Comparison of teaching paradigms in theriogenology among schools of veterinary medicine by use of a uniform assessment tool

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Abstract

Information regarding specific teaching methodologies in theriogenology was provided by 18 North American and Caribbean schools. At least one student each from 12 of those schools completed an on-line, multiple-choice assessment tool and provided demographic information; 45 students were included in a regression analysis comparing score on the completed assessment with various parameters. None of the specific parameters evaluated had a statistically significant association with score, including presence or absence of tracking in the curriculum; course structure; contact hours in lecture or laboratory; or availability of active learning, hands-on laboratories, or training using models. Primary source of variance was the individual student.

Keywords: Education, theriogenology

Introduction

The field of veterinary medicine is undergoing significant change as sophistication and cost of medical care rise and number of patient visits declines, leading to decreased income and reduced salaries even as changes in state funding of veterinary colleges drive rising tuition and greater student debt.[1,2] Many veterinary colleges have undertaken curriculum review and revision with an eye toward greater efficiency of teaching to minimize rising costs of education and control increasing tuition costs for students. This has led to changing paradigms in teaching modalities used in various disciplines and, some suggest, may be associated with changing faculty population, as maintaining a cadre of highly specialized faculty members may not be as cost-effective for colleges as employing faculty members who are willing to provide entry-level training both within and outside of their field of specialty.

There also is a greater trend toward student-centered learning, with recognition that true learning is the student's responsibility and is facilitated by good instruction. Principles of good instruction include encouraging contact between students (peer learning and group work) and between students and faculty, giving prompt feedback, recognizing and promoting different ways of learning, and engaging students in discipline-specific critical thinking.[3,4] Students must be comfortable with general knowledge and skills before they are expected to demonstrate knowledge and competence in discipline-specific skills.[5] Attention must be paid to students' need to learn both information (declarative knowledge) and skills (procedural knowledge). Similarly, attention must be paid to cognitive, emotional or attitudinal, and physical needs of the learner. One author suggests that brick-and-mortar universities may be replaced by on-line learning unless we can create value for learners in face-to-face interactions, by focusing less on reciting content to students and concentrating more on application of content and higher level cognitive processing, and development of intellectual curiosity and other professional attributes of learners.[6] If we are helping them grow into professionals in our field, we have to help students recognize that their knowledge and skills are bounded by the arts of problem solving, implementation, and improvisation, and to permit them to practice manipulation of knowledge and skills to develop that artistry of practice.[7]

In theriogenology training, lectures and live-animal laboratories have been the norm for decades. Lectures are an efficient way of explaining complex material to a large group of students at one time. Concerns about lectures are that students are passive, not active learners, and that the lecture is teacher-centered, not learner-centered.[8] There are many ways to make these large-group teaching sessions more active for the learners, better engaging their attention and enhancing their learning and retention.[9-13] However, lectures are best used for helping students achieve cognitive and perhaps attitudinal objectives, not for acquisition of psychomotor skills.

Laboratories with live animals or use of samples directly collected from those animals are excellent for helping students gain competence in psychomotor skills but are less good for helping students achieve cognitive or attitudinal competencies.[8] Hands-on work should promote development of understanding of information presented prior to the laboratory and acquisition of procedural skills.[14] Learners of all ages, but particularly adult learners, value authentic experiences and live-animal laboratory training is the ultimate authentic pre-clinical experience available in veterinary training.[15] Individualization of instruction and distribution of practice with student reflection and feedback from instructors over time should enhance ability of students to achieve competence.[14,16] Laboratories permit students the opportunity to practice skills in a safe environment by working with teaching animals instead of client-owned animals, while still working within the confines of safe and humane animal handling guidelines. However, maintaining teaching animals is expensive and teaching of laboratories is labor-intensive for faculty.

Determination of what is core content is part of what guides course and curriculum development. The American College of Theriogenologists (ACT) established a core curriculum for all species (Appendix 1). A survey of practicing veterinarians from across North America verified which components of this core curriculum were absolutely key for general practice by species and better defined which content and opportunities for practice were best made available to students while still in veterinary school.[17] Procedures defined as most valuable in large animal practice were transrectal palpation and dystocia management, and in small animal species were vaginal cytology assessment and dystocia management. The group of practitioners surveyed felt that they had been presented with the necessary content as students but not to the extent required for competence prior to graduation, especially for large animal skills. Other concerns brought forward were lack of exposure to small animal theriogenology training in general at many colleges and lack of follow-through on the effect of tracking during veterinary school on subsequent performance of graduate veterinarians.

There is ongoing concern regarding what is the best overall teaching paradigm for theriogenology instruction as veterinary schools make economic decisions that may impact student learning and competence in this discipline as graduate veterinarians. There also is growing pressure from non-veterinarians, who provide aspects of theriogenology service for animals that may be permitted by the veterinary practice act in some states because there is a perceived or documented lack of availability of suitably skilled veterinarians to perform the work.[1]

In this study, student achievement on a set of multiple-choice questions covering all species and topics in theriogenology as defined in the core curriculum was used to evaluate teaching paradigms at participating veterinary colleges. Hypotheses are the following: (1) Students from institutions with theriogenology programs mandating focus on at least two species will have higher scores than those with species-focused programs, (2) Students from institutions with dedicated boarded faculty members and residency or graduate student training will have higher scores than those with limited theriogenology programs, (3) Number of required contact hours will be positively correlated with student scores, (4) Students who take required didactic courses in all species will have higher scores than students who take required species-specific courses or only have elective didactic multi-species courses available to them, (5) Students from institutions that teach theriogenology as a stand-alone discipline will have higher scores than those with integration of theriogenology material into medicine or surgery courses, (6) Students who are exposed to active learning methodologies will have higher scores than those in traditional lectures, (7) Students with practical experience in the form of hands-on laboratories with a given species will have higher scores for questions in that species than students without hands-on experience, (8) Students trained using alternate models (simulations) will have higher scores by species than those without models, but will have lower scores than those with live-animal laboratory experience in that species, and (9) Students at schools that do not track will have higher scores than students from schools that track.

Materials and methods

This study protocol was evaluated and approved by an Institutional Review Board. A teaching survey was generated to address hypotheses as described above and to repeat collection of information gleaned from the survey previously described (Appendix 2).[18] The survey was sent to faculty liaisons of the Society for Theriogenology (SFT) at all North American and Caribbean veterinary schools (n=35).

Multiple-choice questions were solicited from members of the Teaching Educators in the SFT and ACT. Questions were edited for grammar and formatted for uniformity. One hundred questions were chosen to represent the species and topic distribution of the core curriculum (Appendix 1). Answers were written for all questions explaining the correct and incorrect foils (Figure). The questions were posted on a Moodle site hosted at the University of Minnesota and student access was set up as anonymous guest accounts; investigators had access to basic demographic data and an email address for each participant but no personal information was collected. Fourth-year students from all schools that completed the teaching survey were invited to participate through their faculty liaisons, and reminders sent to those faculty liaisons to pass along to their students every two weeks. The site was made available in early September, when students traditionally begin study for the North American Veterinary Licensing Examination (NAVLE) and remained open through the first NAVLE testing window, closing in late December. Students were incentivized to participate by a drawing for an iPad mini™ from email addresses of all students who attempted all 100 questions and got at least 70% correct. Students could come and go from the testing instrument as they chose and were not given guidance regarding whether or not they could or should use outside resources. As students completed answering a given question, the correct response would be displayed to give them instant feedback and enhance their learning.

To assess relationships between each variable and student score, mixed models were used, with a random effect for school, using the score as a response and each variable as a predictor. One score was a significant low outlier (4.34 standard deviations below the mean). Because all student entries were anonymous, the investigators could not contact the student to determine if this was a true score, reflecting lack of ability despite significant effort by the student in completing the assessment, or a false score, reflecting lack of student effort. The investigators chose not to include this outlier in the statistical analysis so as not to generate spurious results. Significance was set at $p < 0.05$.

Results

Theriogenology teaching

Complete surveys were received from 18 schools (51.4% response rate). Participating schools were Atlantic (Prince Edward Island), Auburn, Colorado, Florida, Georgia, Guelph (Ontario), Louisiana, Minnesota, North Carolina, Ohio, Oregon, Pennsylvania, Purdue, Ross, Tuskegee, Washington State, Western (Saskatchewan), and Wisconsin. Total enrollment at participating schools ranged from 224 to 900, with a mean enrollment of 413 +/- 164 students (mean +/- SD; n=14).

Six schools (33%) did not allow tracking at any point in the curriculum. Of the other 12 schools, one offered tracking beginning in the first year, eight in the third year, and three in the fourth year of the curriculum. Tracks available included small animal, equine, bovine or food animal, mixed, and other (exotics, wildlife, public/corporate, research/public health); not all tracks were available at all schools. In general, the small animal track was most subscribed, with the highest percentage of students in this track at eight schools and an overall mean percentage of 44 +/- 20%. Percentages for the other tracks were 10 ± 7% for equine, 9 ± 5% for bovine/food animal, 22 ± 15% for mixed track, and 10 ± 15% for other tracks.

Number of faculty members board-certified in the ACT or equivalent foreign specialty college averaged 4 ± 2, with a range from 1 to 10. Number of residents in programs approved by the ACT averaged 1 ± 1, with a range from 0 to 3. Seven of the responding schools had no resident in training at the time of this survey. Nine of the schools with residents reported that their residents were in a combined residency/graduate degree program; only one resident from these schools was not in such a program. The other two schools with residents reported that those residents were completing residency training only. Number of dedicated theriogenology graduate students averaged 1 ± 1, with a range from 0 to 4. Thirteen of the responding schools had no theriogenology graduate students.

Schools were asked to self-report areas of emphasis, with six options to choose from (dairy, beef, swine, small ruminant, equine, small animal). Only two schools reported emphasis on all six options.

Two schools reported emphasis on all options but swine. Two schools reported emphasis on all but swine and small ruminants. One school reported emphasis on all but swine and beef cattle. Seven schools reported emphasis on three options; all reported emphasis on dairy cattle and horses. Two schools reported emphasis on only two options; horses were emphasized at both schools. Two schools did not report areas of emphasis.

Four schools reported that all information related to theriogenology, including reproductive biology, clinical theriogenology didactic and laboratory teaching, and clinical rotations, was taught by individuals board-certified in theriogenology. Eleven schools reported that reproductive physiology was taught by faculty members outside of theriogenology. Other areas in the curriculum taught by non-theriogenology faculty included food animal laboratories (5), food animal rotations (4), small ruminant rotations (4), surgery (2), small ruminant laboratories (2), exotics clinical rotations (2), exotics laboratories (1), small animal clinical rotations (1), and equine rotations (1).

There was great variability in number or required and elective lecture hours by discipline or species (Table 1). Reproductive biology and physiology was taught exclusively in first year at seven schools, exclusively in second year in six schools, and exclusively in third year in one school. Reproductive physiology training was spread across several years in four schools. The remaining schools did not report when in the curriculum this content was presented. Species-based theriogenology lectures were taught exclusively in second year in two schools and exclusively in third year in nine schools, and were spread across several years in six schools. One school did not report when in the curriculum this content was presented.

All responding schools stated that theriogenology was taught as a stand-alone discipline, with five schools stating that some theriogenology content also was presented in medicine, surgery, and production courses. For required lecture courses, 14 schools presented theriogenology content in a comparative course and two schools covered theriogenology content scattered through systems courses. For elective lecture courses, 14 schools presented theriogenology content by species and one school provided comparative content. Fourteen schools provided content specific to herd health, with number of hours of content ranging from 3 to 50. Several schools noted that this was hard to quantify as material was presented across many courses in the curriculum. All schools reported time spent on small animal genitourinary disease in the curriculum with 11 schools reporting discussion of this content in theriogenology and medicine courses. Fourteen schools reported that no theriogenology text was required. Of those schools requiring a text, it was reported that few students actually purchased that text. Materials were made available for later review by students at 15 schools; specific materials provided included taped lectures, narrated PowerPoint presentations, and podcasts. Most schools reported that they also provide notes as hard or electronic copies. Active learning, defined as provision of course materials to encourage student engagement as a means of enabling them to understand and encode new knowledge, was provided at 11 schools with specific examples including use of cases (individual or group work) and use of audience response systems. Active learning generally was reported to be very instructor-dependent and number of hours of time spent in active learning was not well reported by the schools. No school reported use of the Qualifying Examination available through the National Board of Veterinary Medical Examiners as a tool to determine student readiness for pre-clinical training.

There was great variability in number or required and elective laboratory hours by species (Table 2). Laboratories were offered exclusively in second year by one school, exclusively in third year by eight schools, and across several years by six schools. The other schools did not report in which years of the curriculum laboratories were offered. Live animal laboratories were available for students at all schools except one. Of 14 schools reporting which species of animals were available for live-animal laboratories, all 14 reported availability of horses, 13 of cattle, 9 of dogs, 7 of small ruminants/camelids, and 3 of pigs. Thirteen schools (72%) reported that all students had an opportunity to learn transrectal palpation on either cows or horses, although it was not required at all schools. Hours available in the curriculum for practice to refine transrectal palpation skills was variably reported, with some schools providing contact hours and others providing number of laboratories or clinical rotations. Seventeen schools (94%) reported that all students completed a canine or feline ovariohysterectomy in the first three years of the curriculum. One school reported that 90% of students completed an ovariohysterectomy, and one school reported that less than 10% of students completed this in the first three years but that all students at that school performed ovariohysterectomy as a requirement during the fourth year. Schools generally reported that no students or very few students had an opportunity to participate in a cesarean section in any species in the first three years of the curriculum.

Eleven of 18 schools (61%) reported using models or simulators in laboratories for theriogenology training. Models described included excised reproductive tracts (fresh or frozen/thawed) (6), dead calves (2), and use of the Breed N Betsy model (2).

Clinical rotations were required for all students or required for students within specific tracks at 12 schools. A comparative rotation was required at nine schools, with some schools also requiring species-specific rotations, depending on student track. Species-specific rotations were the sole requirement at two schools. Elective rotations were available at 11 schools. Fourteen schools (78%) offered a comparative rotation, 12 schools offered a food animal rotation, 11 schools offered an equine rotation, and 10 schools offered a small animal rotation. Other services on which students may see theriogenology cases included large animal ambulatory, small animal medicine, large animal medicine, shelter medicine, small animal surgery, large animal surgery, food animal/ruminant rotation, general or community practice, emergency, swine rotation, poultry rotation, and production medicine.

A theriogenologist was routinely called to consult on medical or surgical cases involving the reproductive tract that were not transferred to/maintained by the theriogenology service at 17 schools; one school does not maintain a teaching hospital or clinical outreach services. Reproductive emergencies (dystocia, postpartum disease, testicular/scrotal disease, pyometra/metritis) were seen by the theriogenology service at those same 17 schools, with 16 schools reporting seeing emergencies in horses, 14 in cattle, 8 in small ruminants and camelids, and 7 in small animals.

Fifteen schools reported on the percentage of students that completed an ovariohysterectomy in a dog or cat during their fourth year. Mean percentage was 94% (± 10%) with a range from 70-100%. Percentage of students that participated in a cesarean section during their fourth year was extremely variable, with most schools reporting that 10% or less of students would participate in a cesarean section in any species. Students were most likely to participate in a cesarean section in a cow.

Schools were asked to describe student participation in extracurricular activities. Fifteen schools (83%) hosted a student chapter of the Society for Theriogenology. Other student clubs in which students might gain theriogenology experience included agricultural animal club, bovine club, canine club, diagnostic imaging club, equine club, farm animal club, food animal club, orphan kitten project, palpation team, production animal medicine club, Student Initiative for Reservation Veterinary Services, and the student chapters of the American Animal Hospital Association, American Association of Bovine Practitioners, American Association of Equine Practitioners, American Association of Feline Practitioners, American Association of Small Ruminant Practitioners, and American Veterinary Medical Association. Average number and range of lectures and laboratories available by species was variable. Mean number of lectures and laboratories offered annually in cattle was 9 ± 8, in horses was 3 ± 2, in small animals was 2 ± 1, and in exotics was 0.5 ± 0.5.

Responses from assessment

One hundred seventy five students signed into the assessment tool. Sixty-nine students completed at least one question. Forty-five students completed all 100 questions and the associated demographic data to permit the investigators to link their score with their school. Fourteen students were from Pennsylvania; 8 were from Minnesota; 6 were from Wisconsin; 3 each were from Guelph and North Carolina; 2 each were from Auburn, Florida, Ohio, and Ross; and 1 each was from Louisiana, Oregon, and Washington State. At least one student completed the assessment for each of 12 schools. Only data from those schools was included in the following statistical analysis.

Total score averaged 65 (± 8) with a range of 48 to 77. Scores split out by species were for bovine 17 ± 2 with a range of 13 to 22 (24 questions, mean score = 71%), for equine 12 ± 3 with a range of 4 to 18 (21 questions, mean score = 57%), for small animal 14 ± 2 with a range of 10 to 20 (22 questions, mean score = 64%), for small ruminant 6 ± 1 with a range of 1 to 7 (7 questions, mean score = 86%), for other species 9 ± 2 with a range of 3 to 13 (14 questions, mean score = 64%), and for non-species questions 8 ± 2 with a range of 4 to 11 (12 questions, mean score = 67%).

None of the specific parameters evaluated had a statistically significant association with score, including presence or absence of tracking in the curriculum; course structure; contact hours in lecture or laboratory; or availability of active learning, hands-on laboratories, or training using models. Primary source of variance was the individual student. Ninety-two percent of the variability was associated with the students, with estimated school to school standard deviation of 2.2 points and estimated student within school standard deviation of 7.7 points. Ninety-five percent confidence intervals for the difference due to each variable were also calculated; the bounds for three of the seven were less than 10 points different, and the largest was a 16 point difference. Statistical analysis was repeated looking at individual sets of questions by species or discipline (bovine, equine, small ruminant, small animal, other species, basic science). Again, no variance was shown due to school or specific parameters and the primary source of variance was the individual student. Due to insufficient data, hypotheses concerning variation in scores associated with depth of program as evidenced by number of faculty, residents, and graduate students; comparative versus species-specific required course content; and provision of theriogenology as a stand-alone discipline versus a component of surgery and medicine courses could not be evaluated.

Discussion

There is little research specifically evaluating effect of lecture and laboratory work, either alone or in combination, on acquisition of specific skills in veterinary medicine. This study showed no difference in scores on a uniform assessment tool relative to a variety of parameters that may have impacted student learning. This agrees with studies comparing student learning in physical science, natural science, general biology, home economics, and computer training between lecture-demonstration, laboratory, and individual student work including workbooks and term papers, which showed no differences between groups in knowledge or practical application of that information.[19-23] This may be due to individual student abilities; in one study comparing lecture training to laboratory training in an integrated science course, high achieving students were equally successful with either method while low achieving students were more successful with laboratory training alone than with lecture training alone.[24] This was supported by demonstration in the current study of the preponderance of variation in scores being due to the individual student. In a study comparing lecture only to lecture plus laboratory training in earth science, the latter was superior, with a 33% increase in student mastery of concepts as evaluated by multiple-choice assessment.[25] Learning in lecture with accompanying laboratories is enhanced if strict attention is paid to alignment of content to ensure integration of concepts and appropriate sequencing of material presented.[26] It is perhaps not surprising that no difference was shown in this study, as there were so many more variables than in those studies that did show a difference, including variations in pre-requisite coursework and life experience in students, sequencing of content within the curriculum, and presence or absence of significant extracurricular activities that would reinforce coursework. Recent work suggests that extracurricular activities, if entered into by students with a goal of enhancing their learning, are associated with increased grade point average, making it clear that such parameters should be addressed when comparing learning at various institutions.[27]

This study suffered from insufficient data despite concerted efforts by the authors to gather information about the schools and to encourage students to complete the assessment. Future studies may be more successful if they focus on change within a given school's curriculum as this may give more opportunity to harvest data and will decrease some of the variability inherent in a large, multi-institutional study. This study also suffered from self-selection by students in accessing and completing these questions. It may be that students who chose to participate were only those who had a particular interest in theriogenology or only those who were particularly concerned about theriogenology as they prepared for the board examination. This would have skewed the results.

Information about theriogenology teaching is valuable for comparison as schools consider changing their curriculum. It is difficult to compare information from this study with previous work, which contained information from 31 North American and Caribbean veterinary schools. In that study, didactic training in at least one species was required at all participating schools. Laboratory training in at least one species was required at 75.0% and clinical experience was required at 72.7%.[18] The current study showed great variability in required versus elective course offerings either as lectures or as laboratories. Some of this variability is likely driven by interests and skills of the faculty members at that institution. It has been demonstrated that student interests are driven by their classmates and faculty mentors and it may well be that some schools, with very engaging faculty members and peer support for learning, provide a rich educational experience even with limited contact time and other resources.[28,29]

Conclusion

This study used a uniform assessment tool to gauge the amount of variance in student scores due to differing teaching methodologies between institutions. Sample size was small despite concerted efforts to increase engagement by schools and students. Regression analysis identified the individual student as the primary source of variance, with no parameters relative to differing teaching paradigms a significant source of variance. Smaller, more focused studies, may be required to identify subtle effects of teaching methodology on student performance. Identification of a within-school effect of student of 7.7 points can be used to calculate appropriate sample size for future studies.

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You are vaccinating an 8 month old Golden Retriever and notice that the dog has only one testicle in his scrotum. They are hoping to use the dog for breeding. Which of the following is your best advice for the owners about this dog?

a. He will be sterile and he will not develop the normal secondary sex characteristics.
b. He's too young for you to be able tell them if this will be a problem.
c. He was probably born with only one testicle (monorchid), and he should still be fertile.
d. He should be castrated because this is most likely a heritable condition.

Cryptorchidism is failure of one or both testes to descend into the scrotum. The process by which the gubernaculums assist in decent of the testes into the scrotum should be complete by 8 weeks of age. The retained testicle is not able to produce spermatozoa and tends to be smaller than the scrotal testicle because of the higher temperature inside the body; descended testes are normal. Monorchidism is extremely rare in dogs. Since cryptorchidism is inherited, it is important not to breed this male as he can pass it on to his offspring.

Figure. Example question

Table 1. Required and elective lecture hours

DISCIPLINE/SPECIES	MEAN +/- SD REQUIRED LECTURE HOURS	RANGE REQUIRED LECTURE HOURS	MEAN +/- SD ELECTIVE LECTURE HOURS	RANGE ELECTIVE LECTURE HOURS
REPRODUCTIVE BIOLOGY / PHYSIOLOGY	19 +/- 17	5-57	2 +/- 6	0-26
EQUINE	9 +/- 5	0-20	7 +/- 9	0-28
FOOD ANIMAL	11 +/- 7	0-31	9 +/- 11	0-41
SMALL ANIMAL	7 +/- 4	0-15	5 +/- 6	0-14
SMALL RUMINANT	3 +/- 3	0-10	2 +/- 6	0-8
OTHER*	3 +/- 2	0-8	1 +/- 1	0-4
TOTAL	52 +/- 23	19-132	24 +/- 25	0-76

* Swine, camelid, exotics, biotechnology

Table 2. Required and elective laboratory hours

SPECIES	MEAN +/- SD REQUIRED LABORATORY HOURS	RANGE REQUIRED LABORATORY HOURS	MEAN +/- SD ELECTIVE LABORATORY HOURS	RANGE ELECTIVE LABORATORY HOURS
EQUINE	4 +/- 4	0-13	10 +/- 11	0-30
FOOD ANIMAL	5 +/- 6	0-16	9 +/- 10	0-28
SMALL ANIMAL	1 +/- 8	0-12	1 +/- 1	0-4
SMALL RUMINANT	0 +/- 1	0-4	1 +/- 2	0-8
OTHER*	2 +/- 4	0-15	1 +/- 2	0-9
TOTAL	12 +/- 13	0-40	22 +/- 22	0-58

* Histology, semen evaluation, pathology, swine, obstetrics, fetotomy

Appendix 1. Core curriculum

THERIOGENOLOGY CORE CURRICULUM

SUGGESTED PREREQUISITES TO VETERINARY SCHOOL

- Medical terminology
- Endocrinology
- Genetics

TOPICS IN THE VETERINARY CURRICULUM

1) BASIC SCIENCES
    a) Anatomy
        i) Male and female, representative large and small animal species
    b) Histology
        i) Gonads
        ii) Uterus
        iii) Uterine tubes
        iv) Mammary tissue
    c) Endocrinology
        i) Hypothalamus
        ii) Pituitary
        iii) Gonads
        iv) Uterus
        v) Placenta
        vi) Thyroid
        vii) Adrenal
    d) Embryology and placentation
    e) Reproductive biology
        i) Sex determination and differentiation
        ii) Estrous cycle, representative species
        iii) Folliculogenesis / Oogenesis / Ovulation / Luteinization
        iv) Seasonal, environmental, nutritional effects
        v) Puberty
        vi) Pharmacologic manipulation of estrus
        vii) Intro to advanced reproductive technologies – semen cryopreservation, cloning, embryo manipulation, etc.
        viii) Spermatogenesis / Sperm maturation
        ix) Emission / Ejaculation
        x) Fertilization / Embryo movement / Maternal recognition of pregnancy
        xi) Pregnancy / Parturition
        xii) Artificial insemination
        xiii) Contraception – surgical, pharmacologic, immunologic
        xiv) Mammary gland development / Lactation / Milk biology
    f) Pharmacology
        i) Use of reproductive hormones and analogues
        ii) Use of antibiotics / withdrawal times
    g) Behavior
2) CLINICAL SCIENCES
    a) BOVINE
        i) FEMALE
            (1) Estrous cycle / Breeding management
            (2) Pharmacologic manipulation of estrus
            (3) Anestrus
            (4) Cyclical aberrations
            (5) Pregnancy diagnosis / Pregnancy management
            (6) Dystocia management / Obstetrics, fetotomy
            (7) Abortion
            (8) Periparturient disorders – hydrops, vaginal / uterine eversion, metritis, retained fetal membranes, endometritis
            (9) Infectious diseases / disorders of the reproductive tract
            (10) Mastitis
        ii) MALE
            (1) Infertility, male
            (2) Infectious diseases / disorders of the reproductive tract
        iii) GENERAL
            (1) Herd health / Reproductive performance goals / Economics / Record keeping
            (2) Artificial insemination / Embryo transfer

(3) Testing for heritable disorders / Creation of breeding plans to minimize genetic disorders
(4) Neoplasia of the reproductive tract

iv) TECHNIQUES
(1) History taking / Physical examination / Creation of a diagnostic and treatment scheme
(2) Transrectal reproductive examination
(3) Ultrasound
(4) Breeding soundness examination / Semen collection and evaluation
(5) Passage of pipette / biopsy instrument / insemination pipette into uterus
(6) Neonatal resuscitation
(7) Anesthesia
(8) Surgery
(a) Cesarean section
(b) Teat surgery
(c) Caslick's
(d) Ovariectomy
(e) Castration

b) EQUINE

i) FEMALE
(1) Estrous cycle / Breeding management
(2) Pharmacologic manipulation of estrus
(3) Anestrus
(4) Cyclical aberrations
(5) Pregnancy diagnosis / Pregnancy management
(6) Dystocia management / Obstetrics
(7) Abortion
(8) Periparturient disorders – metritis, retained fetal membranes
(9) Endometritis
(10) Infectious diseases / disorders of the reproductive tract
(11) Mastitis

ii) MALE
(1) Infertility, male
(2) Infectious diseases / disorders of the reproductive tract

iii) GENERAL
(1) Herd health / Reproductive performance goals / Economics / Record keeping
(2) Artificial insemination / Embryo transfer
(3) Testing for heritable disorders / Creation of breeding plans to minimize genetic disorders
(4) Neoplasia of the reproductive tract

iv) TECHNIQUES
(1) History taking / Physical examination / Creation of a diagnostic and treatment scheme
(2) Transrectal reproductive examination
(3) Ultrasound
(4) Breeding soundness examination / Semen collection and evaluation
(5) Passage of pipette / biopsy instrument / insemination pipette into uterus
(6) Neonatal resuscitation
(7) Anesthesia
(8) Surgery
(a) Cesarean section
(b) Perineal reconstruction
(c) Caslick's
(d) Ovariectomy
(e) Castration (descended and cryptorchid)

c) SMALL ANIMAL

i) FEMALE
(1) Estrous cycle / Breeding management
(2) Pregnancy diagnosis / Pregnancy management
(3) Dystocia management / Obstetrics
(4) Abortion
(5) Periparturient disorders – metritis, SIPS, eclampsia
(6) Infectious diseases / disorders of the reproductive tract
(7) Mastitis
(8) Mammary neoplasia

ii) MALE

        (1) Infertility, male
        (2) Infectious diseases / disorders of the reproductive tract
    iii) GENERAL
        (1) Artificial insemination
        (2) Contraception
        (3) Testing for heritable disorders / Creation of breeding plans to minimize genetic disorders
        (4) Neoplasia of the reproductive tract
    iv) TECHNIQUES
        (1) History taking / Physical examination / Creation of a diagnostic and treatment scheme
        (2) Breeding soundness examination / Semen collection and evaluation
        (3) Neonatal resuscitation
        (4) Anesthesia
        (5) Surgery
            (a) Cesarean section
            (b) Ovariectomy / Ovariohysterectomy
            (c) Castration (descended and cryptorchid)
d) PORCINE
    i) Estrous cycle / Breeding management
    ii) Parturition / Obstetrics
    iii) Infectious causes of reproductive loss
    iv) Breeding soundness examination, male
    v) Artificial insemination
e) OVINE / CAPRINE
    i) Estrous cycle / Breeding management
    ii) Pregnancy diagnosis / Pregnancy management
    iii) Abortion
    iv) Parturition / Obstetrics
    v) Breeding soundness examination, male

Appendix 2. Teaching survey

THERIOGENOLOGY TEACHING SURVEY 2013

1) Faculty and training

Number of boarded or board-eligible faculty members:
Number of residents currently in training:
Number of residents concurrently completing a graduate degree:
Number of graduate students (no concurrent residency):

2) Total student enrollment (all years of the curriculum):

3) Is tracking permitted? If no, go to question 3.

If tracking is permitted, which year in the curriculum is the first year where it is permitted?
[ ] 1st year
[ ] 2nd year
[ ] 3rd year
[ ] 4th year

What is the rough percentage of students in each track in your current clinical year? Please designate by putting an X in the box appropriate for each species.

TRACK	ROUGH PERCENTAGE IN EACH TRACK										
	< 5	5-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	>90
SMALL ANIMAL											
EQUINE											
BOVINE											
MIXED											
EXOTIC / WILDLIFE PRACTICE											
OTHER											

Which of the following do you believe is a focus of theriogenology training at your institution, based on emphasis in the curriculum and number of faculty involved in training/research? Please check all that apply.
[ ] Dairy cattle (including cow/calf and herd management)
[ ] Beef cattle (including herd management)
[ ] Swine
[ ] Sheep / goat / camelid
[ ] Equine
[ ] Small animal

4) <u>Didactic</u> coursework – Please complete the table below. Please total the lecture hours by species, required versus elective, and year in curriculum; we are not concerned in this table if they are taught over multiple courses

COURSE	REQUIRED HOURS	ELECTIVE HOURS	YEAR IN CURRICULUM	TAUGHT BY DIPLOMATE?*
LECTURES (**This does not include rotations – see question 4)**				
REPRODUCTIVE BIOLOGY / PHYSIOLOGY				
CLINICAL EQUINE				
CLINICAL FOOD ANIMAL				
CLINICAL SMALL ANIMAL				
CLINICAL SMALL RUMINANT				

CLINICAL OTHER				
LABORATORY HOURS				
EQUINE				
FOOD ANIMAL				
SMALL ANIMAL				
SMALL RUMINANT				
OTHER				

* ACT, ECAR, Australian Fellow
For required courses, does your institution have stand-alone courses by species or one or more courses covering all species of interest?
For elective courses, does your institution have stand-alone courses by species or one or more courses covering all species of interest?
Is theriogenology primarily taught as a discipline or is theriogenology material covered in other courses (e.g. medicine or surgery)?
IN LECTURES:
How many hours in the curriculum are dedicated to herd health/ herd reproductive management vs. individual management/disease management?
Are canine urogenital diseases discussed? Is this a component of a medicine or theriogenology class?
Is a theriogenology textbook required? Please list required texts.
Are lectures available for review outside of class?
Are “alternative teaching tools” applied to teach theriogenology (case-based learning/ problem-based learning / small group learning / flipped classroom)? If yes, please describe briefly:
How many hours of the theriogenology curriculum are devoted to alternative teaching methods?
IN LABORATORIES:
Do all students have an opportunity to learn transrectal palpation on either cows or horses?
How many hours are available in the curriculum to practice transrectal palpation skills?
What percentage of students completes a canine or feline ovariohysterectomy as a component of a teaching laboratory in the first three years of the curriculum?
What percentage of students participates in a C-section in the first three years of the curriculum (species?)?
Are live animal theriogenology labs available for horses, cows, pigs, avian, canine? Are these labs required or elective?
Are artificial teaching tools (palpation models) used instead of live animals for all students? Available for some students?
Do students at your institution take the Qualifying Examination or another capstone assessment to assess basic science knowledge before beginning didactic work in clinical disciplines?

5) <u>Clinical</u> coursework – Please complete the table below.

ROTATION	REQUIRED OR ELECTIVE?	TAUGHT BY DIPLOMATE?*	Comments
GENERAL THERIO			
SMALL ANIMAL THERIO			
EQUINE THERIO			
FOOD ANIMAL THERIO			
OTHER			

* ACT, ECAR, Australian Fellow
If theriogenology is covered on other clinical services, what are they (e.g. General Practice, medicine)?
Is a theriogenologist routinely called to consult on medical or surgical cases involving the reproductive tract that are not transferred to/maintained by the theriogenology service?
Are reproductive emergencies (dystocia, postpartum disease, testicular/scrotal disease, pyometra/metritis) seen by the theriogenology service? If so, in what species?
What percentage of students completes a canine or feline ovariohysterectomy in the fourth year of the curriculum?
What percentage of students participates in a C-section in the fourth year of the curriculum (species?)?

6) Extracurricular training opportunities for DVM students
Does your institution have a Student Chapter of the Society for Theriogenology?
Does your institution have other student clubs that have lectures or wet labs with a focus on theriogenology (palpation team, etc.)?

Please list the approximate number of lectures/labs available per year through these activities for each species group:
SA:
Equine:
Food Animal:
Exotic:
Thank you for taking the time to complete this survey