they require expertise. The preference for complexity, or learning for understanding, carries forward into later life with those who are intrigued by problems and enjoy discovering new information being more motivated to undertake CPD and perceiving fewer barriers to their participation. So at the start, our curricula and those who deliver these sow the seeds for a lifetime of professional engagement that will help determine how well each individual fulfils their responsibility to, and bargain with, society.

Teachers also need to recognise that as students develop they start to really appreciate the value of feedback and its central role in their learning. They see it as helping them to know the standards that they must achieve and also their own performance in relation to that standard and how they can improve, and they are often frustrated that staff do not always value it to the same extent and therefore frequently fail to supply feedback in the form and with the frequency that students need (Sands and May, in preparation). Good feedback is first and foremost about performance and ways to improve, but with inexperienced teachers it can easily degenerate into compliments. A study on the simple task of knot tying revealed the relative ineffectiveness of just telling someone how clever they are, in comparison to direct feedback on their performance. However, compared to the performance score, the satisfaction score was the opposite way around – so your overall satisfaction with an educational programme is not necessarily a good measure of how beneficial it has been for you – a lesson for us all about satisfaction surveys and so called “happy sheets” for course feedback (Boehler et al 2006).

In an attempt to improve the quality of feedback given by a group of clinicians in hospital wards, Connell and colleagues (1999) identified different levels of teacher questioning and discussion with students that seemed to correlate with different levels of quality in the student responses and thinking. Training and encouragement of clinical teachers to engage more with students, to try to understand how they were thinking and the uncertainties that they might have, stimulated more higher order thinking by the students.

Conclusions

In this paper I have tried to take us on a journey together. We have looked at the origins of the veterinary profession, and the social contract which underpins our legitimacy. In exchange for our conscientious service to society, we have a privileged (though not uncontested) monopoly in the diagnosis and treatment of animals. We have seen how information has moved out of libraries, where it was largely the domain of academics and the professionals that they trained, into cyberspace so that it is now everywhere and much more available to all. We have recognised the consequences of this for professionals, who two hundred years ago were employed largely as sources of knowledge and now are employed much more for their reasoning skills and ability to make sound judgements. At the same time, I hope, we have recognised that we can not know everything, and the negative effects of too much information on learning. So we have considered the migration away from filling student heads with information just-in-case one day they might need it to equipping students with the skills to source information on a just-in-time basis, when it is needed (Williams 2007).

We then moved on to the imperative for much better curricula to replace the old so that we can deliver in an efficient and effective way, through integrated programmes and sequencing and bridging skills development, the best graduates possible. We considered as part of our education, and the developing professional identity of the veterinary graduate, the need for that person to recognise what can reasonably be demanded of them and what they can reasonably demand of themselves. Finally, as the last piece of the jigsaw, we considered the vital place of training of our teachers if all this is going to work and our students our going to realise their full potential as the consummate professionals that society demands and that we want to provide.

I hope that at least some of this will make you think of what is best for your own learning and development as a professional, and longer term for the future education of our profession. That way both as individuals and as proud members of the veterinary profession, we can ensure that we provide the best possible advice to our clients and their animals and secure a bright future for our profession, remembering in the words of Alice Hamachek that “Consciously we teach what we know, unconsciously we teach who we are”.

References

Ark, T. K., Brooks, L. R., & Eva, K. W. (2006). Giving learners the best of both worlds: do clinical teachers need to guard against teaching pattern recognition to novices? Academic Medicine : Journal of the Association of American Medical Colleges, 81(4), 405–9.

Ark, T. K., Brooks, L. R., & Eva, K. W. (2007). The benefits of flexibility: the pedagogical value of instructions to adopt multifaceted diagnostic reasoning strategies. Medical Education, 41(3), 281–7.

Auclair, F. (2007). Problem formulation by medical students: an observation study. BMC Medical Education, 7, 16.

Baillie, S. & Rendle, D. (2008). A Virtual Reality Simulator for Training Veterinary Students to Perform Rectal Palpation of Equine Colic Cases. In *International Meeting for Simulation in Healthcare, San Diego, USA*.

Baillie, S., Pierce, S. E., & May, S. A. (2010). Fostering integrated learning and clinical professionalism using contextualized simulation in a small-group role-play. Journal of Veterinary Medical Education, 37(3), 248–53.

Biggs, J. (1999). What the Student Does: teaching for enhanced learning. Higher Education Research & Development, 18(1), 57–75.

Boehler, M. L., Rogers, D. a, Schwind, C. J., Mayforth, R., Quin, J., Williams, R. G., & Dunnington, G. (2006). An investigation of medical student reactions to feedback: a randomised controlled trial. Medical Education, 40(8), 746–9.

Bordage, G. (2007). Prototypes and semantic qualifiers: from past to present. Medical Education, 41(12), 1117–21.

Coderre, S., Mandin, H., Harasym, P. H., & Fick, G. H. (2003). Diagnostic reasoning strategies and diagnostic success. Medical Education, 37(8), 695–703.

Coffield, F., Moseley, D., Hall, E., & Ecclestone, K. (2004). Learning styles and pedagogy in post-16 learning: A systematic and critical review. London: Learning and Skills Research Centre.

Connell, K. J., Bordage, G., Chang, R. W., Howard, B. A., & Sinacore, J. (1999). Measuring the promotion of thinking during percepting encounters in outpatient settings. Academic Medicine, 74(10), S10–S12.

Cook, D. A., Levinson, A. J., Garside, S., Dupras, D. M., Erwin, P. J., & Montori, V. M. (2008). Internet-based learning in the health professions: a meta-analysis. The Journal of the American Medical Association, 300(10), 1181–96.

Croskerry, P., & Norman, G. (2008). Overconfidence in clinical decision making. The American Journal of Medicine, 121(5 Suppl), S24–9.

Croskerry, P., Petrie, D. A., Reilly, J. B., & Tait, G. (2014). Deciding About Fast and Slow Decisions. Academic Medicine : Journal of the Association of American Medical Colleges, 89(2), 197–200.

Custers, E. J. F. M. (2010). Long-term retention of basic science knowledge: a review study. Advances in Health Sciences Education : Theory and Practice, 15(1), 109–28.

Custers, E. J. F. M. (2014). Thirty years of illness scripts: Theoretical origins and practical applications. Medical Teacher, 1–6.

Dale, V. H. M., Pierce, S. E., & May, S. A. (2010). The Importance of Cultivating a Preference for Complexity in Veterinarians for Effective Lifelong Learning. Journal of Veterinary Medical Education, 37(2), 165–171.

Dolmans, D. H. J. M., De Grave, W., Wolfhagen, I. H. A. P., & van Der Vleuten, C. P. M. (2005). Problem-based learning: future challenges for educational practice and research. Medical Education, 39(7), 732–41.

Edgar, A. (2011). Professional values, aesthetic values, and the ends of trade. Medicine, Health Care, and Philosophy, 14(2), 195–201.

Enticott, G., Lowe, P., & Wilkinson, K. (2011). Neoliberal reform and the veterinary profession. The Veterinary Record, 169(13), 327–9.

Ericsson, K. A. (2009). Discovering deliberate practice activities that overcome plateaus and limits on improvement of performance. In A. Willamon, S. Pretty, & R. Buck (Eds.), International Symposium on Performance Science (pp. 11–21). Utrecht, The Netherlands: Association Europienne des Conservatoires Academies de Musique at Musikhochschulen.

Findlen, P. (2004). Athanasius Kircher: The Last Man Who Knew Everything. London: Routledge.

Gladwell, M. (2006). Blink. London: Penguin.

Hafferty, F. W., & Franks, R. (1994). The Hidden Curriculum, Ethics Teaching, and the Structure of Medical Education. Academic Medicine, 69(11), 861–871.

Halliwell, R. (2006). Whither Veterinary Education—Have We Lost Our Direction? Journal of Veterinary Medical Education, 33(3), 309–316.

Harden, R. M. (1999). What is a spiral curriculum? Medical Teacher, 21(2), 141–3.

Harden, R. M. (2000). The integration ladder: a tool for curriculum planning and evaluation. Medical Education, 34(7), 551–7.

Hattie, J. A. C. (2009). Visible Learning: A Synthesis of Over 800 Meta-Analyses Relating to Achievement. Abingdon, Oxfordshire: Routledge.

Heath, T. (2006). The more things change, the more they should stay the same. Journal of Veterinary Medical Education, 33(2), 149–54.

Kinnison, T., & May, S. A. (2013). Veterinary career ambitions correlate with gender and past experience, with current experience influencing curricular perspectives. The Veterinary Record, 172(12), 313.

Latham, C. E., & Morris, A. (2007). Effects of formal training in communication skills on the ability of veterinary students to communicate with clients. Veterinary Record, 160, 181–186.

May, S. A. (2013a). Veterinary Ethics, Professionalism and Society. In C. M. Wathes, S. A. Corr, S. A. May, S. P. McCulloch, & M. C. Whiting (Eds.), Veterinary and Animal Ethics (pp. 44–58). Oxford: Wiley-Blackwell.

May, S. A. (2013b). Clinical reasoning and case-based decision making: the fundamental challenge to veterinary educators. Journal of Veterinary Medical Education, 40(3), 200–9.

May, S. A., & Head, S. D. (2010). Assessment of technical skills: best practices. Journal of Veterinary Medical Education, 37(3), 258–65.

Mitsuda, T. (2007). The equestrian influence and the foundation of veterinary schools in Europe , c . 1760-1790. eSharp, 10(Supplement), 1–20.

Naish, J. (2009). Warning: brain overload. Times Online, (2 June).

Nelson, C. E. (1999). On the Persistence of Unicorns: The Trade-Off between Content and Critical Thinking Revisited. In B. A. Pescosolido & R. Aminzade (Eds.), The Social Worlds of Higher Education: Handbook for Teaching in a New Century (pp. 168–184). Thousand Oaks, California: Pine Forge Press.

Norman, G. (2008). Effectiveness, efficiency, and e-learning. Advances in Health Sciences Education : Theory and Practice, 13(3), 249–51.

Norman, G. (2009). Dual processing and diagnostic errors. Advances in Health Sciences Education : Theory and Practice, 14 Suppl 1, 37–49.

Norman, G., Dore, K., & Grierson, L. (2012). The minimal relationship between simulation fidelity and transfer of learning. Medical Education, 46(7), 636–47.

Parsell, G. J., & Bligh, J. (1995). The changing context of undergraduate medical education. Postgraduate Medical Journal, 71, 397–403.

Pashler, H., Mcdaniel, M., Rohrer, D., & Bjork, R. (2008). Learning styles: Concepts and evidence. Psychological Science, 9(3), 105–119.

Perkins, D. (1995). The Alarm Bells. In Smart Schools: Better Thinking and Learning for Every Child (pp. 19–42). New York: The Free Press, Simon and Schuster Inc.

Prince, M. (2004). Does Active Learning Work? A Review of the Research. Journal of Engineering Education, 93(July), 223–231.

Proctor, A., Lowe, P., Phillipson, J., & Donaldson, A. (2011). Veterinary field expertise: using knowledge gained on the job. The Veterinary Record, 169(16), 408–10.

Radford, A., Silverman, J., & Turner, R. (2006). Development, Teaching, and Evaluation of a Consultation Structure Model for Use in Veterinary Education. Journal of Veterinary Medical Education, 33(1), 38–44.

Radford, A., Stockley, P., Gaskell, C., Taylor, I., Turner, R., Kaney, S., Humphris, G. & Magrath, C. (2003). Use of simulated clients in training veterinary undergraduates in communication skills. Veterinary Record, 152, 422–427.

Ramsden, P. (2003). Learning to Teach in Higher Education, 2nd edition. Abingdon, Oxfordshire: Routledge. p59.

RCVS (2014). Code of Professional Conduct for Veterinary Surgeons. London: Royal College of Veterinary Surgeons.

Redelmeier, D. A., & Shafir, E. (1995). Medical decision making in situations that offer multiple alternatives. Journal of the American Medical Association, 273, 302–305.

Rey, A., Goldstein, R. M., & Perruchet, P. (2009). Does unconscious thought improve complex decision making? Psychological Research, 73(3), 372–9.

Robinson, A. (2006). The Last Man Who Knew Everything. London: One World Publications.

Rosen, C. (2008). The Myth of Multitasking. The New Atlantis, (Spring), 105–110. Accessed on 18 July 2014 from http://www.thenewatlantis.com/publications/the-myth-of-multitasking

Rowe, K. J. (2002). Issue Analysis: The Importance of Teacher Quality. Issue Analysis No 22, (22), 1–12.

Ruohoniemi, M., & Lindblom-Ylanne, S. (2009). Students' experiences concerning course workload and factors enhancing and impeding their learning - a useful resource for quality enhancement in teaching and curriculum planning. International Journal for Academic Development, 14(1), 69–81.

Schmidt, H. G., Norman, G. R., & Boshuizen, H. P. A. (1990). A Cognitive Perspective on Medical Expertise: Theory and Implications. Academic Medicine, 65, 611–621.

Smith, F. (1917). The Early History of Veterinary Literature and its British Development. Journal of Comparative Pathology and Therapeutics, 30, 277–310.

Stanovich, K. E. (2009). The Thinking that IQ Tests Miss. Scientific American Mind, 20(6), 34–39.

Sullivan, W. M. (2000). Medicine under threat: professionalism and professional identity. CMAJ : Canadian Medical Association Journal = Journal de l'Association Medicale Canadienne, 162(5), 673–5.

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. Cognitive Science, 12(2), 257–285.

Tan, O. S. (2000). Reflecting on Innovating the Academic Architecture for the 21st Century: A Singapore Perspective. Educational Developments, 1(3), 8–11.

Taylor, R. M. (2009). Defining , constructing and assessing learning outcomes. La Revue Scientifique et Technique de l'OIE, 28(2), 779–788.

Thistlethwaite, J., & Spencer, J. (2008). Professionalism in Medicine. Abingdon, Oxfordshire: Radcliffe Publishing.

Tomlin, J. L., Pead, M. J., & May, S. A. (2008). Veterinary Students ' Attitudes toward the Assessment of Clinical Reasoning Using Extended Matching Questions. Journal of Veterinary Medical Education, 35(4), 612–621.

Trigwell, K., Prosser, M., & Waterhouse, F. (1999). Relations between teachers' approaches to teaching and students' approaches to learning. Higher Education, 37(1), 57 – 70.

Tulgan B. (2001). Winning the Talent Wars. London: Nicholas Brealey. p37.

Van Mook, W. N. K. A., van Luijk, S. J., O'Sullivan, H., Wass, V., Schuwirth, L. W., & van der Vleuten, C. P. M. (2009). General considerations regarding assessment of professional behaviour. European Journal of Internal Medicine, 20(4), e90–5.

Veritas (1828). Qualifications for a veterinary surgeon. The Veterinarian 1:134–138.

Wakeford, R., Southgate, L., & Wass, V. (1995). Improving oral examinations: selecting, training, and monitoring examiners for the MRCGP. British Medical Journal, 311(7010), 931–935.

Welsh, P. J. K., Jones, L. M., May, S. A., Nunn, P. R., Whittlestone, K. D., & Pead, M. J. (2009). Approaches to defining day-one competency: A framework for learning veterinary skills. La Revue Scientifique et Technique de l'OIE, 28(2), 771–777.

Whitcomb, T. L. (2014). Raising Awareness of the Hidden Curriculum in Veterinary Medical Education: A Review and Call for Research. Journal of Veterinary Medical Education, 1–6.

Williams, P. J. (2007). Valid knowledge: the economy and the academy. Higher Education, 54(4), 511–523.

Wood, D., Bruner, J. S., & Ross, G. (1976). The role of tutoring in problem solving. Journal of Child Psychology and Psychiatry, 17(2), 89–100.

Box 1

Popular Myths in Teaching and Learning

Myth 1

"Individual students have different approaches to learning. An effective teacher must take individual learning styles into account."

Educational research evidence fragmentary and unconvincing, and in some cases completely contradicts this concept (Coffield et al 2004, Pashler et al 2008).

Myth 2

"Modern students are highly effective multi-taskers." It has been said that "children growing up might have an associative genius that we don't".

Multitasking leads to a fall in IQ, stress and long term health problems, and even a reduced ability to use the various pieces of information we learn in the process of multitasking (Rosen 2008).

Myth 3

"E-learning has clear and consistent advantages over alternative approaches. Today's students learn better in a virtual environment."

All teaching produces learning and online learning is not better than traditional methods (Cook et al 2008). The one area where it may outperform is through an increased efficiency for the delivery of facts (Norman 2008).

Myth 4

"Successful simulations must closely resemble the real world (authenticity, high fidelity) to assure successful transfer to the work situation."

High fidelity simulators are no better than low fidelity where they have been compared in areas such as auscultation, critical care or surgical skills (Norman et al 2012).