Important Concepts in Veterinary Education

Scaffolded Active Learning: Nine Pedagogical Principles for Building a Modern Veterinary Curriculum

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Introduction

One of the main challenges facing Deans and other educational leaders in veterinary schools is a lack of confidence of highly qualified clinicians and scientists in engaging in evidence-based improvements in the design and delivery of modern curricula. In the absence of such skills, veterinary teachers tend to default to the familiar which are often the methods that they, themselves, experienced, however critical of these they may have been at the time (Lane, 2007). In addition, those with inquiring minds, who seek to explore the evidence base, may find themselves intimidated by a plethora of advice and learning theories, supported by qualitative evidence, which is unfamiliar territory for those with an academic background in a quantitative discipline (Kandlbinder & Peseta, 2009; Onyura et al., 2015).

This article is meant for all who have looked at the evidence, and then backed away. It is intended as a guide to nine important and interlinked pedagogical principles that have been and are being used in the development of new curricula in Australia, the United Kingdom, and the United States. It is particularly aimed at teachers who have become engaged in curriculum committees, either involved in developing completely new curricula or revising existing curricula, although it should also benefit those involved in delivery of individual classes to aid understanding of the part they play in achieving the overall aims of a professional program.

(1) Outcomes-Based Curriculum Design

"Begin with the end in mind."

S R Covey 1989

Historically, the starting point for most teachers was the content of a curriculum – what needed to be taught (DiCarlo, 2006; Spady, 1988). This approach makes the teacher feel good in terms of

discharging their duty to the learner but it is based on two fundamental fallacies that have always hampered educational processes – teaching is not synonymous with learning (Klionsky, 2004), and the possession of knowledge of an area does not guarantee the ability to perform in that area (Mazur, 2009). The importance of focusing on outcomes of curricula rather than inputs was first pointed out by Spady (1988) in relation to North American high school and elementary programmes. He proposed that course designers "work backwards" compared to conventional practice, which tended to start with teaching and content followed by an assessment which was related to the teaching. He suggested that a much more logical approach would be to look at the skills required – the outcomes – and work backwards from these to the required learning (Harden, Crosby, & Davis, 1999). Once the full range of outcomes appropriate to a veterinary professional curriculum is identified (NAVMEC, 2011; RCVS, 2014), valid assessment methods can be related to these outcomes to verify their achievement. In a modern curriculum, appropriate outcomes are much more than scientific knowledge and technical skills, including communication, collaboration, management, leadership, and cultural awareness (NAVMEC, 2011). From the outcomes and the assessment, it is clear to students what they must achieve to qualify, and this focuses both students and teachers on the support they need to facilitate appropriate learning.

A cultural problem for those advocating an outcomes-based approach is that this model is alien to those whose view is content-driven. If subject matter is seen as the most important factor in the design of a class, "learning outcomes are meaningless" (Morcke & Eika, 2009). Over the past 100 years, this has led to a constant tussle in clinical education, over the last 100 years, between those focussed on outcomes and skills development and those focused on content (Christakis, 1995). This may finally be resolved in the 21st century with the paradigm shift created by the internet age in the sourcing and availability of information (Tan, 2000). An outcomes focus helps identify essential, underpinning knowledge and helps create priorities for inclusion of content, an essential task now that it is abundantly apparent that the curriculum cannot include everything (Harden et al., 1999; Summerlee, 2010).

(2) Valid and Reliable Assessments

> "From our students' point of view, assessment always defines the actual curriculum."
>
> P Ramsden 1992

The focus on content to be learned as well as a lack of clear linkage of assessment to defined learning outcomes meant that assessments evolved that measured knowledge and were cost-

effective in terms of their delivery. Inevitably, these were written tests, which were easily administered and made reliable (May & Head, 2010; Miller, 1990). However, the modern student is very assessment-driven (Rust, 2002; Wass, Vleuten, Shatzer, & Jones, 2001), and is thus guided more by the nature and content of tests than curriculum descriptions of what should be learnt and teacher exhortations in the interest of their classes. Far from promoting the knowledge, skills and attitudes required for successful practice, preparation for these knowledge focused, written format types of examinations often takes students out of practical classrooms and clinics into libraries to cram themselves with facts for regurgitation and subsequent forgetting (Halliwell, 2006; Welsh et al., 2009).

It is clear that the range of knowledge and skills required by the modern clinical graduate is not captured by a single assessment type (Schuwirth, 2004), and, in particular, that technical skills cannot be assessed through written formats (Newble et al., 1994). Increasingly, medical and veterinary schools are using a variety of assessment formats that collectively target core knowledge, scientific and clinical reasoning and decision-making, and practical skills (Baillie & Rhind, 2008). In particular, multiple choice questions (MCQ) and short answer questions are used to assess core knowledge (Schuwirth & van der Vleuten, 2004) "spot tests," involving a set of stations that may include anatomic, pathological, diagnostic imaging and other types of materials, to test observation skills; various clinical scenario formats, including extended matching questions with an extended range of optimal answers (usually 10) (Tomlin, Pead & May, 2008), long answer problem-solving questions (Schuwirth & van der Vleuten, 2004), and script concordance tests (Cobb, Brown & Hammond, 2015), to assess scientific and clinical reasoning; research projects to assess information sourcing, understanding of scientific methods, analytical and written communication skills (Weller & May, 2013); Objective Structured Clinical Examinations (OSCEs) and Direct Observations of Procedural Skills (DOPs), using rubrics to record and grade procedures on real patients, to test technical skills (Wilkinson, Crossley, & Wragg, 2008); and integrated assessments, focused on behaviors and attitudes during clinical rotations, to assess responsibility and professionalism (Turnbull, Gray & MacFadyen, 1998; Dudek & Dojeiji, 2014).

(3) Active Learning

"So far as the mere imparting of information is concerned, no university has had any justification for existence since the popularization of printing in the fifteenth century."

A N Whitehead 1929

Historically, in line with their content focus, many university courses, including veterinary medicine, were lecture-dominated and based on teacher-centred, transmission models of learning (Whitney, Herron, & Weeks, 1993). While a small proportion of students do reflect and theorise during and after a didactic lecture, the vast majority spend most of their time note-taking for subsequent memorisation (Biggs, 1999). This also contributes to the accumulation of "fragile knowledge" that is reproducible in an examination, but, as it is not integrated with the student's personal knowledge, not useful for application in the other contexts for which it is intended (Perkins, 1995). Active learning (Prince, 2004) of various types is now used in a variety of disciplines to promote "deep" as opposed to "superficial" (Marton & Saljo, 1976, 1997), "transformational" as opposed to "reproductive" (Biggs, 1976) and "adaptive" as opposed to "adoptive" (Roach, Blackmore, & Dempster, 2001) learning. Active learning is a term used to cover all teaching formats that involve student engagement. These include a broad range of formats that target analysis, reflection, and problem solving, known as directed learning exercises and discussion classes. They also include team-based and individual projects, and the group of practical classes that includes dissections, laboratory practical classes, clinical skills center exercises and patient-associated activities. A humbling truth for all teachers is the fact that "what the student does is more important in determining what is learned than what the teacher does" (Shuell, 1986).

(4) Integrated Knowledge for Action

"Science is built with facts as a house is with stones. But a collection of facts is no more science than a heap of stones is a house."

H Poincaré 1905

The recognition of the problems associated with traditional, transmission models of teaching and the need to engage the student actively in their own learning led to a very different approach in some institutions which came to be known as problem-based learning (PBL) (Berkson, 1993; Whitney et al., 1993). Medical students explored scientific concepts in the context of clinical cases, and, rather than being provided with a framework of knowledge, established their own learning objectives for categories of knowledge which need to be sourced for the understanding and ultimately solution of clinical challenges (Wood, 2003). The original suggestion was that students developed a superior personal knowledge base, through self-structuring and co-construction with other students, better reasoning skills through solving the problems which provided the context for their learning and improved ability in independent (lifelong) learning (Berkson, 1993). In fact, the interest stimulated through the cases at the heart of PBL does seem to lead to superior integration

of the knowledge that is acquired (Dochy, Siegers, Van Den Bossche, & Gijbels, 2003); however, the superior problem-solving ability has not been convincingly demonstrated (Newman, 2003).

Despite the undoubted pedagogical merits of the pure PBL model, it has not become the universal approach to clinical education. In part this is related to the relatively limited length of the clinical degree (four years for graduate entry; 5-6 years for high school entry), and restricted resources and expertise to support this type of programme. To ensure acquisition of core knowledge and take advantage of the benefits of context-related problem-solving, veterinary curriculum developers have developed models that, collectively, might best be described as "Scaffolded Active Learning". Core knowledge is provided through framework lectures and context-related problem-solving can be supported through exercises such as case-based directed learning, and elaborated through self-directed learning (Jaarsma et al., 2009; May, 2008). The intention is that the interest stimulated by context-related problem solving, and the associated active learning, will build on framework knowledge to allow personal and integrated knowledge construction in a way that is similar to but more efficient than PBL. Together with instruction in scientific and clinical reasoning, it is intended that case-based directed learning will promote effective problem solving, which can then be further developed through clinical skills classes and in the clinics themselves as "integrated knowledge" that supports rational judgments and actions (May, 2013).

(5) Tightly Controlled Core Curriculum

Information overload has "nothing to do with wisdom and everything to do with aimless accumulation…it leads down the same desolate road in every field."

P Ramsden 1992

The enemy of deep learning in every discipline is content overload (Ramsden 1992, Christakis 1995). Therefore, it is important that the framework lectures are kept to a number that allows time for self-directed reflection and additional learning, to permit meaningful integration of new knowledge and skills into each student's personal knowledge and skills base. In the past, some of this "debulking" of curricula was illusory, with more efficient delivery through lectures, lecture handouts, and virtual learning environments concealing continued excessive factual learning demands by clever timetabling (May, 2008). An analysis of all their learning materials and delivery systems side by side is the first step in permitting schools to exert content control. A comprehensive curriculum map allows the prioritization of material for inclusion to achieve genuine content reduction (Jaarsma et al., 2009). Clear priorities based on outcomes are important and likely to focus on three key

inclusion principles: clinical theory and skills relevant to the Day One Competences (Welsh et al., 2009), together with any other externally imposed subject benchmarks, and essential underpinning basic science in support of clinical theory and skills. The balance between these two themes may vary between schools, depending on the emphasis chosen by faculty for their particular curriculum and the expertise of those involved in its delivery. However, the achievement of the full set of Day One Competences by every new graduate, to ensure informed and safe practice, must be paramount in all discussions on inclusion or exclusion of content in relation to intended learning outcomes and a recognition of areas of duplication and omission. Linking this prioritized and refined list to previously agreed direct student contact time (which may be determined both by culture and by discipline) then allows the school to validate, in a rational manner, a complete professional program. There is evidence of an association between student learning and staff contact time. Too little fails to engage students in independent learning, but above the optimal weekly contact, every increment in contact time is matched by a proportional decrease in student personal study (Schmidt et al., 2009).

(6) "Just in Time" rather than "Just in Case" Knowledge

"Knowledge is of two kinds. We know a subject ourselves, or we know where we can find information on it."

S Johnson 1709-1784, quoted in Boswell's Life of Johnson

The continued, rapid expansion of veterinary knowledge, combined with the tightly controlled core knowledge of the modern clinical programme, makes it important that students and clinicians are efficient at sourcing and evaluating the quality of new information. This is a key skill for constructing their own personal repositories of knowledge at university, as well as professional lifelong learning following graduation (Regan, 2005; Wales, 2000). Previous transmission-focused curricula involved the teacher taking sole responsibility for verifying the quality of information and supplying knowledge "just-in-case" students might one day require it. There is still evidence that the effects of this eminence-based approach to professional education persist in our clinical practice today (May, 2012). This was more acceptable when knowledge was "relatively static", and these "just-in-case" stories could be applied at some unknown future date. However, likely redundancy has removed any justification for the "just-in-case" approach beyond core concepts which can act as frameworks for knowledge sourced on a "just-in-time" basis in response to a specific challenge (Tulgan, 2001; Shetzer & Warschauer, 2000). Hand in hand with "just-in-time" sourcing is "just-in-time" application. In addition to recognizing any new knowledge and skills that they require, veterinarians must,

through practice, become versatile and adept at adapting this knowledge and these skills to the problem contexts that they face.

(7) Vertical Integration, the Spiral Curriculum and Sequential Skills Development

"… curriculum is like water, it has a tendency to seek the lowest level of energy it can reach, and without constant renewal, it will stagnate and become putrid."

Watson et al 1998

"The solution which I am arguing is to eradicate the fatal disconnection of subjects which kills the vitality of our modern curriculum. There is only one subject matter for education, and that is Life in all its manifestations."

A N Whitehead 1929

Historically, curricular design amounted to allocation of a specific proportion of available time to each separate discipline, allocation by academic heads of department of their timetable space to individual members of staff and the filling of lecture and practical classes with material at each individual's discretion. This resulted in duplication, omission, and a lack of progress in skills development as the emphasis tended to be on content relevant to a discipline, which, in each subsequent module, was replaced by content relevant to another discipline at a similar level (Harden, 2000; May, 2008).

For any curriculum to be maximally effective, it is essential that it is controlled at school level and that central course designers work together with discipline experts to ensure appropriate sequencing of content, lack of duplication and omission, and progressive skills development. At its most sophisticated, this involves horizontal integration of traditional disciplines, and vertical integration of basic sciences and clinical material, in a spiral arrangement that means that themes are revisited in order for them to be continually developed and reinforced over the duration of the programme (Harden, 1999). Consideration can be given to the best placement of difficult concepts, both clinical and basic science. Simple concepts and practical techniques traditionally taught at the clinical end of a program can thus be integrated in the early years, alongside preliminary exposure to the clinics, and complex concepts in basic sciences can be moved into later parts of the program, when students are better able to cope with these. Traditional curricula followed the Flexnerian model, with a marked preclinical-clinical divide (Parsell & Bligh, 1995). There was a "pivot point" in the middle where students literally turned their knowledge upside down and instead of working

from cause to signs started to work from signs to cause. By teaching basic sciences in a clinical context, learning outcomes, assessment and teaching are "constructively aligned" (Biggs, 1996). This allows modern curricula to emphasise clinical reasoning throughout, and build knowledge and skills more logically. For instance, in relation to critical thinking, scientific and clinical reasoning, and technical skills, it is possible to work backwards from outcomes to individual elements (May & Head, 2010). These can then be sequenced through the programme so that students initially learn individual techniques (e.g. suturing, ligation), move on to clinical procedures (e.g. ovariohysterectomy), and finally take responsibility, under supervision, for whole cases (involving pre- and post-procedure decision-making and communication).

(8) Learning Skills Support

"Memorisation is what we resort to when what we are learning makes no sense."

Anonymous

Many students entering veterinary school from a variety of educational backgrounds, both graduates and high school leavers, demonstrate relatively dependent learning styles. Active learning is not easy, and demands considerable student effort to match that of teachers and facilitators to maximise student outcomes. Particularly for students whose approaches to learning are less mature, it has been recognised, through the work of Vygotski and Bruner, that it is important that the transition from dependent to more independent learner is "scaffolded" in the early years (Grow, 1991; Wood, Bruner, & Ross, 1976). Veterinary schools can address this in various ways: students can be introduced to the basic principles of effective learning through the general educational literature on this subject; effective group work can be modelled by careful choice of early directed learning exercises which focus on problem solving and teamworking; first year directed learning classes can be staffed by greater numbers of facilitators to ensure all group and individual questions and needs are recognised and addressed; and academic tutorials and seminars in the first two years can incorporate a strong focus on student progress in developing high level concepts of learning (Ashwin, 2005). Teachers have a central role in managing this motivation of the students' approach to learning, and it is important that they receive appropriate developmental support to adapt their teaching approach to the year(s) of the program with which they are engaged (Grow, 1991).

(9) Bridges from Classroom to Workplace

"If there were only one truth, you couldn't paint a hundred canvases on the same theme."

P Picasso 1966

A particularly difficult transition for medical and veterinary students is that from the classroom to the workplace (Hell, Kuks, Schoenrock-Adema, Lohuizen, & Cohen-Schotanus, 2008; Prince, Van De Wiel, Scherpbier, Can Der Vleuten, & Boshuizen, 2000). Historically, as already noted, this involved students converting knowledge in one format (basic science, causal agent approach) to knowledge in a completely different format (clinical science, presenting signs approach), as well as an abrupt emergence from a relatively "safe" learning environment to one subjected to constant time pressure, where slowness and errors were barely tolerated as a result of their potential impact on patient safety. Most recently, the change of veterinary hospital caseloads to a predominance of secondary and tertiary material, and the added sophistication of the diagnostic and therapeutic techniques routinely applied to patients, have potentially exacerbated the situation.

As schools modernise their curricula, they are going to considerable lengths to develop a relevant range of professional and technical skills "in vitro" before students enter the clinics. This includes developments such as clinical skills laboratories (Baillie, Pierce, & May, 2010), and formative OSCEs in which students gain feedback on their performance. This approach helps students to be confident in their grasp of the essential techniques before they enter the hospitals and clinics. It is also important that students recognise that clinical problems and their solutions are rarely "black-and-white" (Knight & Mattick, 2006), conforming to classic textbook cases. Every case is individual and every situation will require an answer specific to its needs. Through newly introduced professional skills modules, students can be led to understand how to cope with uncertainty and variety, and tailor their service to individual patient and client circumstances.

Conclusion

"…teaching is the unique and central mission of institutions of higher learning…not just an addendum to research."

S E Dicarlo 2006

In the last century veterinary programmes had to evolve and adapt to match the changing nature of the profession, and its increasingly well-informed science base. It is likely that this was never easy, given the innate conservatism of universities and their faculty, but as the nature of the work of the general practitioner changed much of this involved deletion of old, redundant content and replacement with new. For instance, lengthy courses on material medica and making up medicinal products made way for more teaching on small animals as the pharmaceutical companies started to supply expanded ranges of proprietary medicines and small animal overtook large animal practice as a proportion of the practitioner's work (May, 2015). However, the veterinary degree more than ever has become the initial qualification for a variety of veterinary professions, including multiple specialist clinical routes as well as in increasing variety of non-clinical careers. This has made it more challenging for curriculum designers to produce the ideal veterinary degree to suit the needs of modern society. Therefore it is important that those with this responsibility understand the essential skills required by the modern veterinary graduate, whatever their ultimate career destination, and the principles of learning that will support the development of this individual and their capacity for sound judgement based on high quality reasoning, scientific and clinical, and rational decision making. Inevitably this will involve a degree of differentiation in both knowledge beyond the core and the precise practical skill set possessed by each individual as they graduate. However, it is likely that the ability to tackle completely novel problems in both individual animals and groups of animals, through sourcing and adapting knowledge from a variety different areas, on a daily basis, will remain common to those who share this important qualification in comparative medicine and health. These nine interlinked pedagogical principles (figure 1) are offered as a sound evidence base for designing a curriculum and taking difficult decisions on what to teach, and more importantly what not to teach, in a 21st century veterinary programme.

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