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Veterinary student competence and confidence in calving cows after simulator training in a blended learning approach

Jayne Orr
BVMS MRCVS

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Scottish Centre for Production Animal Health and Food Safety
School of Biodiversity, One Health and Veterinary Medicine
College of Medical, Veterinary & Life Sciences
University of Glasgow

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Abstract

New veterinary graduates are challenged by problem calvings often presenting as emergencies out of hours when support might not be readily on hand despite veterinary accrediting bodies stating that calving a cow is a day one competence. Simulation has been increasingly used in veterinary education and there are numerous reports of its success. Integrating simulation into the curriculum using a blended approach with online material has more limited evidence within the literature. The main aim of this study was to explore whether student confidence levels (CL) and competence (CO) in calving cows are enhanced by a blended learning approach.

Over three academic study years, 347 eligible fourth year veterinary students were allocated to one of four teaching groups: lectures only (LEC, n = 60) computer assisted learning (CAL, n = 59), calving model simulator (SIM, n = 96) and CAL&SIM (n = 85). Students were asked to complete a questionnaire (before and after teaching) and were also assessed in a formative calving OSCE.

For CL, students self-rated with higher confidence after exposure to the SIM (42.3, 95% CI 40.9 – 43.8) alone or blended with the CAL (44.3, 95% CI 42.8 – 45.7) when compared to both the LEC (33.3, 95% CI 31.2 – 35.5) and CAL (35.4, 95% CI 33.5 – 37.4). Multiple logistic regression identified teaching group as influencing overall CL after teaching. For CO, the proportion of pass and excellent students in the LEC teaching group (40%) was lower compared to all other teaching groups (CAL 73%, SIM 84%, CAL&SIM 87%). Regression identified that teaching group and OSCE assessor influenced OSCE pass rates.

In conclusion, the implementation of a SIM as part of a blended learning approach when teaching students how to calve cows has a very positive impact on self-assessed student confidence and on competence assessed by a formative OSCE exam.

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Acknowledgements

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Last but not least, thanks to my friends and family who have listened to me moaning about this thesis for the last four years, I am looking forward to celebrating with them when I finally hand in.

Author's Declaration

I declare that this dissertation is the result of my work, except where explicit reference is made to other people's contributions. It has not been submitted for any other degree at the University of Glasgow or other institution.

Name: Jayne Orr

Signature:

Abbreviations

3D – three dimensional

AICc - Akaike Information Criterion Corrected

AF - African

AS - Asia

ATQ – After Teaching Questionnaire

AVMA – American Veterinary Medicine Association

BCS – Body Condition Score

BCVA – British Cattle Veterinary Association

BTQ – Before Teaching Questionnaire

BVMS – Batchelor of Veterinary Medicine and Surgery

CAL – Computer assisted learning

CDM – Clinical Decision Making

CI - Confidence Interval

CL – Confidence level

CO – Competence

CONF - Confidence

CPD – Continuing Profession Development

CTA – Cognitive Task Analysis

DIQ – Data Interpretation Question

DOPS – Direct Observation of Procedural Skill

DVD - Digital Video Disk

EMQ – Extended Matching Question

EMS – Extra Mural Studies

EPA – Entrustable Professional Activities

EU – Europe

FA – Farm Animal

ILO – Intended Learning Outcome

IT – Information Technology

LEC – Lecture

MCQ – Multiple Choice Question

MEQ – Modified Essay Question

Na – Not Applicable

NA – North America

OSCE – Observed Structured Clinical Exam

OVH – Ovariohysterectomy

PDF – Portable Document Format

PROMT - Practical Obstetric multi-Professional Training

Q - Questionnaire

RCVS – Royal College of Veterinary Surgeons

SD – Standard Deviation

SIM – practical class using bovine dystocia simulator

SPVS – Society for Practising Veterinary Surgeons

SVM – School of Veterinary Medicine

UOG – University of Glasgow

VLE – Virtual Learning Environment

Chapter 1 Literature Review

1.1 Why do we need to teach vet students how to calve cows?

1.1.1 Day one competence

Many of the veterinary accrediting bodies define attending an animal in an emergency and performing first aid to be one of the day one competences required of newly qualified veterinary graduates (ECCVT, 2019; Molgaard et al., 2018; RCVS, 2022; Salisbury et al., 2019). Attending a call to calve a cow would be one such emergency so veterinary educators have a responsibility to teach students this skill in an effective and efficient way. More specifically, the British Cattle Veterinary Association (BCVA) lists *'able to assess an obstetrical problem for example a calving or prolapse and perform a thorough examination'* and *'be able to know personal limitations and when to request assistance'* in their day one skills list (BCVA, n.d.). Obstetrics has also been identified as one of the top 15 important competences by dairy veterinarians in the United States (Miller et al., 2008) and farm animal practitioners report that they carry out manual extraction of a calf at least once a week (Morin et al., 2002).

The need for competence in bovine obstetrics is further evidenced by studies that have investigated the Entrustable Professional Activities (EPA) required of new graduates. These EPAs align with day one competence but put them in a workplace context. They are defined as being observable and measurable so that competence in that EPA can be clearly demonstrated (Cate et al., 2015). Obstetric deliveries were reported as one of 29 sub-EPAs identified by both veterinary educators and practicing veterinarians (with various levels of experience); in addition, research participants thought graduates should be able to do obstetric deliveries without supervision at time of graduation (Duijn et al., 2019). A further study, specifically of 124 recent graduates in Utrecht, again reported that obstetrics deliveries was worthy of being an EPA. Interestingly only 19% of graduates indicated they could execute obstetrics delivery with supervision (at a distance) or with no supervision, and the mean number of months it took the new graduates to execute obstetrics without supervision was 9.7 months. These studies indicate that there is a mismatch between what is expected from new graduates by practitioners and what competences in bovine obstetrics graduates are equipped with. This gives evidence that further hands-on training in bovine obstetrics is required and that research into the optimum way to teach the skill is needed (Morin et al., 2002).

Requests from farmers to veterinarians to help a cow calving often arrive out of hours when support will be limited and new graduates are working on their own. To add to the stressors of the call, the farmer will likely be stressed, may not know the new veterinarian that arrives, and there may also be significant emotional (e.g. favourite cow) or financial pressures (e.g. embryo calf) depending on the circumstances.

1.1.2 Clinical relevance

The prevalence of dystocia in dairy cows is reported to be between 2% and 7% (Mee 2008). Related to dystocia, the average perinatal mortality incidence within the United Kingdom has reported to be between 5.3 – 7.9% (Brickell et al., 2009; McGuirk et al., 1999) for dairy calves and 0 – 25% for beef calves (Barber, 2018; Norquay et al., 2020). There is however a wide variation in incidence within and between herds. Figures for perinatal mortality across the world are reported to be similar (Cuttance & Laven, 2019; J. Mee, 2011) but there are differences around defining the term perinatal mortality which can make comparisons between studies difficult (Cuttance & Laven, 2019). Successful outcomes when calving cows is an opportunity to influence calf survival on farm.

Competence and confidence are both important attributes needed when new graduates encounter a cow calving as they are often seen as emergencies, out of hours and at night when new graduates might be working on their own (hopefully with some backup but this may not be immediately available). During these situations there can be high value animals involved, farmers can be stressed, and they can put veterinarians under pressure for a successful outcome. Often this is the first time a new graduate would meet their client, so they also feel under pressure to make a good impression. The graduate has to have the clinical skills i.e. competence to do the job (see first paragraph) but they also need to feel confident in order to take on the task - both are needed.

Out with the emergency situation of calving a cow, veterinarians might also be involved in providing training for farm staff in bovine obstetrics. Hence veterinarians can have an influence on the perinatal mortality rate in beef and dairy farms while also improving animal welfare not only by their using their own clinical skills but transferring this knowledge to others. Therefore, educators have a role to teach the students the skills they need to calve a cow, but they also have a duty to listen to the profession and make sure the graduates they are training meet expected levels of competence.

1.1.3 Lack of farm animal vets

The most recent RCVS survey conducted in 2019 reported that 13.4% of respondents were working in mixed practice and 3.7% in farm practice. Numbers for mixed practice in particular, were declining when compared to the 2014 (15.8%) and 2010 survey (22.1%) (Robinson D, 2019). There are also reports anecdotally and in the literature that there is a lack of farm animal vets (Adam et al., 2015; Remnant, 2021). This has been reported in a recent Society for Practicing Veterinary Surgeons (SPVS) survey to be partly due to recruitment difficulties with 70% of 316 respondents reporting recruitment as an issue. Reasons for difficulties were reported to be that applicants were not suitable for the job or lacked the skills needed ("SPVS Calls for Vets to Be Returned to the Occupational Shortage List," 2015).

Retention of new graduates in mixed or farm animal practice roles has been identified as even more of an issue than the initial recruitment. The median length of time working in farm/mixed practice of those that had left, is six years with many of them seeking alternative career paths thereafter (Adam et al., 2015). Thematic analysis of the free text comments of a survey of 380 questionnaire responses from veterinarians with experience in farm animal practice identified that graduates that felt that they were not good enough for the job and/or lacked competence and confidence were more likely to leave the profession (Adam et al., 2015). Perhaps, as respondents to the questionnaire also stated that being called out during the night and feeling unprepared was an issue (Adam et al., 2015), there is more evidence for veterinary educators to prepare graduates with the skills they need so they do not become stressed and then disillusioned with the profession.

1.1.4 Stress in the Veterinary Profession

Stress is a well-known symptom of modern day living and is defined by the National Health service (NHS) as the '*body's reaction to feeling threatened or under pressure'* (*Stress - Every Mind Matters - NHS*, n.d.). Stress was reported as one of the top two challenges facing the professional when the Royal College of Veterinary Surgeons (RCVS) reported the results of a survey of members in 2019 (Robinson D, 2019). An element of stress is inevitable in a job such as being a veterinarian and a manageable amount of stress may be useful to perform well under pressure; it can however, become detrimental when levels are excessive (Kalaniti & Campbell, 2015).

There are various reasons why stress is common, particularly in new graduates. Depending on the practice set up in their first job, graduates may have a lack of mentoring/support (Mellanby & Herrtage, 2004), work long unsociable hours and suffer from isolation (especially if working in a rural mixed or farm animal practice where veterinarians are often working alone). Being a veterinarian often involves making high stakes, life or death decisions that may have an ethical dilemma element (Batchelor & McKeegan, 2012). This means that owners and human emotions are also involved. In addition, it is expected that all veterinarians, but graduates in particular, will make mistakes. In a study of recent graduates, 78% reported making a mistake since starting work and of those that made a mistake, 54% put it down to lack of experience (Mellanby &

Herrtage, 2004). This is further supported by a study reporting the reasons for veterinarian insurance claims, lack of technical knowledge or practical ability was identified as a common reason for claims (Oxtoby et al., 2015).

The levels of stress more than likely contribute to the high levels of depression and suicide within the veterinary profession with the suicide rate in veterinarians twice the rate of that in other medical professionals and four times the rate of the general population (Bartram & Baldwin, 2010). Other reasons for the high rate of suicide in the veterinary profession have been investigated and are reported to be related to

- Pressures of the job (working hours, on-call etc)
- Client expectations and risks of litigation
- Dealing with death on a daily basis
- Having easy access to the means in which to do it e.g. barbiturates
- Suicide reportedly being common in the profession
- Professional and social isolation
  (Bartram & Baldwin, 2010)

With all of this in mind, universities have role to equip new graduates with not only the skill set needed to carry out the clinical skills they will encounter but also to teach them in a way that they develop the confidence to do the job. Undergraduates need to be provided with a safe environment in which to learn, to encourage them to have a go (perhaps involving simulation which is no risk to animal health), make safe mistakes and ask appropriate questions.

1.2 How do you calve a cow?

In an emergency situation, veterinarians have a professional responsibility to attend a cow having difficulty calving (RCVS, 2022), yet this is a complex event that can be very stressful for new graduates or inexperienced veterinarians. Calving a cow is a procedure made up of multiple tasks such as taking the history, assessing what the problem is, correcting the problem and delivering a live, healthy calf without damaging the cow (Read & Baillie, 2013). Decisions need to be made throughout the procedure such as where to restrain the cow (so it is a safe working environment), and whether the calf can be delivered via vaginal delivery without doing any harm to cow or calf.

1.2.1 History, clinical exam and initial assessment

The first step in an obstetrics encounter is taking a history from the farmer (Mortimer & Toombs, 1993). Veterinarians need to establish the general health of the cow, stage of labour and what interventions have been attempted by the farmer already. They also need to ascertain the genetic merit and potential financial value of the cow and calf as this may influence subsequent decision making. Effective communication is important so that the correct questions are asked without overwhelming the farmer and wasting precious time (Walters, 2014).

Establishing the stage of labour is critical to work out if, and when to intervene. The accuracy of this information is very dependent on the frequency of checking of the animals by the farmer (J. F. Mee, 2004). Careful questioning around clinical signs and their duration will help the veterinarian establish what stage of labour the cow is in. Intervention too early and there will be risk of damaging the cow e.g. vaginal or vulval tears by applying traction when the cow is not fully dilated. Intervention too late and the calf may have experienced significant stress, could be suffering from anoxia, acidosis or worse still, could be dead (J. F. Mee, 2004)

Safety when calving a cow is paramount. Cows can be fractious and stressed during parturition but there needs to be a balance between restraining the animal and giving space for the animal to go down safely during the procedure. It is advised not to calve cows in a crush so identifying a suitable area and securing the cow by means of a halter tied by a quick release knot are essential (J. F. Mee, 2004; Walters, 2014). It is suggested that there is more space within the pelvis of the cow if the animal is in lateral recumbency but it is thought that few veterinarians would take the time to cast a cow down.

1.2.2 Vaginal exam, palpation of the calf and coming to a conclusion

Before performing the vaginal exam, the vulva and perineum area should be inspected for any issues such as previous trauma or presence of a bad smell. The body condition score of the animal should also be assessed. The vulva should then be cleaned and disinfected so as not to allow faecal material to enter the reproductive tract during the examination (Youngquist & Threlfall, 2006). It is advisable to wear gloves to minimise the risk of zoonotic disease (Mortimer, 1973).

The reproductive tract is entered via the vulva using a cupped hand. Initial assessment is to establish the following;

- Is the cervix open, closed or twisted? If the cervix is closed, time needs to be spent dilating it or alternatively give the cow more time and re-examine her later. If the cervix is twisted, specific manipulations need to be performed to untwist it (Funnell & Hilton, 2016)
- Is the calf presented in anterior or posterior position? If posterior, traction will need to be fast (Mortimer, 1973)
- Are there any malpresentations to deal with e.g. head back, leg back, breach (see section below)
- Is the calf dead or alive? This can be done by pinching the toes/tongue, gag reflex or palpating for a pulse. If the calf is dead, this may influence subsequent decision making (Mortimer, 1973)
- Following the initial vaginal examination, the veterinarian should come to a conclusion regarding the problem, decide how to correct it and communicate their findings and plans to the farmer. The veterinarian should also recognise if any assistance from a more experienced colleague is required and call for help to avoid further delay

1.2.3 Correcting the problem, applying ropes and extracting the calf

It is beyond the scope of this literature review to describe how to manipulate each possible bovine obstetric malpresentation, but some general principles are described. For the majority of malpresentations, pushing the calf back into the uterus is one of the first steps. This moves the calf out of the pelvic region back into the abdomen and gives more space for manipulations. Making use of a caudal epidural or using clenbuterol (a smooth muscle relaxant) may help (Youngquist & Threlfall, 2006). From then, the head, legs, body can be manipulated in a safe way making sure not to perforate the uterus in the process. Using the hand to 'cup' the hooves as they are moved into the birth canal is essential to ensure damage to the uterus does not occur. Time should be taken to manually stretch the cervix and vulva prior to extraction of the calf (Mortimer, 1973).

Assessing for room within the pelvis can be one of the most difficult things for an in-experienced veterinarian to carry out. Experience has a big influence on decision making, while 'trial and error' and/or 'having a go' can have serious welfare and economic consequences (Green et al., 1999). Furthermore, poor decision making at this point can be harmful to the trust and professional relationship between veterinarian and farmer. Various methods can be used to assess for room within the pelvis, but the following general principles should be employed;

- Do not confuse treatment (applying traction to the calf) and diagnosis (gathering information about the space in the pelvis available for extraction) (Funnell & Hilton, 2016; Oultram & Holman, 2015)
- Know the 'point of no return' whereby a caesarean section can no longer be performed
- Do no harm (Mortimer, 1973)

Table 1.1 Parameters reported in the literature to be used to indicate if vaginal delivery is possible shows various parameters that have been reported to establish if the calf can be extracted by vaginal delivery. Many of these parameters will be assessed in combination with the history, and with clear communication with the farmer a decision can be made.

Table 1.1 Parameters reported in the literature to be used to indicate if vaginal delivery is possible

Parameter indicating vaginal delivery possible	Reference
Head comes into the pelvic canal itself and stays there without being pulled	(Oultram & Holman, 2015; Youngquist & Threlfall, 2006)
One person plus a push from the cow brings calf into pelvis	(Youngquist & Threlfall, 2006)
One person pulls one leg to bring shoulder into canal and holds it there while other person pulls second leg	(Fields et al., 2001; Youngquist & Threlfall, 2006)
Hand passes over head and shoulders when calf in pelvis	(Funnell & Hilton, 2016)
Feet can be extracted 10cm beyond the vulva of the cow	(Funnell & Hilton, 2016; Momont, 2005; Youngquist & Threlfall, 2006)
Parameter indicating vaginal delivery NOT possible	
Feet are crossing over	(Funnell & Hilton, 2016; Walters, 2014; Youngquist & Threlfall, 2006)
Feet are rotating inwards	(Youngquist & Threlfall, 2006)
Feet are big	(J. F. Mee, 2004)

Decisions trees have also been produced to guide veterinarians and farmers through the decision-making process see Figure 1.1 Decision tree for delivery of a calf in anterior presentation (Oultram & Holman, 2015).

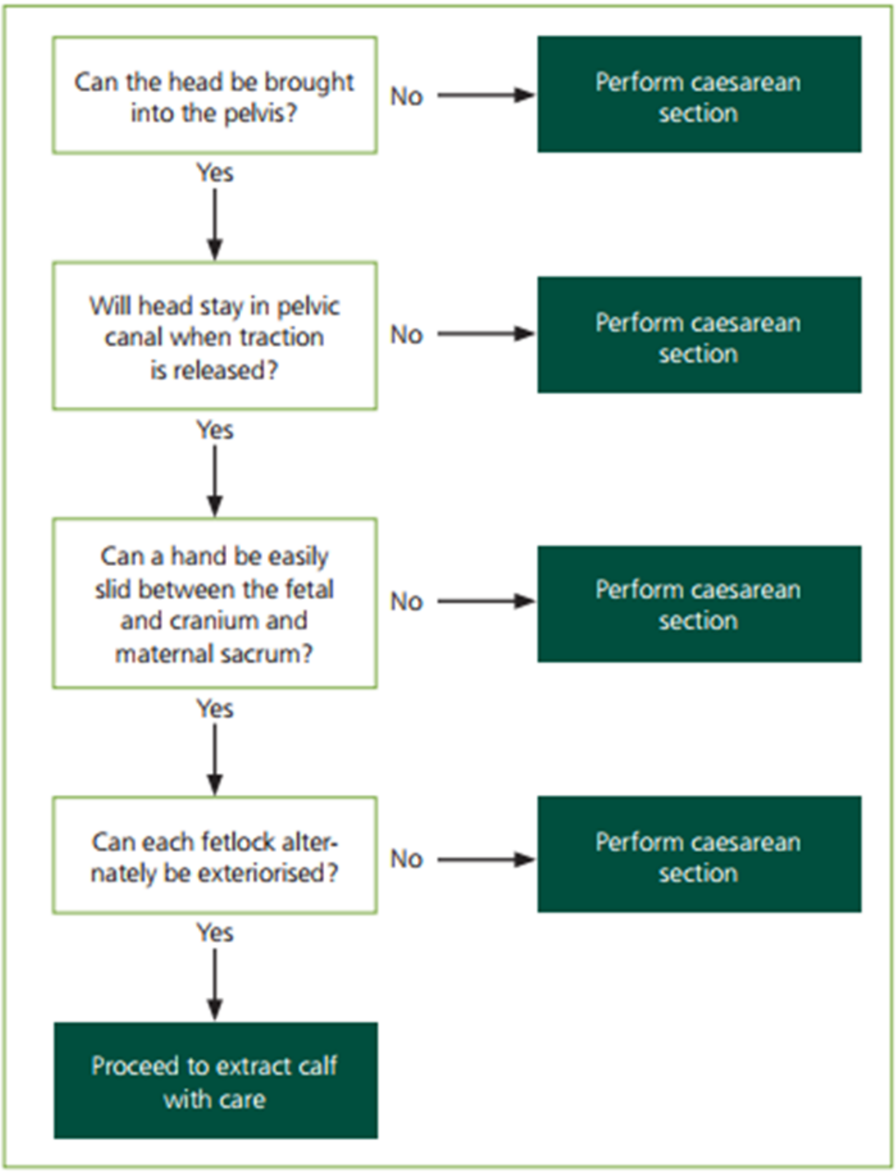


Figure 1.1 Decision tree for delivery of a calf in anterior presentation (Oultram & Holman, 2015)

Once a decision has been made to extract the calf via the vagina, leg ropes/chains and a head rope/snare (if required) can be applied. The ropes used in calving generally have a loop at one end to allow threading of the other end through the loop to make a self-tightening hitch (Youngquist & Threlfall, 2006). One rope/chain is placed on each leg above the level of the fetlock joint with the free end of the rope/chain coming from the ventral aspect of the foot see Figure 1.2 Position of calving chains above the fetlock. The leg ropes should be pulled tight to avoid them slipping off the leg. The head rope/snare is applied behind both ears so that when traction is applied to the rope, it tightens behind the ears and draws the head into the birth canal see Figure 1.3 Position of head rope behind the ears.

Figure 1.2 Position of calving chains above the fetlock

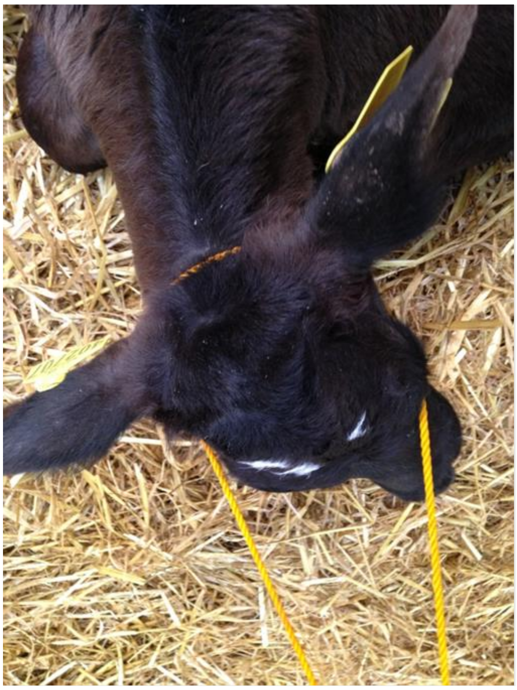


Figure 1.3 Position of head rope behind the ears

Once the ropes are applied, traction can commence. Application of plenty of lubrication will facilitate this. Traction needs to be performed in a controlled and calculated way so as not to do undue harm to cow or calf. The maximum amount of force that should be applied is that of two people (300kg) (Funnell & Hilton, 2016; J. F. Mee, 2004; Youngquist & Threlfall, 2006). A calving aid or calving jack may be employed to aid extraction. The ropes are attached to the calving aid/jack and the rachet mechanism is used to extract the calf.

Traction should be applied when the cow contracts so that blood supply to the calf is not under pressure continuously from contraction from the cow then traction applied via the calving aid (Mortimer & Toombs, 1993). If using a calving aid/jack, leverage downwards should provide the force to extract the calf, while the rachet mechanism is used to take up the strain in between the application of downward leverage. There should be a cycle of events between downward leverage > apply rachet > relax, which allows the cow and calf a rest period in between application of traction (J. F. Mee, 2004; Youngquist & Threlfall, 2006). The aim is to mimic the natural calving process as much as possible (Green et al., 1999).

1.2.4 Reviving the calf and dealing with complications

Once the calf is extracted it should be given immediate attention to make sure it has established breathing and that the umbilicus is not haemorrhaging. Various techniques for stimulating breathing have been reported and are listed below (much of these are based on anecdote and an evidence base for their use is limited);

- Get the calf in sternal recumbency to allow full inflation of the lungs
- Clear the airway
- Put water down the ears
- Poke straw up the nose
- Rub chest
- Bring hind and fore limbs together
- Acupuncture of the nasal planum
- Intubation and delivery of air or pure oxygen
- Doxapram (respiratory stimulant drug)

(Nagy, 2009; Oultram & Holman, 2015)

Another vaginal exam should be performed on the cow post calving to check for any tears, excessive haemorrhage and of course, another calf (Oultram & Holman, 2015). Additional complications to look out for in the cow, are nerve damage (sciatic, obturator, peroneal) possibly resulting in a 'down cow', uterine prolapse and milk fever (Frame, 2006; Momont, 2005; Rees, 2016). For the calf, the complications include acidosis, fractured ribs, jaw or legs, femoral nerve (or other nerve damage), glossal oedema and umbilical haemorrhage/hernia.

Throughout the process the veterinarian has to communicate effectively with the farmer (Momont, 2005). This often involves multitasking as communications occur while the procedure is being carried out. As claims against veterinarians involving calving cows often occur due to poor communication (which the farmer interprets as human error) it is important that time is spent learning this skill as well as the more practical aspects of the procedure (Veterinary Defence Society, personal communication).

1.3 How do you teach a vet student to calve a cow?

1.3.1 Lecturing

Lectures are based on transfer of information in a formal way by a lecturer with students having limited interaction with the lecturer and the content. The most common format is a solitary lecturer at the front of the room, often with some sort of visual aid such as power point slides delivering information to a group of students (often a large number which makes lecturing cost effective) who are sitting in an audience taking notes (Campanella & Lygo-Baker, 2014; Schmidt et al., 2015).

Although lecturing has been the foundation of teaching delivery for many university courses for a number of years, its effectiveness has been brought into question. Lectures are a very passive way of learning which do not promote critical thinking and they have questionable use in terms of what students actually learn from them (Schmidt et al., 2015). It was shown in a study of 10 generations of medical students in the Netherlands that the less time students spent in lectures and more time they had for their own study, the more likely they were to graduate (Schmidt et al., 2009). There are some advantages to lectures, however; they create a sense of community, they are cost effective and when delivered effectively they can really inspire the learner to go and find out more about the topic (Campanella & Lygo-Baker, 2014). Educators are trying to improve the format of lectures with techniques such as the flipped classroom being reported as an alternative format, where students read the lecture material in their own time and the lecture time is used for discussion and exploring the more complex aspects of the topic (Matthew et al., 2018).

1.3.2 CAL

Computer Assisted Learning (CAL) is the use of computers (in any way) for educational purposes (Sharma, 2017). With the increasing use of technology using computers, tablets and smart phones, the use of CAL has increased massively in the last 20 years. The Covid-19 pandemic further increased the use of such technology when all learning had to move online when the most severe lockdown measures were in place during the first peak of the pandemic (Simons et al., 2022).

One CAL medium is placing video resources, and such a video CAL offers many benefits for learners and educators;

- It can be used asynchronously at a time convenient for the learner offering flexibility (Klupiec et al., 2014; Massey et al., 2017; Roshier et al., 2011)
- It can be paused, rewound, and re-watched allowing learners to review material more than once and at their own speed (Klupiec et al., 2014; Massey et al., 2017)
- It can be used before or in conjunction with other types of learning e.g. a practical class, so that learners can come to class more prepared, or to

review material that they were unsure of after the class (Allavena et al., 2017; Roshier et al., 2011)
- It can be standardised so that all students see the same thing. This can be useful when preparing them for exams or to meet accreditation requirements (Klupiec et al., 2014; Massey et al., 2017; Roshier et al., 2011)
- It saves educators timetabled delivery time as once the videos are created they can be used as many times as needed. There are also examples of communities of educators making videos that are commercially available that can reach a much wider audience (Jang & Kim, 2014; Schifferdecker et al., 2012)

Some of the disadvantages of CAL video resources include;

- Variable quality of video e.g. audio not clear, image blurry, angles not showing the best view of the task (Roshier et al., 2011)
- Issues with accessibility e.g. long videos may take a while to download or the videos might not be indexed and organised into a way that the learners can find them (Allavena et al., 2017; Jang & Kim, 2014; Roshier et al., 2011)
- They need technical expertise, creativity and time to produce (Chan, 2010)
- They can lack the tactile, visual and orientation qualities of a model or real-life situation and students often still want to have a practical class (Allavena et al., 2017; Klupiec et al., 2014)
- Learners might not engage with it, especially if not linked to assessment or linked clearly to other teaching modalities (Jang & Kim, 2014)

There are reports of CAL being used in the veterinary education literature but few of the reports have a completely negative control where no further teaching of any kind is used. In terms of OSCE results, no difference was seen when final year students learnt cardiac dissection using a low fidelity simulator (with no instructor) versus with a video of dissection on a real heart (although both teaching groups did improve on their pre-teaching scores) (Allavena et al., 2017). Similarly, a study of 44 third year vet students that had initial teaching of ovariohysterectomy (OVH) in dogs with lectures, videos and practical classes using a model then further teaching with either a virtual reality video or no virtual reality video, showed they did not perform better in terms of time and overall score when assessed doing a live animal OVH (Hunt et al., 2020). It could be that the effect of the model diluted the effect of the virtual reality activity in that study. In nursing education, giving students free access to OSCE exemplars in video format and comparing OSCE results that year to the previous year (where no videos were available) showed no difference in OSCE scores (Massey et al., 2017). When assessing the impact of the implementation of a three-dimensional (3D) animation (made into quick time virtual reality material) for obstetrical problems in horses on written exam scores, students that used the resource had higher mean scores when compared to the students that did not use the resource (Gao et al., 2020). In terms of CAL influencing confidence, some of the aforementioned studies did report an increase in student confidence and reduced anxiety after accessing the CAL material (Allavena et al., 2017; Massey et al., 2017) while others reported no difference (Hunt et al., 2020).

1.3.3 Simulation

Simulation has been described as '*an artificial representation of a real-world process to achieve educational goals through experiential learning*' (Al-Elq, 2010). A simulator is the equipment used to achieve this. It is widely used in medical education and is increasingly being used in veterinary education (Scalese & Issenberg, 2008). In a medical context, simulation may be used to replicate clinical scenarios to allow students to experience a realistic clinical encounter but without the pressure of a live animal or person. Medical education is moving away from the 'see one, do one, teach one' approach (Kalaniti & Campbell, 2015). This approach puts patients at risk and the student undertaking the task is put under a considerable amount of stress if they are performing a task that they do not have the competence or confidence to carry out.

Simulation has various advantages over live animal teaching in veterinary undergraduate teaching, these include;

- Less impact on animal welfare and less ethical issues around the use of animals for teaching (Scalese & Issenberg, 2008)
- Predictability with every student getting a similar experience
- Improved student safety as live animals are not involved
- Repeatability allowing for deliberate practice
- Same standard for every student which is useful in an examination context where measuring competence can be a key part of an outcomes-based curriculum. It also means that every student is exposed to a very similar learning opportunity (Scalese & Issenberg, 2008)
- Reduced stress on students as not in a ‘real’ situation with a client and animal (Kalaniti & Campbell, 2015)
- Flexible learning and not reliant on ‘being there at the right time’ to experience a situation (Scalese & Issenberg, 2008)
- Allows increasing student numbers as no issues with number of times a live animal is used
- Opportunity to give immediate feedback as there is less pressure than there would be in a real clinical encounter
- Allows students to make mistakes without harming an animal thus allowing them to reflect in a safe space about what went wrong and how they could prevent that in the future (Kalaniti & Campbell, 2015)

Ultimately these advantages are a positive step towards producing veterinary graduates that have achieved the competences required of them upon graduation. However, some of the criticism of simulators include it not being real life, it can involve a considerable amount of money to purchase and maintain the simulators, and students may not see the relevance. Simulators also need teachers that are trained in their use and giving feedback to students (Al-Elq, 2010).

Simulators have been classified based on their fidelity. Low fidelity simulators tend to be low cost and lack much resemblance to the real-life situation. They might only replicate one or two steps from a much more complex task. On the other hand, high fidelity simulators are life sized, can be manipulated in a similar way to a real patient and often have an interactive element (Maran & Glavin, 2003). This can involve some sort of computer software, virtual reality or haptic technology which can change the outcome and outputs from the simulator depending on what the student does e.g. the Noelle ® maternal birthing simulator (NOELLE® - Gaumard, n.d.) used in human medicine. Some high-fidelity simulators can be adapted so that they can be used for learning more than one aspect of a clinical encounter.

Fidelity can also be further described based on;

- Environment
    - where the simulation takes place, ideally this is in a clinical environment similar to where it would happen in real life
- Equipment
    - the actual simulator itself and how this relates to real life
- Psychological
    - how real life the learner perceives the simulation encounter

(Maran & Glavin, 2003)

The literature suggests that clearer definitions of fidelity are needed (Maran & Glavin, 2003). In addition, there is also debate about how much fidelity is optimum for learning and if the additional financial investment needed for a high-fidelity simulator is worth it (Zendejas, Wang, et al., 2013).

1.1.1.1 **Integrating Simulation into the Curriculum**

For simulation to meet the intended learning outcomes it was intended for, it needs to be integrated properly into the curriculum, and various attributes of a successful simulation educational experience have been described (Issenberg et al., 2005) and subsequently evaluated (Cook et al., 2012). It needs to be well planned and have a sense of purpose and place. Attention to detail in the planning stages, making use of realistic scenarios will result in a better learning outcome. By setting the scene and giving the simulation a place within a clinical scenario, other skills such as communication, team working and problem solving can also be learnt over and above the main focus of learning a particular clinical skill (Cook et al., 2012).

Measuring the success of simulation implementation can be difficult. A meta-analysis of simulation-based education for health professionals showed that the effect of simulation implementation can be small and that researchers are often repeatedly asking the same question within their research (simulation versus no simulation (or something else)) rather than exploring new concepts, such as the number of repetitions needed for effective learning with simulation (Cook, 2014).

1.1.1.2 Simulation examples in veterinary education – clinical skills in general

There are numerous examples of simulation being used for teaching clinical skills in veterinary education. There are relatively few that have combined simulation with a bespoke CAL to assess how both of these resources can be used in a blended way. Further information on some of the veterinary education simulators available is shown in Table 1.2 Published research reporting the effect of simulation used in veterinary education.

Table 1.2 Published research reporting the effect of simulation used in veterinary education

Clinical skill and type of simulator (SIM)	Number of students and year	Time with SIM (min)	Blended with CAL yes (Y)/no (N) and control details	Validation of SIM Y/N	Outcomes measured	Results	Reference
Dental cleaning using a low fidelity home-made model	25 3rd year	90	N Control = CAL only	Y	OSCE and Q	100% of SIM students passed compared to 25% of CAL, SIM had higher mean. Q - SIM students had increased conf. CAL – helpful but students wanted SIM	(Lumbis et al., 2012)
Alpaca venopuncture using commercially available model	36 3rd year	30	N (but all students had video access) Control = no further teaching	N	Performance on live animal and Q	No difference in attempts needed, total time and total score.	(Rousseau et al., 2017)
Feline ovarian hysterectomy using homemade model	28 4th and 5th years	Not stated	N Control = no further teaching	N	Q including confidence	Change in conf higher in SIM group compared to students with written instructions	(Badman et al., 2016)

Intravenous injection in horses using homemade elements incorporated into head/neck horse model	24 3rd years (+ 19 vets)	30 x 3	N (but all students had lecture and demo and SIM group also got a CAL). Control = no further teaching	Y	Q on confidence and OSCE on live horse	Confidence in SIM group improved. SIM group had higher OSCE score and less variability NB OSCE assessors gave same scores	(Eichel et al., 2013)
Bovine castration using a homemade model	19 3rd year	120	N Control = live animal training	Y	Performance in live animal castration	SIM group performed better in specific tasks and needed less assistance but took same amount of time. No difference in overall global rating	(Anderson et al., 2021)
Bovine rectal exam using a haptic device	16 3rd year	Not specified	N Control = anatomy lecture and lab	N	Performance in live cow rectal exam	SIM trained students identified the uterus in 56% of cows compared to 3% in control	(Baillie et al., 2005)
Equine rectal exam (including ultrasound) using commercial equine SIM	25 3rd year	40	Y (All students got lecture, demo and case-based e-learning) Control = live horse (4 times or once)	N	Performance of rectal exam and ultrasound in live horse and student self-assessment of skills	Performance better in live horse (4 times). SIM almost as good as live horse (4 times). No difference for ultrasound	(Nagel et al., 2015)

Canine ovario hysterectomy using homemade, low fidelity SIM	74 2nd year	120	N Control = no further teaching	N	Q re anxiety, competence, confidence and knowledge and live animal OSCE equivalent	Anatomical knowledge and competence improved but no difference in confidence, OSCE score and anxiety	(MacArthur et al., 2021)
Blood vessel ligation using a homemade SIM	20 1st year	Ad lib	Y (SIM students also had CAL) Control = CAL	N	Ligation in live animals before euthanasia	SIM trained students better as surgeon/assistant, total psychomotor skills and accuracy	(Smeak et al., 1991)

Observed Structure Clinical Exam (OSCE)

Computer Assisted Learning (CAL)

Questionnaire (Q)

1.1.1.3 Simulation examples in veterinary education – obstetrics

A recently published study reported test scores and confidence questionnaire results, both before and after teaching with a low cost, low fidelity equine obstetrics simulator which was used in conjunction with game technology (Ferreira et al., 2021). The 29 fourth year students had four hours of theory (which included access to videos), then answered a questionnaire (on teaching methodology and confidence) and test (on specific obstetrics scenarios) before they all had access to the simulator. Students then completed a similar questionnaire and test after they used the simulator. Confidence improved for various elements of obstetrics procedures and test scores were higher and had less variability after simulation training.

There are more published studies looking at the impact of three-dimensional (3D) video aids for large animal veterinary obstetrics. Scherzer et al., 2010 assessed the impact of virtual reality video of bovine dystocia by means of a transparent cow (which students could control) when compared to traditional teaching media for 188 second year students over three years. The study reported very slight improvements in multiple choice question and essay results after students had access to the virtual reality video. Another study of 178 5th year veterinary students used 3D animated movies of pregnancy and parturition (with or without guidance) then tested student knowledge, cognitive load and skills. After teaching with the 3D movies, there was no difference in knowledge but there was a difference in skill acquisition and self-efficacy (especially if guidance was given) (Govaere Jan et al., 2012).

1.1.1.4 Simulation examples from medical education – obstetrics

General simulation used in medical education and specifically obstetrics training using simulation has been reviewed several times (Bergh et al., 2015; Crofts et al., 2011; Ennen & Satin, 2010; Zendejas, Brydges, et al., 2013). The general themes that emerge is that simulation training does show improvements in both knowledge, skills and patient outcomes, although sometimes the reported patient benefits are small to moderate (Zendejas, Brydges, et al., 2013). Some of the literature also investigated how long the knowledge and skills gained form simulation training lasts with studies suggesting training on a yearly basis would be advantageous (Crofts et al., 2013).

It appears that the medical profession has the same challenges as the veterinary profession in terms of junior doctors not having been exposed to many cases. As a result, some of them lack confidence and experience and opt for caesarean section rather than an obstetrical manoeuvre as they do not feel comfortable to carry them out (Jaufuraully et al., 2021).

There are numerous different types of obstetrics simulators reported for different emergencies, e.g. uterine haemorrhage, forceps delivery and shoulder dystocia (Ennen & Satin, 2010). Training on forceps delivery and shoulder dystocia appear to be the two that have most similarities to bovine obstetrics. Some examples of studies showing positive outcomes using simulators in training for these are shown in Table 1.3 Published research reporting the effect of obstetrics simulation used in medical education below (those reporting team outcomes are not included).

Table 1.3 Published research reporting the effect of obstetrics simulation used in medical education

Type of simulator	Number and type of student	Time with SIM	Outcomes measured	Results	Reference
Mannequin vaginal delivery SIM	33, 3rd year students	60 min	Competency-based skill assessment tool, self-assessed confidence and patient logs (before and after SIM)	Competence and confidence increased and SIM trained students participated in more deliveries	(Dayal et al., 2009)
Eclampsia, shoulder dystocia, post partum haemorrhage and vacuum assisted delivery	43 obstetricians, 20 residents	60 – 90 mins	MCQ to test knowledge and self-assessed comfort levels before and after SIM (at 0, 4 and 12 months after training)	Improved knowledge and comfort levels but this decreased over time	(Vadnais et al., 2012)
Full sized robotic birth simulator for vaginal delivery (NOELLE)	33 3rd year students	Not reported	Confidence for various steps in vaginal delivery	More SIM students felt ready for full vaginal delivery (88% v 12.5%) and were more confident in some tasks.	(Jude et al., 2006)
Shoulder dystocia training mannequin	Multi-professional (numbers not reported)	30 mins as part of full day emergency obstetrics course	Review of clinical notes before and after training introduced	After training, more manoeuvres were used, reduced neonatal injury and less excessive traction	(Draycott et al., 2008)*
Computerised anthropomorphic robotic birthing simulator (NOELLE) and human actor	20 obstetrics residents	Not specified	Physician graded (1-5) scenario before and 2 weeks after SIM training	Improved overall score for competence of delivery after SIM training and better scores in some tasks	(S.Deering et al., 2006)

(nurse) for vaginal breech delivery					
Computerised anthropomorphic robotic birthing simulator (NOELLE) for basic obstetrics techniques including complete vaginal delivery	3rd year students. 60 untrained, 18 used SIM	90 mins	Knowledge and comfort levels	SIM trained students more comfortable with some tasks	(S. H. Deering et al., 2006)
Shoulder Dystocia using a high fidelity (which measured forces) v low fidelity	45 doctors and 95 midwives	40 mins as part of 1-2 day training course in obstetric emergencies (+/- team work training)	Video recorded assessment of a shoulder dystocia scenario before and after training assessed by trained assessors, communication assessed by actor, force data and key events	Higher successful delivery rate and speed of delivery for both models after SIM. High fidelity trained were less likely to call for support and applied less force. No difference in comms between high and low.	(Crofts et al., 2006)
High fidelity forceps delivery sim	All residents in a programme but number not stated	1 – 2 hours (including assessment)	Review of clinical notes of 6058 forceps-assisted vaginal deliveries 2.5 years after and 7.5 years before training	26% reduction in laceration rate after training	(Gossett et al., 2016)*

*studies reporting patient based outcomes

Multiple choice question (MCQ)

There is a big emphasis in the medical literature on team training with the focus not so much on the skill set of an individual medic but that of the team and how it performs when under the high-pressure environment of an obstetrics emergency. This makes the logistics of training difficult as releasing all parties that could be involved in an obstetrics emergency from clinical work can be difficult to plan (Fransen et al., 2020). As farm animal vets are often working on their own with just a farmer to help them, the team training reported extensively in medical education is not applicable. Furthermore, as newly qualified doctors undergo two years of further training, they are always working under the supervision of a consultant. Newly qualified veterinarians often attend a calving cow initially on their own and call for help if or when they need it.

Organisations such as Practical Obstetric multi-Professional Training (PROMT) provide freely available guidelines on best practice in human obstetrics which is based on published evidence (which is graded in terms of quality) so that there is a universally accepted approach to various scenarios (*Fetal Outcomes | PROMPT Maternity Foundation*, n.d.). While doctors are reminded that these are guidelines and need to be used in context of an individual patient, they at least go some way to producing a standardised approach, which in the case of possible litigation, would be very welcome in the veterinary field. As well as clinical guidelines, PROMPT also includes recommendations on training (knowledge, simulation and clinical) and competency demonstration before doctors carry out a birth unsupervised.

1.3.4 Blended learning

The Higher Education Academy describes blended learning as an approach that uses '*multiple methods to deliver learning by combining face-to-face interactions with online activities*' (Blended Learning | Advance HE, n.d.). There is a huge variety in the different teaching modalities used in a blended approach to learning. The face-to-face element can include lectures, practical classes and tutorials. The online component can include video, quizzes, online lectures and interactive cases. There is a huge amount of complexity in the way a blended learning approach can be implemented with students directed to spend different amounts of time on each activity (Garrison & Kanuka, 2004). It is important that the balance of face-to-face and online activity time is optimal, and the online material needs to be properly integrated into the timetable for the blended approach to work effectively. During the Covid 19 pandemic, all learning had to be transferred to an entirely remote and online method of delivery, but as restrictions eased and some face-to-face teaching was permitted, blended learning was thrown into the limelight (Parkes & Barrs, 2021). As we emerge from the Covid-19 pandemic and try to live with the virus, the legacy of the change in teaching delivery during this time has given educators an opportunity to review what elements of the remote learning worked well and to combine this, using a blended learning approach, with the most appropriate face to face activities (Simons et al., 2022).

The advantages of a blended learning method are that it is student centred, which allows more flexibility for learning with the opportunity to do the online component at a time that suits students; this often generates more opportunity to review online material which can empower them to take control of their own learning (Garrison & Kanuka, 2004). This is an important skill for students to learn as they embark on Continuing Professional Development (CPD) after graduation (RCVS, 2020). It also gives educators the opportunity to develop innovative new ways to deliver a subject and may reduce timetabled staff time requirement if a topic that was previously taught via intensive face to face sessions could be adapted and delivered online instead. A blended approach can take the pressure off tightly scheduled practical sessions with students using the online material to prepare for the practical session giving students more time to do the practical aspects of a skill when in the practical (Lehmann et al., 2013).

The disadvantages of a blended approach are that it takes time and expertise to plan, create and implement online material which needs backing from faculty, driven by overriding educational policy (Garrison & Kanuka, 2004). It also requires good information technology (IT) infrastructure and support as students quickly become frustrated if the activity does not work or they do not have access to the material (Kelly et al., 2019). Students and staff may also be reluctant to embrace it if they are used to more traditional ways of teaching and learning.

The impact of blended learning in medical education was recently reviewed by Müller & Mildenberger (2021), and findings of the review suggest that positive differences between blended learning and traditional classroom teaching are actually quite small. In another review of blended learning adoption in Higher Education, researchers state that studies more often report the student perspective and rarely that of the educator or administrators implementing the online blended material (Anthony et al., 2020). That said, there are some reports of success in clinical skills taught in veterinary education. A study of first year veterinary students learning cat restraint and physical exam where a blended approach was compared to a conventional lecture and face to face practical showed students in the blended group were more confident with some aspects of cat restraint and physical exam and the authors reported an overall positive effect of the blended approach (Duijvestijn et al., 2021).

The medical literature has also reported success with a blended approach for learning of clinical skills with fifth year medical students that were exposed to online virtual patients, combined with practical lab sessions, lectures and problem based learning sessions for skills training in paediatrics. This study reports an overall high acceptance rating for the blended design and the qualitative results showed that students liked the individuality the online virtual patients allowed. The tutors also reported that students were well prepared for the practical sessions (Lehmann et al., 2013).

1.3.5 Role of Extra Mural Studies (EMS)

Exposure of students to real life cases and practical, hands-on experience of calving cows is highly reliant on EMS as exposure to cases in most university teaching establishments is very limited. In the UK, the RCVS specifies the number of EMS weeks each student needs to carry out which is currently 38 weeks in total over the course of their undergraduate veterinary degree programme. Students should spend 12 weeks in a pre-clinical/animal husbandry type setting and 26 weeks doing clinical EMS (RCVS, n.d.). While students value their EMS placements, various issues with EMS have been highlighted (and are listed below) which could mean that students are not exposed to calving cows while on EMS.

- Quality of placements can be highly variable unless students have been given a specific recommendation from another vet student
- It is expensive if students need to travel to EMS placements and pay for accommodation nearby. This may limit the EMS opportunities a student can partake in and cause competition between students for placements close to university
- Health and safety concerns from supervising veterinarians and students may dictate that a student cannot get involved with a clinical encounter
- Potential discrimination and inequality of students while on placement
- Mismatch between what the student gets from EMS and what the supervising veterinarian feels they are obliged to provide
- An increasing number of veterinary schools in the UK (45% increase in the last 10 years) means more students are looking for EMS placements
- The recruitment and retention crisis hitting the sector means that veterinarians in practice are under increased time pressure which means they have less time to teach EMS students
- There is an element of being ‘in the right place at the right time’ and during the busy spring calving period, students may not be available for EMS placements due to commitments of their course

(RCVS, 2021)

When it comes to EMS exposure to calving cows, calls to calve a cow might not happen during the day, the student might miss the call if they are out with another veterinarian, and they might attend at a quiet time of year when no calvings are taking place. As calving is a stressful and high stakes event, even if students have chosen a farm animal EMS placement and make it out on the call to calve the cow with an experienced veterinarian, the student might not be given the opportunity to get involved during the procedure. The farmer and supervising veterinarian may be concerned about animal welfare if the student was to get involved and then subsequently make a mistake. The supervising veterinarians also cannot visualise inside the cow to see what the student is doing. If the student had received some formal training at veterinary school, the veterinarian and farmer might feel more re-assured and allow the students to get more involved.

While exposure to real-life clinical cases in a university setting are understandably limited, veterinary educators definitely have a role in providing veterinary students with bovine obstetrics teaching in another way and simulation teaching using a blended learning technique is one possible option which deserves further exploration. It is important that students feel equipped with the skills needed when they go out onto EMS so that they are willing to have a go should the opportunity to get involved with a cow calving present itself.

1.4 How do you assess student success in calving a cow?

1.4.1 Confidence

The Wikipedia definition of confidence is the *'state of being clear-headed either that a hypothesis or prediction is correct or that a chosen course of action is the best or most effective'* (*Wikipedia, Confidence*, n.d.). In a medical context it has been defined as a judgement which influenced whether an individual was willing or not to undertake an activity (Stewart et al., 2000). In the veterinary field confidence has been described as new graduates believing in themselves/their ability to succeed and it is regarded as essential for communication and effective team working (Casey, 2019). Confidence is context specific, dynamic and can change over time. It is needed in addition to competence to allow students to carry out a task (Perry, 2011).

Low levels of confidence can be associated with negative emotions such as anxiety and stress which can be detrimental to patient safety (Leigh, 2008; Stewart et al., 2000). If students are suffering from anxiety they might have shaky hands, make mistakes and take too long to do a task which could have patient safety implications (Rezaiefar et al., 2019). Students and new graduates could miss out on learning opportunities if they do not have the confidence to do a task (even if they have demonstrated competence) (Bambini, 2009; Vinten, 2020). Lack of confidence can be a barrier to students 'having a go' at certain tasks which decreases confidence even more (Bell et al., 2019). It also makes clients feel uncomfortable and can interfere with the important trust relationship between client and veterinarian (Tenney et al., 2008). On the other hand, there are also issues with students that are overconfident for example, these students may attempt procedures that are beyond their capabilities. Similar to low confidence this puts patient safety at risk. They tend not to engage with feedback and spend less time processing their thoughts and thinking about the consequences of their actions (Perry, 2011).

Ultimately animal welfare can be compromised at the hands of both an under- or an overconfident veterinarian which can negatively impact the essential trust needed for an effective client and veterinarian relationship (Bell et al., 2019; Ruston et al., 2016; Tenney et al., 2008). Moderating confidence depending on the situation is therefore a critical step where learners need to balance lack of confidence holding them back and too much confidence having an impact on patient safety. In the context of being a farm animal veterinarian, having confidence in their abilities was reported as a reason for farm animal veterinarians staying in the profession, and reasons to leave included a negative out of hours experience or 'not feeling good enough' (Adam et al., 2019). Therefore, having the confidence to at least, adequately assess the animal and be able to decide on the right course of action, is essential to graduates gaining a positive experience of farm animal practice. Educators have a responsibility to ensure newly graduated veterinarians have enough confidence in their abilities as this could aid retention of veterinarians in farm practice.

Confidence can be enhanced if learners are provided with a supportive environment with less uncertainty in which to learn (Gottlieb et al., 2022). Experience therefore is essential and as EMS opportunities can be both variable and difficult to come by, especially for farm animal EMS (RCVS, 2021), a simulator which exposes students to tasks they might encounter out in practice can play a crucial role. Confidence needs to be considered in combination with basic knowledge and a certain level of competence (Perry, 2011) (see later).

There are specific tools available for measuring confidence, but many researchers make up their own measuring tools which are often based on a Likert type scale with descriptors and must be validated before being used (Casey, 2019; Perry, 2011). Some of the difficulties encountered when asking students to self-assess their confidence levels are that some students might downplay their confidence so as not to appear overconfident or cocky. In addition, students that have very little experience of a task, might not know enough about it, to say how confident or otherwise they feel about doing it (Morton et al., 2006). Other useful ways to measure confidence are to do thematic analysis of portfolio reflection or to video record students and score their body language. Knowing what level of confidence is enough for a task to be done safely and effectively is very difficult to know and will be different for each individual (Vinten, 2020).

The relationship between confidence and self-efficacy is also worth exploring albeit difficult to unpick. Much of the initial constructs on self-efficacy came from Albert Bandura and his works are extensively cited in this field (Bandura et al., 1999). Many of the theories described above for confidence can also be applied to self-efficacy and often the terms self-confidence and self-efficacy are used synonymously (Gottlieb et al., 2022). For example, both can be increased in ways such as success in doing the task, watching someone else having success doing the task, receiving positive feedback about their performance with a task and motivation to do the task (Bandura, 1986).

It should be noted that the two terms refer to different constructs, however. Self-efficacy is a term that is based in social cognitive theory and is described by Bandura as ‘people’s beliefs in their capabilities to produce given attainments’ (Bandura et al., 1999). Self-efficacy is needed in order to perform an action (through psychological, emotional or physiological changes) and to achieve general life goals. People with higher levels of self-efficacy tend to perform better (Artino, A. R., 2012). Confidence, as defined previously is more of a state of mind that might not always result in an action and the theoretical frameworks behind this term are less well described.

1.4.2 Competence

Competence-Based Medical Education (CBME) has been used in the context of medical education worldwide for a number of years. The foundations of CBME are student-centred with students demonstrating competence in a particular outcome before progressing rather than just making them spend time learning presuming, that they have achieved the outcome. In veterinary education, various competence frameworks are in circulation. Most recently an international and inter-institutional collaborative CBME framework was established by veterinary schools that are members of the Association of American Veterinary Medical Colleges (AAVMC) (Molgaard et al., 2018) and the methodology for how the framework was produced was also published (Mathew et al., 2020). The framework has nine essential competency domains. Calving a cow would involve many of the nine domains including 1. Clinical reasoning and decision making, 2. individual animal care and management, 5. Communication, 6 Collaboration, 7. Professionalism and professional identity and 8. Financial and practice management.

As mentioned above, accrediting bodies such as the RCVS publish a list of day one competences expected from students upon graduation. The RCVS define competence as ‘*the knowledge, skills and attributes required of veterinary students upon graduation to ensure that they are prepared for their first role in the profession and safe to practise independently*’ (RCVS, 2022). The competences required of a new graduate working in farm animal practice have also been defined by published research of veterinarians working in the field (Duijn et al., 2019).

Linked to the CBVE framework described above, EPA’s were also developed (Salisbury et al., 2020) and were previously described in section 1.1.1 above. EPA’s can be used as a basis for assessing competence in a workplace context. Assessing competence can take many forms including Observed Structured Clinical Exam (OSCE), Direct Observation of a Procedural Skill (DOPS), performance in a clinical setting or within a student portfolio. The accrediting bodies do not dictate how the competencies they prescribe for new veterinarians upon graduation should be assessed and it can be difficult to assess competence until students are actually in the workplace with real life situations (Vinten, 2020). Arguably, veterinary students need to attain a higher level of clinical skill competence upon graduation when compared with medical students as new graduate vets are expected to go into to the workplace with less supervision and much less structure to their further development (Baillie et al., 2014).

For the purpose of this literature review, only the OSCE method of competence assessment is reviewed.

1.1.1.5 **What is an OSCE?**

As education of medical professionals has developed over the years to encompass more emphasis on clinical skills, the need to develop reliable and valid means of assessing these clinical skills has emerged. The written examination has its place but for assessing the ‘how to’ do a task. the written exam cannot be used (Miller G, 1990). The Objective Structured Clinical Examination (OSCE) was first introduced in the 1970’s in response to the changing demands of competencies required to be assessed in certain subject areas as well as the need to make the assessment standardised (Hodges, 2006). It is now widely used in many medical subjects including veterinary medicine.

OSCE often involves a standardised patient or simulator. The theory is that if the student can perform the task on the standardised patient or simulator they should be able to do the task on a real patient.

The OSCE involves a timed task (generally 5 – 15 minutes) of a practical nature. Considerable thought and planning is needed in order to produce a valid and reliable OSCE examination. The first step is to identify the task that you want to assess then to break that down into individual elements (Hodges, 2006). Then, these elements are formed into a checklist of items to be assessed and awarded a numerical score during the OSCE. Items in the checklist can be weighted so that the most important aspects of the exam are worth a higher proportion of the total marks (Coombes & Silva-Fletcher, 2018). Importantly, the checklist should be pilot tested and edited (validation) before being used in a summative examination (Davis et al., 2008). The equipment, personnel and logistics of the exam need to be considered and planned for. In addition suitable examiners need to be recruited prior to the OSCE and they need to have sufficient expertise in the subject area and be trained in OSCE assessment before they embark on any assessments (Davis et al., 2008; May & Head, 2010).

During the OSCE, the student is given instructions and asked to perform the practical skill within the time available. The examiner observes the student and awards a numerical score based on the sum of the individual checklist items (the objective component of the OSCE). Independent of the numerical grade from the checklist items, the examiner also awards a global rating. This classically is based on four or five rating descriptors e.g. fail, borderline fail, borderline pass, pass and excellent. Before the exam, assessors should agree on some descriptive standards for each of the global ratings.

Students themselves tend to rate OSCEs as a ‘good’ assessment as they involve day one practical skills which are important to them and drive their learning (Turner & Dankoski, 2008). That said, the OSCE exam is not the perfect method of assessment, and it has some flaws. It is very labour intensive to prepare and run on the day (Gormley, 2011), there can be variation between examiners, and some critics claim it does not reflect the real world (Davis et al., 2008; May & Head, 2010). This is particularly noticeable when students learn the items on a check list and go through a box ticking exercise in the exam (Hodges, 2006). In addition, more experienced students can be disadvantaged as they might use pattern recognition and come to conclusions quicker than less experienced students and as a result, lose out on checklist scores as they do not do all of the tasks listed (Hodges, 2006).

The advantages of using simulation in an OSCE over a real-life clinical encounter include the ability to standardise the exam (making it the same for each student), reducing animal welfare and ethical concerns of repeated use of animals during an assessment, reducing anxiety in students if no real animals are involved and negating the need to source reliable clinical material (Davis et al., 2008; Hodges, 2006; May & Head, 2010).

1.1.1.6 Standard setting an OSCE

Various methods of standard setting a pass score for OSCE exams have been described and evaluated (McKinley & Norcini, 2014). Each has its own merits and the context of the exam needs to be considered before deciding what method to use. The methods fall into two categories (McKinley & Norcini, 2014)

1. Relative (examinee centred or norm referenced) – which involves calculating the pass mark based on the students that sit the exam on that particular day. This means, the pass score may change from one exam to another which can be an advantage when external factors can influence the exam e.g. live animals.

2. Absolute (exam centred or criterion referenced) - which involves a panel looking at the exam beforehand and deciding what the pass standard should be. This is used more when there is a credential type exam e.g.

RCVS licence exam and will result in an unknown proportion of students either passing or failing.

The borderline regression method is classed as a relative method for standard setting an OSCE exam and it seems to be one of the more popular methods adopted (Boursicot et al., 2011; Coombes & Silva-Fletcher, 2018). In this method, the results for the exam are used to plot a linear regression which plots the global rating as a numerical element along the x-axis e.g. Fail = 1, borderline =2, pass = 3, excellent = 4, against the numerical scores on the y-axis. The pass mark is established by calculating where on the numerical score scale the regression line crosses the 'Borderline = 2' on the x-axis. The reliability of this can be measured by using the R squared value for the regression line graph, with an R squared value of > 0.55 deemed acceptable (Patterson, 2015). OSCE 'Pass' or 'Fail' results for each student are then established depending on the new pass mark. The examiners assessing on the day do not know the numerical pass mark for the exam. The borderline group method has also been described but this method only performs the regression on the students that were in the borderline category so can be problematic if the exam involved small numbers of students or only small numbers of students were in the borderline category (Dwyer et al., 2016).

1.4.3 Relationship between confidence and competence

As reported above, there are distinct differences between confidence and competence and a recent review of the relationship between the two in medical education identified that the recent emphasis on CBME frameworks does not address the importance of confidence. Confidence and competence need to be considered together and the relationship between the two could be measured in ratio terms, over time. Although there will be variability depending on the situation, ideally they should mirror each other (Gottlieb et al., 2022). Knowing what threshold of confidence and competence is needed for a learner to carry out an action successfully is also an essential component of this complex relationship.

A related concept is the Dunning-Kruger effect where students that lack expertise or are poor performers are unaware of how poor they actually are. As a result, a student with poor competence may be overconfident in their abilities and the opposite can also occur with high performers underestimating their ability (Dunning 2011). Within the context of calving a cow, an overconfident new graduate that lacks competence might rush into extracting a calf that they think could be delivered successfully per vagina only for the calf to get stuck during delivery. On the other hand, an underconfident student that has the competence, might be reluctant to attempt extraction of such a calf and waste valuable time waiting on help rather than just getting on with a caesarean section.

There is conflicting evidence in the literature about the relationship with the two. There are many studies in medical education that report that the two are poorly correlated (Barnsley et al., 2004; Morgan & Cleave-Hogg, 2002; Rezaiefar et al., 2019; Root Kustritz et al., 2011). However, there are some reports of confidence and competence being correlated (Clanton et al., 2014; Guarenghi et al., 2019). It is clear that both are needed for a graduate to carry out the tasks that would be expected of them in their first job.

1.4.4 Theoretical frameworks for assessing educational interventions

Miller, M.D. (1990) suggested a framework for assessment of clinical skills/competence/performance based on a pyramid which from base upwards includes knows (knowledge), knows how (competence), shows how (performance) and does (action). This was seen as a positive step towards getting away from simple knowledge recall type assessment. A more specific framework for assessing educational interventions is the Kirkpatrick model which was first published in 1959 with further updates over the years (Kirkpatrick et al., 2006).

The four levels of the Kirkpatrick framework with increasing validity are:

1 – Student rating of the educational intervention
2 – What did students learn, what skills were gained, what changed (all within an educational setting)
3 – Did student behaviour change in a real-world setting
4 – What was the return on investment or contribution of the intervention. In a medical context this would be seen as patient based outcomes

This model has been criticised however and new models either based on Kirkpatrick's or using new concepts entirely have been proposed (Tamkin et al., 2002).

1.4.5 Patient-based outcomes

As mentioned above measuring the effectiveness of simulation in education by measuring student confidence or competence levels (Kirkpatrick's level 2) has been criticised (McGaghie et al., 2016). It could be argued that asking students what they thought of the simulation having no prior experience of the skill themselves is not appropriate and that assessing competence on a simulator is nothing like a real-life scenario.

The ultimate goal when assessing effectiveness of simulation implementation is measuring patient-based outcomes (Calvert et al., 2013). In other words, if a student was taught using a simulator, do patients that they are subsequently treating have less complications, feel better, live longer or indeed live at all. Measuring patient-based outcomes is challenging to do but is where educators should be concentrating their efforts. These challenges, such as nature of farm animal work being remote, emergencies situation not lending themselves to research and the fact that graduates disperse all over the world after graduation mean that reports of these types of outcomes are definitely lacking in the veterinary medical literature. It was previously lacking in the medical education literature, but recently more medical studies are reporting patient outcomes. Currently most of the published studies on the impact of medical simulation for obstetrics report neonatal outcomes but not outcomes for the mother and the literature suggests some studies are poorly designed acknowledging that reporting patient-based outcomes is difficult to do well (Calvert et al., 2013).

1.5 Conclusion

This literature review aims to communicate that there is a definite need to teach students how to calve cows in an effective way. The procedure is complex and involves a variety of different skills, and so it is important that any teaching implementation is evaluated in an appropriate way to make sure teaching is effective. In addition, teaching these clinical skills is labour and resource intensive, so looking at alternative ways to teach this skill is also of relevance. It is hoped that if teaching of calving cows is done well, graduates will leave veterinary school with the competence and confidence levels needed for this day one competence thereby positively influencing farm productivity, animal health and welfare and veterinary surgeon well-being.

1.6 Aims

There are two main aims for this research project

1. Investigate the impact on veterinary undergraduate student confidence and competence in calving cows following the implementation of a calving simulator as part of a blended learning approach.

2. Investigate the demographic factors that influence student competence and confidence calving cows following the implementation of a calving simulator as part of a blended learning approach.

Chapter 2 Materials and Methods

2.1 Bachelor of Veterinary Medicine (BVMS) Programme

The Bachelor of Veterinary Medicine (BVMS) undergraduate programme at the University of Glasgow (UOG) School of Veterinary Medicine (SVM) is a five-year, full-time programme. The course went through significant curriculum review and change to modular structure in BVMS years 1-5 from 2013. Years 1-4 became more integrated in relation to the underpinning 'ologies' with systems defining most of the generally four-week modules both in foundation, BVMS 1-2, and clinical phases BVMS 3-4, providing clinical context to the underpinning sciences. This also allowed progression from understanding the sciences underlying disease (in the Foundation Phase) to the clinical diagnosis and management of disease in the Clinical Phase. In final year, the course is lecture free and involves small groups of students rotating around six different clinical environments in four-week rotations. Therefore, all final year students partake in a four-week production animal module which consists of two weeks spent in the farm animal hospital on the University campus, one week out on herd visits (doing mainly routine fertility visits) and one week in first opinion farm animal practice with an external placement provider.

The aim of the new curriculum was to produce students that were better equipped to be independent life-long learners using student centred learning methods. The curriculum is spiral, with topics re-visited in more depth and with a clinical focus from the foundation to the clinical and professional phases throughout the programme. A range of teaching methods are used e.g. whole class lectures, small group practicals, self-directed learning activities (online or as in-course tasks to be submitted) and clinical reasoning workshops. Clinical and professional skills are taught and assessed from BVMS1. The structure of the course is summarised in Table 2.1 Summary of teaching in the BVMS curriculum (green highlight = reproduction and obstetrics teaching modules, red highlight = timing of the study presented in this thesis)

Table 2.1 Summary of teaching in the BVMS curriculum (green highlight = reproduction and obstetrics teaching modules, red highlight = timing of the study presented in this thesis)

BVMS Year	Phase	Modules (BVMS 1-4) Core Rotations (BVMS 5)	Other curriculum elements	
1	Foundation	1.1 Getting started 1.2 Natural defences 1.3 Digestion 1.4 Infectious agents 1.5 Reproduction 1.6 Urinary system	Clinical and professional skills (which includes a self-reflective portfolio)	12 weeks of pre-clinical extra mural studies
2		2.7 Skin and bones 2.8 Neural Networks 2.9 Respiration 2.10 Cardiovascular 2.11 Niches Species 2.12 Integrated body systems		
3	Clinical	3.13 Being a vet is being professional 3.14 Supporting the patient 3.15 Cardiorespiratory and haemopoietic 3.16 Alimentary 3.17 Urinary, endocrinology and oncology 3.18 Ruminant Production 1 (birth to point of production) 3.19 Farmed species and meat harvest (2016/17 and 2017/18) Veterinary Public Health and Aspects of Food Safety (2018/19)		26 weeks of clinical extra mural studies
4		4.20 Global Veterinary Medicine 4.21 Ruminant production 2 (production)		

		(study carried out here) 4.22 Clinical Reproduction and Fertility 4.23 Neuro-locomotor 4.24 Skin, Eye, Niche & Pets, Zoo & Wildlife 4.25 Food hygiene & safety (2016/17 and 2017/18) Intensive animal medicine/business & finance (2018/19)		
5	Professional Core rotations	Anaesthesia and Diagnostic Imaging Small animal – Primary Care Small animal - Specialist Equine Practice Production Animal practice Public Health and Pathology (students also chose two 4 week selective rotations in an area of veterinary medicine that interested them)		

2.1.1 Parturition and obstetrics teaching within the programme

2.1.1.1 Foundation Phase

In first year, there is a five-week reproduction module. This includes a total of four, 50 minutes lectures on normal parturition, lambing obstetrics, and the neonatal care of lambs and foals, plus an online, timetabled SDL (self-directed learning) activity where students answer questions in relation to videos of normal parturition and normal neonate behaviour in the different domestic species, hosted in a learning resource library linked to the Virtual Learning Environment (VLE). These videos include calving aids used and the neonatal care of the calf. Students also receive practical classes on lambing using a simulator box with a ewe pelvis and lambs that had unfortunately died after birth on-farm and were frozen-thawed for the practical. This is a relevant simulator, as it also gives palpation and correction practice, with no visual aids as well as discussing different obstetric scenarios. Students look at and role play different presentations and positions of the limbs and head. They take turns in arranging different malpresentations and watching from above, while the other student palpates and corrects, so it is very similar to the calving simulator described later. This same simulator is used for assessing lambing competence in the lambing OSCE (see following section). Pictures of the lambing simulator are shown in Figure 2.1 Lambing simulator used for teaching sheep obstetrics in BVMS 1.

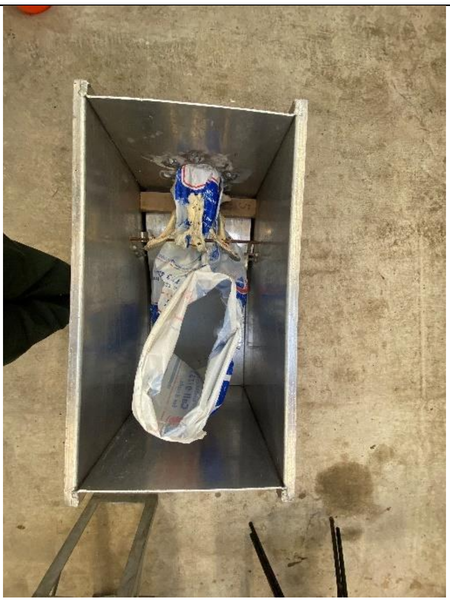
	
Figure 2.1.1 Side view of lambing box mounted at correct height to mimic real sheep	Figure 2.1.2 Inside view of lambing box. White bag mimics the uterus and pelvis/sacrum bones are in normal anatomical position

Figure 2.1 Lambing simulator used for teaching sheep obstetrics in BVMS 1

2.1.1.2 Clinical Phase

Students are specifically taught bovine obstetrics in the third-year *Ruminant Production 1* module during three, 50-minute lectures with the following titles and content;

- Lecture 1 - Pre-partum conditions of cattle and the approach to the normal calving. This includes vaginal prolapse, calving history taking, initial examination, common malpresentations and how to correct them, how to assess for foetal oversize and how to extract the calf using a calving aid.

- Lecture 2- Complicated calving and post-partum conditions of cattle. This includes twisted uterus, deformed calves, uterine prolapse, nerve damage as well as resuscitation and initial care of the calf.

- Lecture 3 - Reproductive surgery of the adult ruminant, which includes caesarean and episiotomy.

In fourth year, the students received a four-week *Ruminant Production 2* module and a four-week *Reproduction and Fertility* module. There are no specific bovine (or any other species) obstetrics lectures in either of these modules but there is reference to obstetrics where appropriate, for example in a bovine rectal practical when students may examine and discuss early postpartum cows. Practical teaching with the calving simulator (described in more detail below) was carried out during a six-week teaching period split between the two aforementioned modules (four weeks of module 4.21 and the first two weeks of module 4.22). As in the foundation phase, students are directed to pre-existing video material in the VLE. For the purpose of this study, however, access to bespoke, newly made video material was controlled during the study period (see later).

2.1.2 Parturition and obstetrics assessment within the programme

Parturition and obstetrics assessments takes place throughout the programme using various assessment modalities as described in Table 2.2 Parturition and obstetrics assessment in BVMS 1 to 4 (Green highlight = assessment used in this study). The formative calving OSCE investigated in this study is highlighted in green. Assessment is used to assess knowledge, as well as clinical and professional skills of the undergraduate students. This informs progression through the curriculum and ultimately fitness to practise/graduate. The written and spot degree exams in BVMS1 frequently include relevant MEQs (modified essay question) and DIQs (Data interpretation question), as well as Observed Structured Clinical Examinations (OSCE) using lambing aids. The written BVMS3 exams sometimes included a calving relevant Clinical Decision Making (CDM) question, while written exams in BVMS4 sometimes included the parturient bitch or mare, caesarean indications in the bitch, or clinical management of neonatal puppies or foals.

Table 2.2 Parturition and obstetrics assessment in BVMS 1 to 4 (Green highlight = assessment used in this study).

Type of assessment	Subject areas assessed			
	BVMS1	BVMS2	BVMS3	BVMS4
Written exam (MEQ, DIQ, CDM, EMQ and MCQ)	Reproduction and normal parturition, neonatal care	-	Cattle and sheep obstetrics and neonatal disease	Bovine peri- and post-partum diseases and herd health implications, clinical management of the periparturient dam and neonates in other domestic species
Spot exam (mostly anatomy)	Reproductive tract anatomy, lambing aids	-	-	-
OSCE	Sheep lambing (formative)	Sheep lambing (summative)	Calving communication skills (formative)	Calving using simulator (formative and summative)
DOPS	Cattle handling and BCS, sheep turning (proportion of students pass this in BVMS 1)	Cattle handling and BCS, sheep turning (remaining students must pass in BVMS 2)	-	Cattle clinical exam

MEQ – Modified essay question

DIQ – Data interpretation question

CDM – Clinical decision-making question

EMQ – Extended matching question
MCQ – Multiple choice question
DOPS – Direct observation of procedural skill
OSCE – Observed structured clinical examination
BCS – Body condition score

In terms of practical obstetrics assessment, prior to the purchase of the calving simulators there was no practical (formative or summative) assessment of bovine obstetrics. When the simulators were purchased in early 2016, a new bovine obstetrics clinical skills practical and OSCE were developed and integrated into the BVMS4 curriculum as described below. As well as the formative assessment described for this study, a calving OSCE was then also used for the end of the year summative assessment in BVMS4.

2.1.3 Extra Mural studies (EMS)

The Extra Mural Study (EMS) requirements of the course are prescribed by the Royal College of Veterinary Surgeons (RCVS). EMS is an extension of the training provided by the University and the aim of EMS is to expose students to clinical practice (in various aspects of veterinary medicine) to help develop their practical, clinical and professional skills (RCVS, n.d.). Students are responsible for arranging their own EMS placements. As a result, the species and type of placements undertaken by students can be quite varied.

In the foundation phase at UOG students partake in pre-clinical EMS. The students in this study needed to complete twelve weeks in total where the focus was on management and handling of domestic animals. It was mandatory that this included two weeks each of dairy, lambing and equine, the other six weeks were flexible. The absolute majority of students will have had adequate to extensive lambing practise by the end of BVMS2.

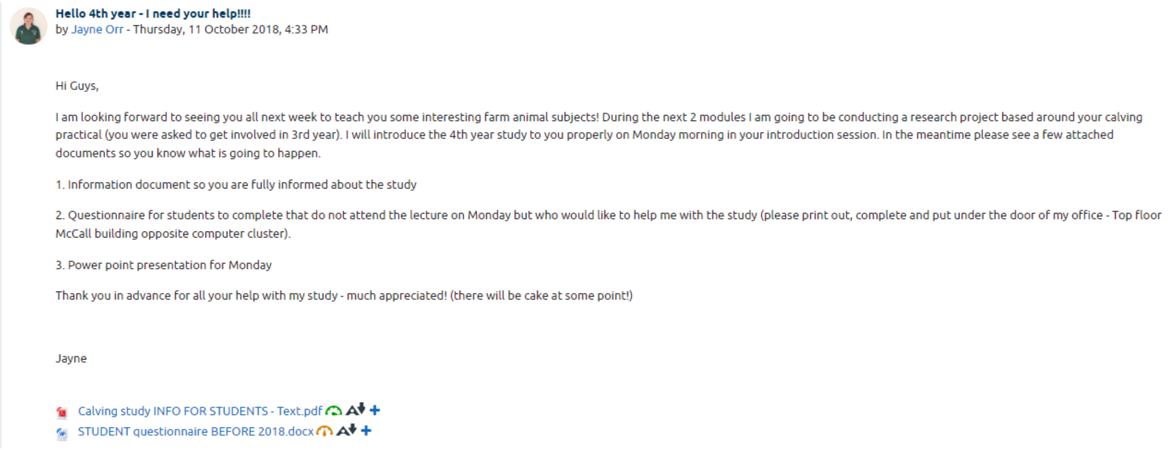
In the Clinical and Professional phases students undertake clinical EMS. From the end of BVMS2 to the end of BVMS5, the students in this study needed to complete 26 weeks of clinical EMS (20 weeks of which needed to be practical placements) over the three years in total. It was not specified how many weeks students should spend in each species area and the questionnaire (see later and appendix 4) did not ask students to specify this. From experience, ½ to ¾ of the students will equally divide between mixed / farm animal or dedicated small animal clinical placements, however, exposure to real life calving scenarios is highly variable even within a farm animal placement.

2.2 Teaching modality study design and integration into curriculum

2.2.1 Ethics and consent

Prior to commencing the study, ethical approval was sought from the University of Glasgow Ethics Committee (application number 20016009). This application was then amended and approved to include data beyond May 2018 (the final study cohort and data collection was in November 2018) and for gathering questionnaire data from students via paper forms.

Students were informed about the study one week before the experimental teaching period in each study year by way of a forum (see later) post on the Virtual Learning Environment (VLE). The forum post included a Portable Document Format (PDF) attachment of the ‘Information for students’ document (see appendix 3.1) and a copy of the Before Teaching Questionnaire (BTQ). An example of the forum post can be seen in Figure 2.2 Screenshot of forum post used to introduce the study to students in 2018/19.



Hello 4th year - I need your help!!!!
by Jayne Orr - Thursday, 11 October 2018, 4:33 PM

Hi Guys,

I am looking forward to seeing you all next week to teach you some interesting farm animal subjects! During the next 2 modules I am going to be conducting a research project based around your calving practical (you were asked to get involved in 3rd year). I will introduce the 4th year study to you properly on Monday morning in your introduction session. In the meantime please see a few attached documents so you know what is going to happen.

1. Information document so you are fully informed about the study

2. Questionnaire for students to complete that do not attend the lecture on Monday but who would like to help me with the study (please print out, complete and put under the door of my office - Top floor McCall building opposite computer cluster).

3. Power point presentation for Monday

Thank you in advance for all your help with my study - much appreciated! (there will be cake at some point!)

Jayne

Calving study INFO FOR STUDENTS - Text.pdf
STUDENT questionnaire BEFORE 2018.docx

Figure 2.2 Screenshot of forum post used to introduce the study to students in 2018/19.

On the first day of the experimental teaching period, students had a module introduction session with faculty staff in one of the lecture theatres. During this session, students were also given a ten-minute study briefing presentation by the principal researcher. This included information on what was involved in the study, how their information would be stored/used and gave them the opportunity to ask any questions (See appendix 3.2 for example power point presentation). Students were advised that at any point they could withdraw from the study by emailing the researchers.

Written consent was obtained from students when they completed the before teaching questionnaire (BTQ, see further details below). The BTQ contained a consent section on the first page. Students had to tick a box to acknowledge they consented, see appendix 4 for further details of consent. Overview of study design

The study was designed around the existing curriculum to avoid disruption to the course. There were 347 4th year students eligible to take part across all three study years. In each study year, 2016/17, 2017/18 and 2018/19, the students were divided into four different experimental teaching groups exposed to different (individual or combined) teaching modalities. Further description of each teaching group is shown in Table 2.3 Teaching group name, abbreviation and description. The term ‘teaching group’ will be used throughout this thesis when referring to the experimental groups exposed to different modes of teaching.

Table 2.3 Teaching group name, abbreviation and description

Teaching group	Teaching group abbreviation	Description
1. Lecture only	LEC	No further teaching over and above the specific cow calving lectures that were delivered in BVMS3
2. Lecture and computer assisted learning only	CAL	BVMS3 lecture material plus access to the Computer Assisted Learning (CAL) video resources for the practical*
3. Lecture and calving simulator practical class	SIM	BVMS3 lecture material plus the calving simulator practical class (SIM)
4. Lecture and computer assisted learning and simulator class	CAL & SIM	BVMS3 lecture material plus the computer assisted learning (CAL) and the calving simulator practical class (SIM)*

*these are recognised blended approaches to teaching, with face to face lectures supported by a CAL (2.), or a SIM practical supplementing the CAL (4.)

2.2.2 Assigning students to teaching groups and planning the schedule of events

To simplify assigning students to teaching groups, previously assigned student lab groups were used. These numerical lab groups are set up by teaching administration staff and used for scheduling of practical classes throughout the BVMS course. There were 45 (2016/17) or 48 (2017/18 and 2018/19) lab groups in each study year, with two to three students in each lab group. Therefore, assigning two (very occasionally one) lab groups per calving simulator class resulted in a maximum of six students per calving class, and as there were two simulators, two to three students per simulator.

The experimental study was carried out over the first three and a half-weeks in the *Ruminant Production 2* module, which is a four-week module closely followed by 2 weeks of ruminant reproduction teaching (as part of the clinical reproduction & fertility module). This meant that over the whole six weeks of ruminant production and reproduction teaching a total of 24 calving simulator practical classes (and all of the 45 or 48 lab groups) could be scheduled (two calving simulator practical classes per teaching day, and there were two teaching days per teaching week). However, halfway through, after the three and a half weeks of teaching delivery mentioned above, a formative calving OSCE was scheduled on the Wednesday or Thursday of week four of the *Ruminant Production 2* module.

The scheduling of lab groups to the calving simulator practical class before or after the formative OSCE then defined what teaching group each lab group and therefore, each student was part of, either SIM or CAL&SIM if scheduled before the OSCE, or either CAL or LEC if scheduled after the OSCE. The lab group numbers assigned to a practical class before the formative OSCE were split evenly between the SIM and SIM&CAL teaching groups (26 lab groups in 2016/17 and 28 lab groups in 2017/18 and 2018/19). The remaining lab groups assigned to the practical classes after the OSCE were also split evenly between CAL or LEC (19 lab groups in 2016/17 and 20 lab groups in 2017/18 and 2018/19. This meant teaching group sizes were as even as possible within the constraints of scheduling. Table 2.4 Schedule of events showing CAL and SIM access, formative OSCE exam and BTQ/ATQ delivery for the 2016/17 study. Lab group numbers assigned to each teaching group - LEC = 1 to 8, CAL = 9 to 16 and 43 to 45, SIM = 17 to 29, SIM&CAL = 30 to 42, gives detail on the schedule of events and access to teaching material for each teaching group in 2016/17. All other experimental study years were organised in a similar way.

Table 2.4 Schedule of events showing CAL and SIM access, formative OSCE exam and BTQ/ATQ delivery for the 2016/17 study. Lab group numbers assigned to each teaching group - LEC = 1 to 8, CAL = 9 to 16 and 43 to 45, SIM = 17 to 29, SIM&CAL = 30 to 42

Teaching Week	1	2	3	4			5	6
Date week commencing	17/10	24/10	31/11	7/11			14/11	21/11
Clinical phase module	CP 4.21 *Ruminant Production 2*						CP 4.22 Clinical reproduction & fertility (ruminant reproduction)	
3rd year LEC access	All teaching groups							
CAL access	CAL and SIM&CAL teaching groups (lab groups 9 – 16 and 30 – 45)				OSCE Wed 9th Nov	All teaching groups		
SIM class	SIM and CAL&SIM teaching groups (lab groups 17 – 42)					LEC and CAL teaching groups (lab groups 43 – 45 and 1 – 16)		
Questionnaire	BTQ				ATQ			

BTQ = Before Teaching Questionnaire

ATQ = After Teaching Questionnaire

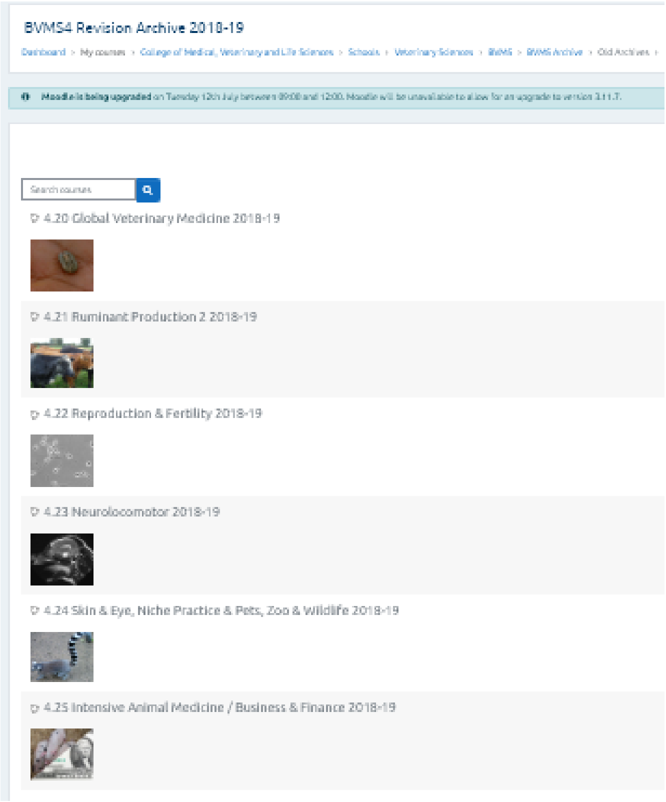
As mentioned previously, after the formative OSCE, all students had free access to the CAL and students in the CAL and LEC group had their SIM practicals. By the end of the six-week teaching period, all students had received the opportunity to practise and access all the teaching materials, with additional open revision classes for the calving simulator held at the end of module 4.22.

This opportunity (which was two weeks after the six-week ruminant teaching period) was taken up by at least half the students.

In 2017/18 and 2018/19, students were specifically asked to contact the researcher if they had previously used the dystocia simulator (as it was purchased in 2016) or if they had swapped practical sessions with one of the other students as this could affect what teaching they were exposed to before the OSCE. This would allow adjustments to teaching group if students had used the calving simulator before and were assigned to the LEC group, for example. Students were not specifically asked to do this in 2016/17 but a small number of students did volunteer this information and teaching group adjustments were made.

2.2.3 Virtual Learning Environment (VLE)

The UOG utilises a virtual learning environment (VLE) called Moodle™. This web-based system allows educators to host learning material online and it is designed with blended learning in mind. As well as uploading content such as lecture power point slides, additional file resources and created videos or links, there is functionality to host a forum which allows a communication stream between staff and students on specific topics. The UOG veterinary VLE on Moodle™ is divided into each of the three programme phases, then each year within the phase has its own home page which has links to each of the modules or rotations within the year, as shown in Figure 2.3 Screenshot of 2018/19 Moodle page with list of modules taught that year.



BVMS4 Revision Archive 2018-19

Dashboard > My courses > College of Medical, Veterinary and Life Sciences > Schools > Veterinary Sciences > BVMS > BVMS Archive > Old Archives >

Moodle is being upgraded on Tuesday 12th July between 09:00 and 12:00. Moodle will be unavailable to allow for an upgrade to version 3.11.7.

4.20 Global Veterinary Medicine 2018-19

4.21 Ruminant Production 2 2018-19

4.22 Reproduction & Fertility 2018-19

4.23 Neurolocomotor 2018-19

4.24 Skin & Eye, Niche Practice & Pets, Zoo & Wildlife 2018-19

4.25 Intensive Animal Medicine / Business & Finance 2018-19

Figure 2.3 Screenshot of 2018/19 Moodle page with list of modules taught that year

Access to resources such as worksheet documents on Moodle™ can be controlled by only allowing specified lab groups access.

2.2.4 Preparation and delivery of the Computer Assisted Learning (CAL)

The Computer Assisted Learning (CAL) activity consisted of video material of the calving simulator being demonstrated and described by the principal researcher. The videos were produced during the summer of 2016 in conjunction with undergraduate students during their summer research project (completely unrelated to this study). A plan for what should be covered in the videos was produced based on what was deemed important for a day one graduate and what could realistically be portrayed in a video of the simulator. Various elements were demonstrated (detailed below) using the simulator and the summer research students recorded and edited the material. Following recording the video material was reviewed to make sure it was suitable for release to students.

The following aspects of calving were covered within the five videos;

1. Equipment needed for calving a cow and placement of head and leg ropes with the calf outside the simulator (lying on the floor) to aid visualisation of technique (2 minutes 22 seconds)

2. Normal anterior presentation delivery with calving aid (8 minutes 2 seconds)

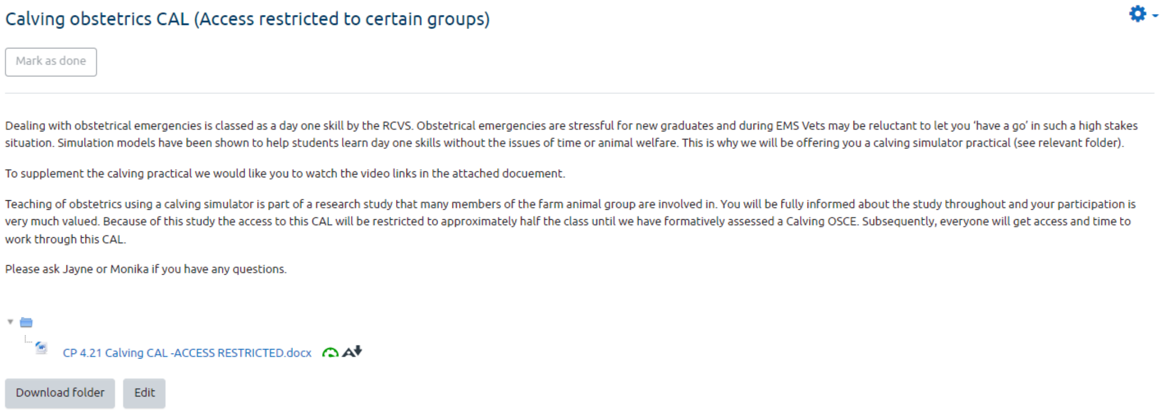
3. How to differentiate front versus back legs and how to identify and correct a head back presentation (3 minutes 45 seconds)

4. Posterior presentation delivery with calving aid (2 minutes 29 seconds)

5. Correction of breach presentation (no delivery, referred to posterior presentation delivery video above) (3 minutes 35 seconds)

In total, the video material would take students about 20 minutes to watch through once. The CAL remained unchanged for the three years of the study.

The videos were uploaded onto a private YouTube (GB) channel. Links to the YouTube videos were detailed in a CAL word document (see appendix 1.1) uploaded onto the Virtual Learning Environment (VLE), Moodle™ see Figure 2.4 Screen shot of Moodle page where CAL was displayed. Access to the CAL document on Moodle was restricted to the CAL and SIM&CAL lab groups for the three and a half weeks before the formative OSCE using access controls within Moodle. Following the OSCE, access to the CAL document was open to all students.



Calving obstetrics CAL (Access restricted to certain groups)

Dealing with obstetrical emergencies is classed as a day one skill by the RCVS. Obstetrical emergencies are stressful for new graduates and during EMS Vets may be reluctant to let you 'have a go' in such a high stakes situation. Simulation models have been shown to help students learn day one skills without the issues of time or animal welfare. This is why we will be offering you a calving simulator practical (see relevant folder).

To supplement the calving practical we would like you to watch the video links in the attached docuement.

Teaching of obstetrics using a calving simulator is part of a research study that many members of the farm animal group are involved in. You will be fully informed about the study throughout and your participation is very much valued. Because of this study the access to this CAL will be restricted to approximately half the class until we have formatively assessed a Calving OSCE. Subsequently, everyone will get access and time to work through this CAL.

Please ask Jayne or Monika if you have any questions.

Figure 2.4 Screen shot of Moodle page where CAL was displayed

2.2.5 Preparation and delivery of the calving simulator practical class

The SIM class plan was developed to ensure consistency between tutors and to ensure specific Intended Learning Outcomes (ILO's) were achieved. The class was planned on the basis that there would be one tutor, two simulators and four to six students per class. Each class was planned to run for one hour and fifteen minutes. The plan was circulated and discussed with all the tutors prior to the first class.

The class was taught by four different tutors over the three experimental years. All tutors were trained by the principal researcher. The principal researcher and a first opinion practitioner taught all the classes in 2016/17, with the addition of two more first opinion practitioners from 2017/18. The principal researcher that taught the class is an academic member of UOG SVM staff (with nine years mixed practice experience prior to joining the University in 2013) and practitioners are all experienced mixed practice vets that are each, at least fifteen years qualified.

The following was included in the plan (see appendix 2.1 for class plan document);

- Introduction and health and safety (10 minutes)
- Applying head and leg ropes with the calf lying on the ground (10 minutes)
- Normal calving – applying head/leg ropes within the simulator, assessing for space, extracting the calf, aftercare for cow and calf (25 minutes)
- Abnormal caving – including scenarios such as head back, leg back, breach, plus anything else there is time for in the class. Drugs used during obstetrics were also discussed (30 minutes)

The class plan remained unchanged for the three years of the study. Tutors were advised that during the class, students should take it in turns to be the farmer and veterinarian so that they could also practise their history taking techniques. Each student got at least one chance to be both the farmer and the veterinarian, and they also got the opportunity to visualise the simulator from above to see the relationship of the pelvis and the calf. A Photograph showing students participating in the class is shown in Figure 2.5 Students working in groups of three during the calving simulator practical class.

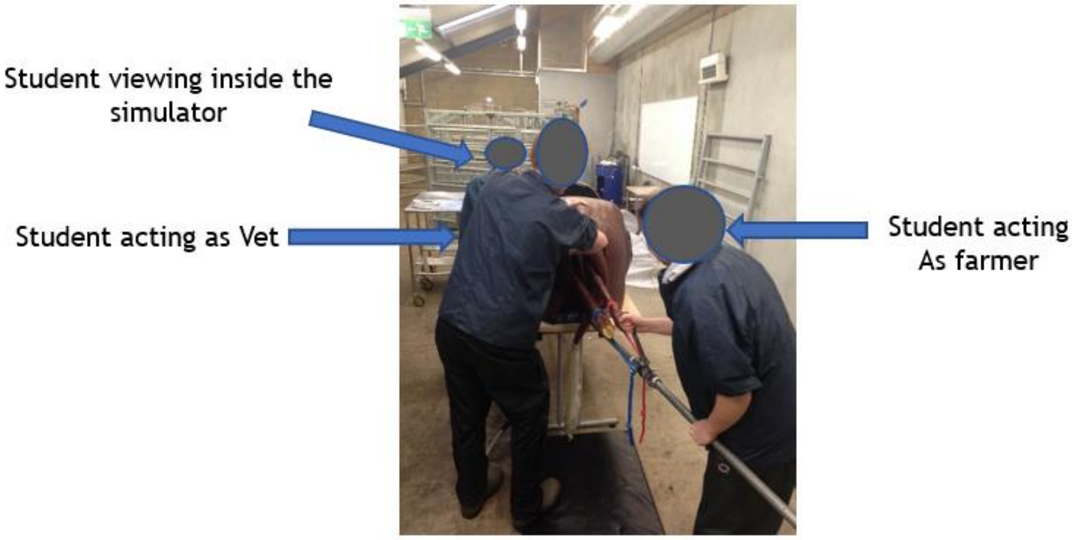


Figure 2.5 Students working in groups of three during the calving simulator practical class

As well as the class plan, a *student practical instruction document* was produced for all students to access on Moodle (see appendix 1.2). Students were instructed to read this before the class, as they would for any other practical class. The document advised students of the intended learning outcomes for the class, what to wear and the pre-reading material expected to be read before the class (Frame, 2006). The student practical instruction document was unchanged during the three years of the study.

2.2.6 The calving simulator

Two bovine compact model dystocia simulators were purchased from Vet Simulator Industries © (*Compact Dystocia Model - Veterinary Simulator Industries*, n.d.). Buying two allowed for efficient parallel teaching and OSCE. The dystocia simulator and its features (as described on the Vet Simulator website) are shown in Figure 2.6 Screenshot of Compact Dystocia Model calving simulator from veterinary simulator website. The simulator is a life sized, fibreglass cow (without legs) that is secured on a table at the correct height to replicate the height of a real cow. It contains an anatomically correct (for a cow) pelvis, inflatable air bags to mimic other abdominal organs and pelvic content as well as a vinyl bag to replicate the uterus. See images of the calving simulator in Figure 2.7 Pictures of various elements of the calving simulator. The simulator included a life sized fully articulated neonatal calf, weighing 22.7kg which could be placed inside the uterus within the simulator and extracted using human force or using a calving aid. The calf could be placed in various malpresentations including head back, one or two legs back, backwards, breach, upside down etc. The calf could then be manipulated back into the correct position and extracted. See images in Figure 2.7 Pictures of various elements of the calving simulator and Figure 2.8 Pictures of calf out of the simulator showing it in lateral recumbency and two malpresentations.

Compact Dystocia Model

VETERINARY SIMULATOR INDUSTRIES

COMPACT MODEL
DYSTOCIA SIMULATOR

Price Available Upon Request
Crating/Shipping/Handling not included

- Tabletop simulator that is modeled as a Hereford
- Steel reinforced epoxy/fiberglass construction, with water resistant components throughout for ease of cleaning.
- 0.65m tall and 1.3 long, tail to bulkhead and 0.8m at widest point
- Matching calf included
- Inflatable calf air bed support system
- Clear vinyl uterine bag
- Soft, durable perineum panel
- Soft removable tail
- Replica polyurethane pelvis
- Padded fetal extractor, obstetric chain and head snare
- Landing mat provided to prevent damage to calf

Replaceable Parts
Birthing Perineum Panel • Uterine Bag • Tail • Calf

The Compact Dystocia Model is also compatible with our ***Bovine Theriogenology Uterus Set***

See our Bovine product videos at www.youtube.com/vetsimulators

Designed & Manufactured in Canada

Developed in collaboration with

OLDS COLLEGE

UNIVERSITY OF CALGARY
FACULTY OF VETERINARY MEDICINE

Figure 2.6 Screenshot of Compact Dystocia Model calving simulator from veterinary simulator website

Figure 2.7.1 Calving simulator class set up which includes calf, landing mat, bucket of lube and ladders (to allow smaller students to see inside and easier loading of the calf)

Figure 2.7.2 Inside calving simulator. Plastic sheet is the uterus (which has been opened up but can be secured with Velcro). Pelvis can also be seen

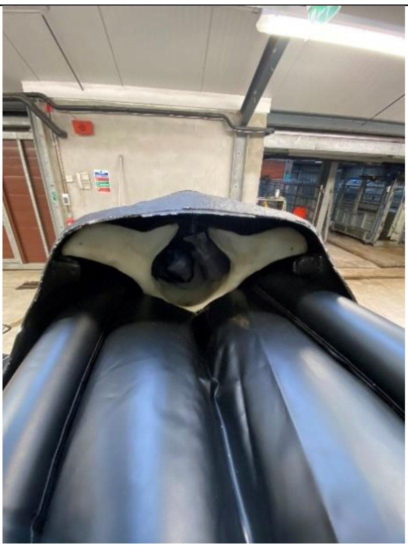


Figure 2.7.3 Inside the calving simulator with uterus removed so that air bags and pelvis can be visualised

	
Figure 2.7.4 Normal calf presentation inside the simulator (uterus open)	**Figure 2.7.5 Breach presentation inside the simulator (uterus open). Note front legs need to be bent to allow space for the student to push the calf back and correct the breach**

Figure 2.7 Pictures of various elements of the calving simulator

Figure 2.8.1 Calf in lateral recumbency on landing mat to show external features

Figure 2.8.2 Calf in head back position

Figure 2.8.3 Calf in one front leg back position

Figure 2.8 Pictures of calf out of the simulator showing it in lateral recumbency and two malpresentations

Prior to use, the simulator would have the air bags blown up using an air compressor (with care taken to make sure the air levels were the same in both simulators) and powder lubricant (J Lube 284g by J Lube ©) approximately 25 grams mixed with one litre of water were poured into the uterus of each simulator and topped up when necessary.

The equipment used in the class included (per simulator);

- Two calf leg ropes
- One calf head rope
- One calf head snare
- Rectal gloves
- Hand gloves (various sizes, not shown in image)
- Lubricant (bucket full of powder lube mixed with water to go into simulator and standard veterinary lube container for use on hands and vulva)
- Calving aid
- Landing mat (to prevent damage to the calf, see figure 2.7.1 above)

Some of this is equipment is also shown in Figure 2.9 Equipment needed for the calving simulator class.

Figure 2.9 Equipment needed for the calving simulator class

After each class, the calf was removed, washed with warm soapy water and left to air dry. Calving ropes were also washed with warm soapy water and left to air dry. The air bags were removed from the calving simulator and it was washed out with cold water and allowed to drain.

2.3 Formative Observed Structured Clinical Exam (OSCE)

2.3.1 Designing the OSCE exam

The formative OSCE was designed to assess the students ability to identify a malpresentation, safely correct the malpresentation, and the initial steps of extracting the calf (i.e. applying head/leg ropes and attaching these to the calving aid). When designing the OSCE, what could feasibly be assessed during a five-minute OSCE (with only one minute to re-set the OSCE) had to be considered (Hodges, 2006). The exam was designed around one of two anterior malpresentations;

1. Head back

2. One front leg back

A checklist of items was created, the majority of which were the same for both malpresentations with just slight changes in wording required in the ‘correcting position’ section of each checklist. The checklist broke the process of calving a cow into individual tasks, each task was awarded a proportion of the marks out of a total of 20 marks. The total score from the checklist would give an objectively assessed numerical result. As well as the numerical result, a global rating, based on specified criteria and assessor judgement was used. The global ratings used were fail, borderline (borderline pass and borderline fail was introduced in 2018/19), pass and excellent.

In 2016/17 the criteria for each global rating grade was discussed informally with assessors prior to the OSCE exam. In 2017/18 there was a more formal pre-exam briefing and in 2018/19 assessors were also given a written marking guide for the global rating criteria. The written notes for the global rating criteria used in 2018/19 are shown in Table 2.5 Global rating marking guide used for formative OSCE assessment in 2018/19.

Table 2.5 Global rating marking guide used for formative OSCE assessment in 2018/19

Global Rating	Description
Fail	Too rough and high chance would have perforated the uterus OR no attempt to correct the position OR calf not corrected OR no ropes placed OR ropes in unsafe position (head rope round the neck) OR consider if student only manages to correct head, then ran out of time for anything else
Borderline fail	Calf corrected but moderate chance would have damaged the uterus (did not push sufficiently back) OR considerable hesitation OR serious issues with head/leg ropes/calving aid (they did not run out of time to do this)
Borderline pass	Calf corrected but very slight chance would have damaged the uterus OR position corrected but took a long time/some hesitation OR moderate issues with head/leg ropes/calving aid.
Pass	Calf manipulated safely AND position corrected AND confident approach AND no/minor rope issues. Head rope not essential but if applied it had to be correct.
Excellent	Confident approach AND calf manipulated safely (pushing back should have been performed) AND position corrected AND ropes correct (head and leg) AND good dexterity AND no hesitation.

2.3.2 Changes made to the OSCE exam over the three study years

The malpresentation was changed each year so that students were not expecting the same as the previous year. The malpresentation used for each year is displayed in Table 2.6 Summary of OSCE tasks and changes made to OSCE marking checklist over the three years of the study, along with other changes made to the OSCE as described below.

There was no opportunity to validate the OSCE checklist other than with the staff involved prior to the 2016/17 formative exam, hence over the course of the three study years there were some slight adjustments to the OSCE checklist. The most significant of these changes was the introduction of a higher weighted safety element (worth four marks in total) in 2018/19. These marks were not awarded if students were too rough during their manipulation and would be at risk of perforating the uterus. They would also be deducted if the head rope ended up around the neck and would have strangled the calf if pulled. This change was in line with OSCE writing guidelines which suggest that important items can be weighted (Coombes & Silva-Fletcher, 2018). In addition, some items in the checklist were either always or never done by any student and thus not considered an important discriminator item by the researchers or of no significance for the clinical skill, so were removed. A copy of each study years OSCE checklist can be found in appendix 6.2, 6.3 and 6.4.

Table 2.6 Summary of OSCE tasks and changes made to OSCE marking checklist over the three years of the study

OSCE marksheet items	2016/17	2017/18	2018/19
Malpresentation	Head back	Leg back	Head back
Specific global rating marking instructions given to examiners	No – informal discussion before and during the OSCE	Yes – formal pre-exam briefing before the OSCE	Yes – formal pre-exam briefing and marking guide issued before the OSCE
Checklist items removed from previous year's OSCE sheet	Na	Inserting hand/hand position (1 mark) Calf palpation (1 mark) Description of the malpresentation (3 marks)	Calf palpation (1 mark) Position of the calving aid beneath the vulva (1 mark) Statement that 'ready to deliver' (1 mark) Communication (1 mark) Efficient and safe (1 mark)
Checklist items added	Na	Applying a head rope (2 marks) attaching leg ropes to the calving aid (2 marks) Communication (1 mark)	Attaching head rope to the calving aid (1 mark) Safety (4 marks)

Not applicable (Na)

2.3.3 OSCE Assessors

During each study year, multiple OSCE assessors were used. In total, there were four clinical faculty staff assessors, one farm animal faculty technician, one external vet assessor and four final year student assessors. All assessors (apart from the final year students) had undergone UOG OSCE assessor training lasting half a day and had assessed multiple summative OSCE exam diets previously. Two of the OSCE assessors were also involved in the delivery of the SIM while all other staff assessors had prior experience of bovine obstetrics on farm or in veterinary practice. In two of the years (2016/17 and 2017/18), final year students that had chosen the farm animal selective rotation were used as peer assessors, but they were overall supervised by (and could check queries with) a trained staff member while assessing. OSCE assessors were given access to the OSCE checklist (and marking guide in 2018/19) at least seven days before the OSCE day to give the opportunity to ask questions.

2.3.4 The day of the OSCE exam

The OSCE exam was planned to run in two parallel streams. The day was split into four exam sessions with scheduled tea/coffee and lunch breaks in between. Students were allocated to an OSCE exam time on an alphabetical basis. Students were told the date of the OSCE exam at the study briefing session and the timetable with their specific exam time was posted on Moodle™ seven days before the exam. An example of the schedule for the day is shown in appendix 6.

Assessors met 15 - 30 minutes before the exam to discuss the checklist, global rating criteria and any questions on marking. Furthermore, there was an opportunity for brief consultation and agreement between assessors during the reading time and coffee/lunch breaks throughout the day. Assessors were able to edit marks and global ratings awarded after each exam session to reflect any discussions with other assessors.

Students registered for the OSCE exam fifteen minutes before their allocated exam time, they completed the After Teaching Questionnaire (ATQ, see later) during this time. There was no holding system in place, so students were free to go after the OSCE.

Pre-printed OSCE marking checklist paper sheets were used to record exam results for each student. Students were provided with stickers (which displayed their name and matriculation number) in registration. They handed a sticker to their assessor when they arrived at the OSCE station. The assessor stuck this on the paper sheet to avoid any issues with handwriting and identifying students. Assessors identified on the sheet if students had/had not done each of the checklist items by writing the numerical score awarded for each item (zero marks were awarded if a checklist item was not done or was done incorrectly). They recorded a total checklist score by adding up all the individual checklist item scores. Finally, assessors gave the student a global rating (independent of the numerical score) and made notes where relevant (e.g. run out of time, too rough).

Each OSCE station required one assessor and one assistant. The assistant had to re-set the station by putting the calf back into the malpresentation ready for the next student and the assistant also posed as a farmer when students started using the calving aid. An OSCE supervisor was also on duty at all times to usher students, sort out additional/spare equipment if needed and deal with any queries from assessors, assistants or students.

After each OSCE (during the next students one-minute reading time), students were given verbal formative feedback (a distance away from the next student so that they could not be heard) and had a brief opportunity to discuss their performance with the assessor. This was considered essential for the students to experience the OSCE as a learning exercise and feedback opportunity ensured high student turnout.

At the end of the exam, all the OSCE marking checklist paper sheets were collected and stored in a locked office.

2.3.5 Moderation of OSCE results

Following three years of OSCE exams, a final OSCE marking guide for moderation was produced (see appendix 6.1). This was applied across all three study years to ensure consistency of marking since the marking scheme had changed slightly in each year. All OSCE marking checklists were initially reviewed by the principal researcher using this marking guide in combination with the comments written by assessors. The total checklist score and global ratings were reviewed for each student and any sheets that were identified as requiring moderation were then reviewed in conjunction with a second researcher. A final (moderated) checklist score and a global Pass, Borderline or Fail rating was agreed for each student by the two researchers. Excellent ratings all remained unchanged. Note, that these ratings were agreed before the OSCE pass mark was calculated, to allow using the Borderline regression method, hence did not necessarily represent the final (Pass or Fail) OSCE outcome.

2.3.6 Calculating the OSCE pass mark using the borderline regression method

To calculate the pass mark for each OSCE exam, the borderline regression method was (McKinley & Norcini, 2014). This was carried out for each experimental study year separately as different malpresentations were used and there were slight adjustments to the checklist each year.

To perform the regression, all final checklist scores were entered into Minitab® (version 20.3.0.0) and the following steps were used to calculate the pass mark.

1. The agreed global rating was converted into a number
    - Fail = 1
    - Borderline = 2 (2016/17 and 2017/18)
    - Borderline fail = 1.5 (used only in 2018/19)
    - Borderline pass = 2.5 (used only in 2018/19)
    - Pass = 3
    - Excellent = 4
2. This numerical global rating was plotted on the x-axis against the checklist score on the y-axis using a scatter plot, and a best fit line was added to the graph together with the trendline regression equation.
3. The pass mark was established using the linear regression equation, with x = 2 (borderline or midpoint between borderline fail and borderline pass).
4. Based on this calculated pass mark for that individual study year, a final OSCE rating of Fail or Pass was established for each student. Specifically, if the numerical score was above the calculated pass park, they were awarded a pass, if it was below the pass mark, they were given a fail independent of the agreed global rating. Excellent ratings remained unchanged.

2.3.7 OSCE Validation

To validate the OSCE exam, the mean final (moderated) checklist score for students rated as Fail, Pass or Excellent for each study year was calculated to ensure there was no overlap between the means (Coombes & Silva-Fletcher, 2018). The distribution of Fail, Pass and Excellent students was also graphed in a different colour against the OSCE checklist score along the x-axis (see appendix 6.5).

2.4 Questionnaire design and delivery

2.4.1 Questionnaire Design

To investigate specific demographic factors influencing self-rated confidence and competence in calving cows, a questionnaire was designed with four sections:

> Section A - Background demographics which included questions on gender, year of birth, continent of origin and intention following graduation (students were given options – mixed, small animal, equine, farm animal, non-clinical or don't know).
>
> Section B - Calving confidence level self-assessment for 13 different calving tasks (see further information below).
>
> Section C - Calving experience which had a question split into three parts where students were asked how many calvings they had 1. observed, 2. helped with and 3. carried out with no help. They were asked to circle one of five options representing the estimated number of calvings, specifically none, one or two, several (up to five), quite a few (6 -10) and lots (> ten) (0, 1 -2, 3-5, 6-10 or >10) for each part of the question.
>
> Section D - Qualitative section asked questions for aspects of calvings that students look forward to, were worried about and also what they felt

> would increase their confidence and competence. There was also an option to leave any further comments. This section was not used in every study year (see later).
>
> A full version of the questionnaire can be found in appendix 4.1 and 4.2.

To construct the table for the self-assessed calving confidence section of the questionnaire, the results of a study by Read and Baillie (Read & Baillie, 2013) were consulted. This study used cognitive task analysis (CTA) to ascertain the individual steps that experienced veterinarians took to successfully calve a cow. In the CTA study, Read & Baillie identified a final list of steps involved in performing a calving. These steps were modified slightly to make them a bit clearer for undergraduate students before being incorporated into the confidence part of the questionnaire (section C). The list of steps from the paper with details of modifications made for the questionnaire and details of where the skills were taught in the BVMS programme are shown below in Table 2.7 Calving steps identified by Read and Bailie and the modifications made to each step (if any) before incorporating into the calving confidence questionnaire.

Table 2.7 Calving steps identified by Read and Bailie and the modifications made to each step (if any) before incorporating into the calving confidence questionnaire.

Step letter in Questionnaire	Step description (Read & Baillie, 2013)	Modification yes or no	Details of modification	Where this step is taught in BVMS program
Not in Questionnaire	Preparation of self to perform the task	Yes	Not included in questionnaire as felt would be confusion with ‘preparation for vaginal exam’	BVMS3 calving lecture
a)	Restraint of the cow	No	Na	BVMS1 cattle handling class, BVMS 3 calving lecture and SIM class
b)	Evaluation of cows health status	No	Na	BVMS2 and 3 clinical exam class, BVMS3 clinical exam class, BVMS3 calving lectures
c)	History taking	No	Na	BVMS2, BVMS3 clinical exam class and BVMS3 calving lectures, BVMS4 SIM class
d)	Preparation for vaginal exam	Yes	Preparing the cow for vaginal examination	BVMS3 calving lectures, BVMS4 CAL and SIM class

e)	Assessing internal aspects of the cow	Yes – wording change to make it more explicit for students	Palpation of vagina/cervix/fetus	BVMS3 calving lectures, BVMS4 CAL and SIM class
f)	*NEW*	Yes – added as missing from steps published in paper	Coming to a conclusion about the obstetrical problem	BVMS3 calving lectures, BVMS4 CAL and SIM class
g)	Correction of anterior leg back and breach presentation	Yes – made more generic	Correcting the obstetrical problem	BVMS3 calving lectures, BVMS4 CAL and SIM class
h)	Determining if there is sufficient room to extract the calf safely	Yes – condensed slightly	Determining if sufficient room to extract the calf	BVMS3 calving lectures, BVMS4 CAL and SIM class
i)	Applying the calving jack	Yes – added head and leg ropes	Applying the head rope, leg ropes and calving aid	BVMS1 parturition videos, BVMS3 calving lectures, BVMS 4 CAL and SIM class
j)	Extracting the calf	No	Na	BVMS3 calving lectures, BVMS4 CAL and SIM class

k)	Caring for the calf	Yes – made more specific	Reviving the calf	BVMS1 parturition videos, BVMS3 calving lectures and BVMS4 SIM class
l)	Caring for the cow post-partum	Yes – made more specific	Dealing with immediate postpartum complications in the cow (e.g. bleeding)	BVMS3 calving lectures and BVMS4 SIM class
m)	*NEW*	Yes – added as felt this was an important part of calving a cow albeit it not a specific step	Communicating with the farmer	General communication skills from BVMS, BVMS2, BVMS3 calving lectures and farm specific communication skills, BVMS4 SIM class

Each of these tasks were included in a table in the self-rated confidence part of the questionnaire and the students were asked to rate their confidence for each of the tasks on a one to five, numerical Likert type scale with a descriptor as shown in Table 2.8 Numerical scale and descriptors used for calving confidence questionnaire.

Table 2.8 Numerical scale and descriptors used for calving confidence questionnaire

Numerical scale number	Confidence description
1	No confidence
2	Little confidence
3	Some confidence
4	Confident
5	Very confident

In both before (BTQ) and after teaching questionnaires (ATQ), students were asked to identify themselves in the questionnaire using the last four digits of their matriculation number and the first letter of their surname so that they could not be personally identified from the questionnaire itself or within the subsequent data set produced. However, this way of identifying still allowed matching BTQ and ATQ to link questionnaire responses. The ATQ just included the confidence section as the demographic and experience question responses were very unlikely to have changed significantly within the time period between BTQ and ATQ.

The complete questionnaire was pilot tested with twelve final year students before it was used for the study students. Some minor changes were made before a final version was produced.

2.4.2 Questionnaire changes between study years

In 2018/19 the gender question was adjusted to give the additional option of ‘other’ and ‘would rather not say’. The five qualitative questions were only used in 2017/18 and 2018/19. In 2017/18 these were included in the BTQ only, in 2018/19 they were included in both BTQ and ATQ. Copies of the 2018/19 BTQ and ATQ are included in appendix 4.1 and 4.2.

2.4.3 Questionnaire Delivery

Following the briefing in each study year at the start of the six week teaching period, paper copies of the BTQ were handed out and students were asked to complete them during the morning lecture series. Completed questionnaires were collected before any obstetrics teaching had been delivered. Students were also given the opportunity to download the questionnaire and complete it in their own time before any further teaching was given. The ATQ was also administered in paper format. It was issued to students during OSCE registration after they had been exposed to the teaching modality they had been allocated to (about three and a half weeks after the BTQ).

Students that consented and completed both the BTQ and ATQ were used for the confidence (confidence self-rating) study reported in Chapter 3. Students that consented but only completed the BTQ (not the ATQ) were still included for the OSCE study (see Chapter 4) and any before confidence analyses.

2.5 Data entry and categorisation

Data from the BTQ, ATQ and OSCE were entered into a Microsoft Excel© (Version 2205 Build 16.0.15225.20348) 64-bit) spreadsheet.

During data entry, all communications regarding teaching group changes and previous exposure to the simulator were reviewed and adjustments made regarding teaching groups allocations as needed. For example, if a student in the LEC teaching group was part of the Glasgow Farm Animal Veterinary Society (GFAVS), they would have used the simulator during one of their extra-curricular sessions (which was a very similar format to the SIM class). In this situation they were changed to the SIM teaching group. Likewise, if a student allocated to the SIM group missed their practical class prior to the OSCE, the allocated teaching modality group was changed to LEC.

At the end of the data collection period, data from all study years and all teaching groups were combined into one Excel© spreadsheet for the final analysis. To ensure consistency with data entry throughout, data validation (a feature of Excel©) was used where possible.

For some of the analyses data were combined into categories or converted into a different format. The details of the categorisation are explained below for each variable in turn.

2.5.1 Year of birth

Year of birth was converted to age by taking into account the month of the year the study was carried out i.e. November. The year of birth was subtracted from 2016 for 2016/17, 2017 for 2017/18 and 2018 for 2018/19 respectively. There would be a small proportion of students that had a birthday in November or December that would have had an age one year older than they actually were.

2.5.2 Intention following graduation

Students were categorised into two new categories depending on their response:

1. Students that would encounter a cow in practice – this included students that selected farm, mixed, or if students ticked more than one box that included a combination of farm and/or mixed

2. Students that would NOT encounter a cow – this included equine, small animal, exotics/wildlife, lab animal, non-clinical, don’t know or if students ticked more than one box, any combination of these

2.5.3 Calving experience before teaching

There is no validated scale available for calving experience so numbers of calvings ticked for each of the three calving experience questions were converted into a numerical score as shown in Table 2.9 Calving experience before teaching – numerical score given to number of calvings in each calving experience scenario to allow calculation of overall calving experience score. The higher the number on the scale, the more experience the student had. An overall calving experience numerical score was calculated for each student which was out of a possible maximum total of 24 (4+8+12).

Table 2.9 Calving experience before teaching – numerical score given to number of calvings in each calving experience scenario to allow calculation of overall calving experience score

Calving experience question	Number of calvings and numerical score used for conversion				
	0	1-2	3-5	6-10	10+
Observed (student did not do anything practical)	0	1	2	3	4
Helped (student had some direction from farmer, vet)	0	5	6	7	8
Carried out with no help (no direction from farmer, vet)	0	9	10	11	12

For some of the further analyses, this numerical score was itself converted into a prior experience category using a histogram of the results to establish patterns in the data and where the cut scores should occur (see graph in appendix 5.5). Then, for the regression analysis, all students with a score of five or higher (some or lots of experience categories) became a combined ‘something’ experience category. This is shown in Table 2.10 BTQ calving experience categories assigned to BTQ calving experience numerical score.

Table 2.10 BTQ calving experience categories assigned to BTQ calving experience numerical score

Total before teaching calving experience numerical score	Three categories used for descriptive statistics	Two categories used for regression
0 – 4	minimal/none	Minimal/none
5 – 12	Some	Something
13 – 24	Lots	

2.5.4 Before and after teaching calving confidence

The total before and after teaching calving confidence scores were calculated by adding the confidence score for all 13 calving tasks together. As there was no obvious pattern to the data after plotting a histogram of the total calving confidence score using a histogram (see graphs in appendix 5.6) the same Likert type categories used for the individual tasks were applied to the total confidence score in order to establish cut scores and categorise the data. The total calving confidence categories were established by adding the same confidence score for each task e.g. one for '*no confidence*' (for all 13 tasks, so the total score is 13), two for '*little confidence*' (to a maximum of 2 for all 13 tasks, so total scores of 14-26) etc. This resulted in five confidence categories (the same terms for each of the confidence categories were used in the questionnaires given to the students before or after teaching delivery) as shown in the first column, and a self-rated score band as shown in the second column of Table 2.11 Numerical scoring bands and further categorisation used to categorise before and after teaching calving confidence. Note, that no student chose '*no confidence*' for all the tasks, hence all respondents had a total score of > 13.

Table 2.11 Numerical scoring bands and further categorisation used to categorise before and after teaching calving confidence

Confidence level from questionnaire	Confidence category numerical score band	Category for descriptive statistics	Category for regression analyses (BTQ confidence rating)	Categories for regression analyses (ATQ confidence rating
No confidence Score = 1	13	No confidence (no students in this category so not used)	Not used	Not used
Little confidence Score = 2	14 – 26	Little confidence	Little confidence	Combined little/some confidence
Some confidence Score = 3	27 – 39	Some confidence	Combined some confidence/ confident/ very confident. Called ‘some or more confidence’	
Confident Score = 4	40 – 52	Confident		Combined confident/very confident
Very confident Score = 5	53 – 65	Very confident		

The categories were then also further condensed into two final confidence categories for the purpose of the regression analyses (explained below). This is further shown in Table 2.11 Numerical scoring bands and further categorisation used to categorise before and after teaching calving confidence. In relation to the BTQ self-rated confidence (reflecting the confidence of BVMS4 students with no specialist skill training), it was felt investigating what influences a student to have even a small amount of confidence before further teaching was delivered was of most interest. It was considered that any, even the ‘*some confidence’* rating is beneficial compared to ‘*little’*, and identifying which variables may lead to students being categorised into the ‘*some or more confidence*’ category was of interest. While in relation to the ATQ self-rated confidence (reflecting the confidence level of students after they had received specific skills training), we were interested in which variables led to students attaining a higher confidence total score, so the categories for ‘*little/some confidence’* were combined and compared to a combined ‘*confident/very confident’* category. It was felt that these students were the ones that would be more likely to ‘have a go’ at calving a cow and the variables that influenced having more confidence were of particular interest.

2.5.5 Calving Task Confidence

The following six tasks were identified as being the most important based on their clinical relevance of actual calving skill and confidence ratings so were combined to give a more specific calving task score – palpation, coming to a conclusion, correcting the problem, assessing for room, applying ropes and extracting the calf. A cut score of 18 or above (each of the six tasks multiplied by 3 ‘*some confidence*’) was used to categorise this data further into students that would be more likely to have a go at that part of calving when out on EMS.

2.5.6 OSCE assessor

As there were multiple OSCE assessors with most only assessing a small proportion of OSCEs, assessors were grouped according to academic background into two categories

1. Clinical faculty staff – vets who worked at UOG

2. Non-clinical faculty staff (farm animal technician), external veterinary tutor and final year student

2.5.7 OSCE result

Pass and excellent numbers were combined for the pass outcome, which was compared to the fail outcome.

2.6 Data analysis and statistics

Descriptive data analysis and statistics were carried out in Minitab ® 19.2020.1. For numerical data, this included calculations of means, medians, 95% confidence intervals and standard deviations. For categorical data, percentages in each category were analysed. All results were graphically displayed using Microsoft Excel® before more specific statistical analysis.

For initial statistical exploration of numerical data e.g. age or before teaching calving confidence, distribution of data was checked using an Anderson Darling normality test. If data were normally distributed an ANOVA was used to compare means between groups. When data were not normally distributed, Johnsson transformation was attempted. If this did not normalise the data, non-parametric tests such as the Mann-Whitney (for two groups) and Kruskal Wallace (for more than two groups) tests were used to assess for statistical differences in the medians. For categorical data e.g. study year or teaching group, Chi square tests or Fishers exact test (if expected counts in chi square test were < five) were used to look for statistical differences in the proportions for categorical data. An overall chi square test was carried out when there was more than a 2 x 2 contingency table; if this was statistically significant, each group was compared to the other using additional chi square tests. Significant levels were set as $p < 0.05$ unless otherwise stated and a tendency was indicated at $p < 0.1$.

Further statistical analyses investigated the effect of variables on each of the three outcomes of interest using logistic regression. Logistic regression was chosen rather than linear regression as we were interested in binary outcomes in terms of passing the OSCE exam or having confidence in calving cows. The following outcomes were investigated;

1. OSCE result (pass as outcome of interest versus fail)

2. Confidence before teaching (combined '*some or more confidence* as outcome of interest versus '*little confidence*')

3. Confidence after teaching (combined '*confident*'/'*very confident*' as outcome of interest versus combined '*little*'/'*some confidence*')

Data from respondents falling into demographic categories with very low numbers, specifically, *would rather not say* for gender (only one) and *African* students for continent of origin (only six), were excluded from the univariant and multivariable regression analyses, as leaving them in the analysis as a separate category meant the final model did not converge, but there was also no logical way to combine them with another category. Univariate logistic regression was initially used to establish which variables may significantly influence (at $p < 0.2$) each of the outcomes of interest and thus be included in the multiple logistic regression. The results of the univariate logistic regression agreed with the initial ANOVA, non-parametric or chi square results, and the latter were used for post hoc comparisons of the different groups with each other when there were more than two. Interactions between all variables that were significant at the univariant level were then explored (using chi squared tests for all categorical variables and a Kruskal Wallace test for numerical variables). Any significant relationships were noted prior to multiple logistic regression being carried out.

The multivariant backwards stepwise logistic regression was carried out manually initially. All statistically significant variables (at $p < 0.2$) from the univariate regression were included in an initial base model despite some interactions between variables being identified. The Akaike Information Criterion Corrected (AICc) of the base model was then used to compare the effect of removing one variable at a time (backwards stepwise logistic regression). The variable removal that caused the AICc to decrease the most (or caused the smallest increase), when compared to the base model was then removed permanently to give a new base model and new AICc for further comparisons. With this variable removed permanently, the next variables that remained were then removed one at a time again. The AICc of the new model (with one variable removed) was compared to the new base model again. As before, the variable removal that caused the AICc to decrease the most (or caused the smallest increase in AICc), when compared to the base model was then removed permanently. Variables were no longer removed when the difference between the AICc of the base model and the AICc of the model with the variable removed differed by more than + two. In other words, the variables that remained in the final model were the variables that were needed to keep the AICc as low as possible as removing them caused too big an increase in AICc indicating this variable has a strong effect in the model.

The model was then built again using an automatic backwards logistic regression function in Minitab®. The interactions through order was always set to one and the p value for variables to be removed was 0.05. The model building process in minitab determined which of the interactions between variables was most representative to retain but the process was checked by the researchers to make sure the variables that remined made real-world sense. The results obtained from the automatic backwards logistic regression were the same as the manual method, so any further model building was carried out using the automatic function.

Model quality was assessed using the area under the ROC curve where a value of 0.5 indicated the model was no better at predicting the outcome than a guess and a value on 1 indicating the model could predict the outcome completely (Bartlett, 2014). Despite its reported limitations (Glen, n.d.) the Hosmer-Lemeshow goodness of fit test was also used to assess how well the model predicted the observed data (a high p value indicating good model fit).

For thematic analyses of a subset of qualitative data, responses to one of the questions in the BTQ and the same question in the ATQ (what do you think would increase your confidence in calving cows?) were entered into excel. The data were reviewed extensively by the primary researcher to identify initial patterns in the data and common ideas that were evident within the text responses. From this initial substantial review of the data, categories for each of the ideas were developed and each of the categories were given a coding number. A description for each category was drawn up and the data were analysed again one by one, allocated to a code category and given the appropriate code number. The data were reviewed multiple times once code numbers were applied to ensure the application was consistent. Where applicable, individual code categories were grouped together into higher level themes. A second researcher then reviewed the data and results. This was an iterative process and any discrepancies between researchers were discussed and agreement was sought (Braun et al., 2006, King et al., 2021).

Chapter 3 Results - Demographics and calving confidence

3.1 Introduction

The implementation of simulation in veterinary and medical education for developing confidence in clinical skills is reported to be a useful mode of learning in a variety of different education settings (Alanazi et al., 2017; Cook et al., 2013). Confidence and competence are both required when veterinary students graduate. When learning with simulation, students can be exposed to contextual clinical scenarios and carry out a simulation exercise which is away from the client and doing no harm to a live animal, while gaining positive re-enforcement from their peers and clinical teachers (Kalaniti & Campbell, 2015). While there are, of course, limitations as this may not be seen as ‘real life’, simulation can be an important and useful junction between the theory learned in lectures and the students first clinical encounter with a live animal. Knowing the impact of such educational interventions on student confidence are essential to ensure resources invested in the implementation are justified and in light of the covid-19 pandemic, knowing the impact of simulation in a blended approach could add further value to their implementation.

As students undertaking the veterinary programme are becoming increasingly diverse, knowing the exact demographic factors such as gender, background, farm animal/calving experience, and intention following graduation, all of which may influence confidence, will help educators plan the type and amount of teaching required by individual undergraduates to achieve optimum outcomes.

There are two main aims for this chapter

1. Investigate the impact on veterinary undergraduate student confidence in calving cows following the implementation of a calving simulator as part of a blended learning approach.

2. Investigate the demographic factors that influence student confidence calving cows following the implementation of a calving simulator as part of a blended learning approach.

3.2 Materials and Methods

Materials and methods are described in chapter 2.

3.3 Results

3.3.1 Descriptive analysis of questionnaire respondents

During the three study years, there were 347 fourth year veterinary students eligible to take part. Of these, 300 gave consent via the BTQ, giving an overall initial response rate of 86%. Initial response rate varied slightly between study years with 2016/17 having the lowest (75%) and 2017/18 having the highest (95%). Almost all consenting students (295/300, 85% of all eligible students) that completed the BTQ also completed the ATQ. This information is summarised in Table 3.1 Student numbers for confidence study. Response rate percentage out of total eligible students is shown in brackets.

Table 3.1 Student numbers for confidence study. Response rate percentage out of total eligible students is shown in brackets.

	Study year n (%)			
	2016/17	2017/18	2018/19	Total
Number of students eligible to take part	116	120	111	347
Number of students giving consent with BTQ	87 (75%)	114 (95%)	99 (89%)	300 (86%)
Number of consenting students that completed the ATQ	87 (75%)	112 (93%)	96 (86%)	295 (85%)

The following section describes the demographic data of the 300 students that gave consent and completed the BTQ at the start of the study.

3.3.1.1 Gender, Age and continent of origin

The number of declared female students were 232 (77.3%), 67 were declared male (22.3%) and 1 (0.3%) would rather not reveal their gender. The option to select '*would rather not say*' for this question was only introduced for the 2018/19 study year. The difference in the numbers of males and females in each study year was not significant (p = 0.568). The ages of the students in each study year are shown in Figure 3.1 Boxplot of age of students in each study year (black circle = median, cross = mean). The mean age of all three study years combined was 23.4 (95% CI 23.0 to 23.8, SD +/- 3.39), and the mean age for each study year was 23.8 (95% CI 22.9 to 24.7, SD +/- 4.14), 23.5 (95% CI 23.0 to 24.1, SD +/- 3.09) and 23.0 (95% CI 22.4 to 23.6, SD +/- 2.94) for 2016/17, 2017/18 and

2018/19, respectively. The range of ages overall was 20 to 49 years (2016/17 had outlier). The median age did not differ between each study year (p = 0.221).

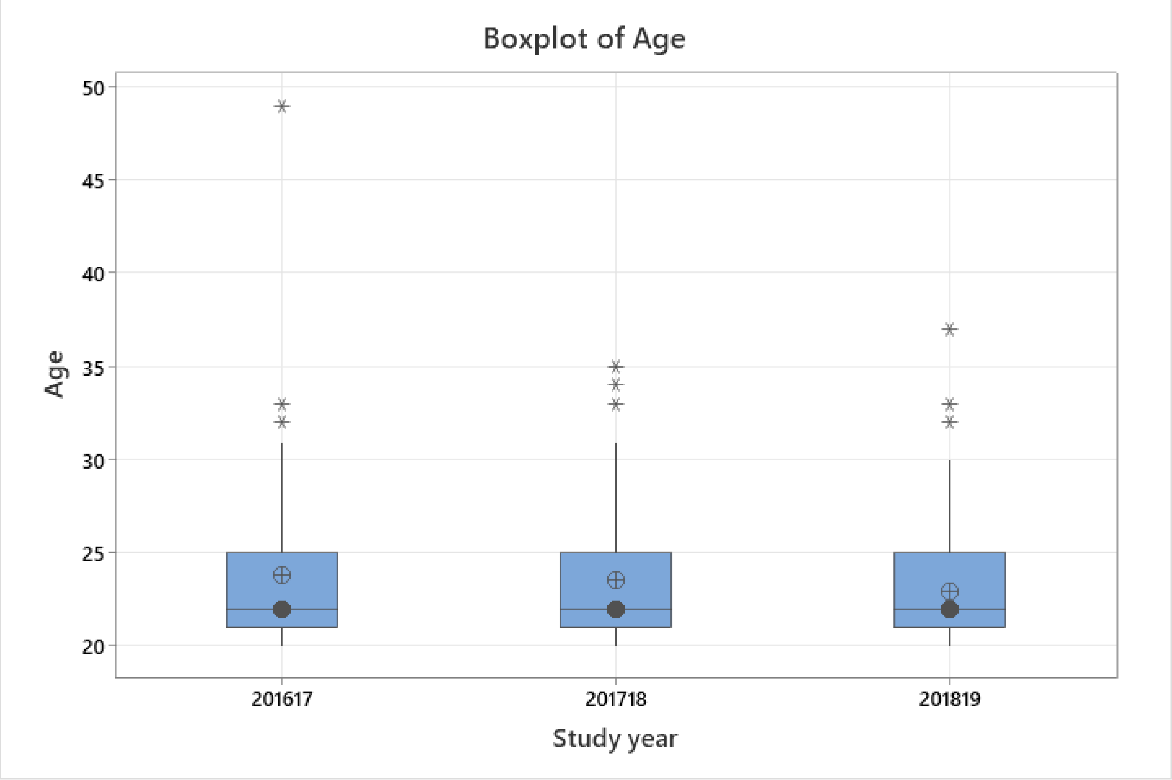


Figure 3.1 Boxplot of age of students in each study year (black circle = median, cross = mean)

The number of students that came from each continent is shown in Table 3.2 Number of students in each continent of origin for each study year and total study population. The majority of students were from Europe. No students originated from Australasia or South America. In each study year, the proportion of students in each continent was similar, although in 2018/19 there were slightly more European students and slightly less Asian students. With African students removed (as numbers were very small, 6/300=2%), the number of students from each continent did not differ between study years (p = 0.620).

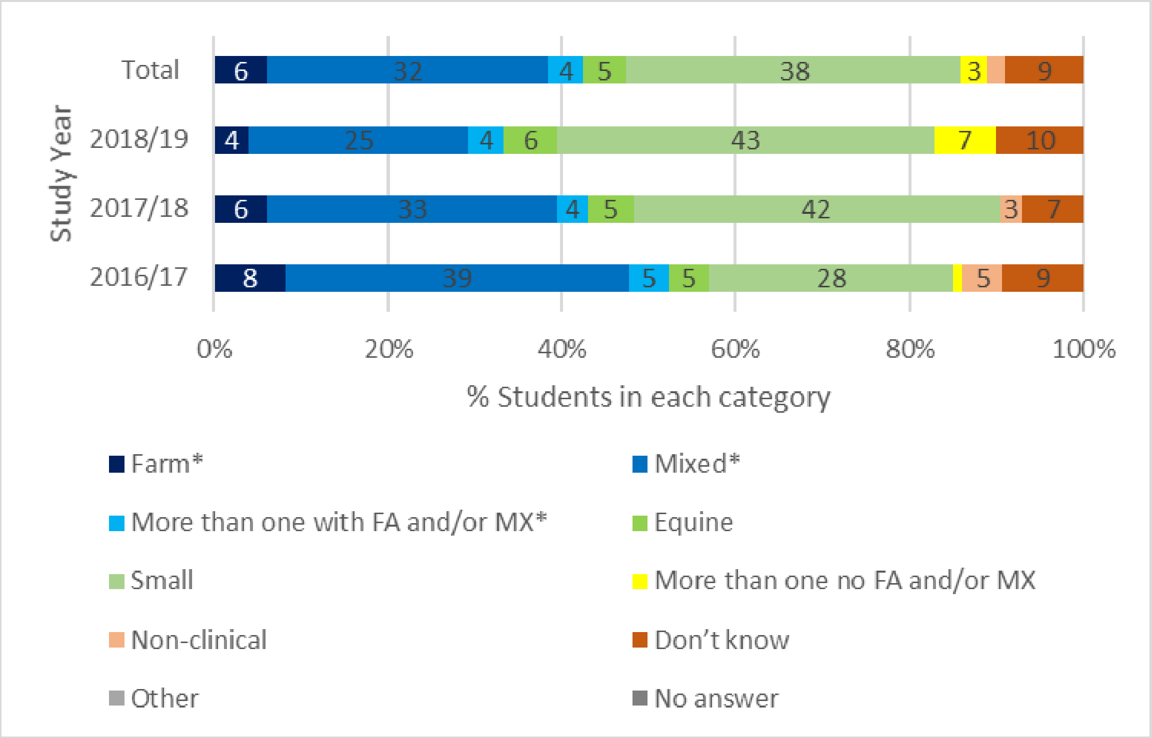
Table 3.2 Number of students in each continent of origin for each study year and total study population

	Study year % (n)			Total
	2016/17	2017/18	2018/19	
Europe	44 (51%)	60 (53%)	58 (59%)	162 (54%)
North America	27 (31%)	37 (32%)	32 (32%)	96 (32%)
Asia	13 (15%)	15 (13%)	8 (8%)	36 (12%)
Africa	3 (3%)	2 (2%)	1 (1%)	6 (2%)
Australalaisa, South America, no answer	0	0	0	0
Total	87	114	99	300

3.3.1.2 Intention following graduation

Thirty eight percent of students intended to go into small animal practice which was only slightly more than the number that intended to go into mixed practice (32%). Only 18 students (6%) wanted to go into farm animal only practice and 26 (9%) did not know what they wanted to do following graduation. In consecutive student cohorts, there was a slight decline in the number of students that wanted to do farm animal only/mixed practice and an increase in the number that wanted to small animal (or a mixture of species but with no farm animal). These results are shown graphically in Figure 3.2 Student intention following graduation for each study year and total study population, data labels are percentages (*categories that were combined for further analysis).

Figure 3.2 Student intention following graduation for each study year and total study population, data labels are percentages (*categories that were combined for further analysis)



When the intention following graduation was further categorised, just less than half the students overall would encounter a cow in their future role, however, with each consecutive study year, less and less students planned to encounter cows (p = 0.040). The data for each study year are shown in Table 3.3 Student intention following graduation further categorised for each study year and overall.

Table 3.3 Student intention following graduation further categorised for each study year and overall

Study year	Would encounter a cow	Would not encounter a cow	Total
2016/17	45 (52%)	42 (48%)	87
2017/18	49 (43%)	65 (57%)	114
2018/19	33 (33%)	66 (64%)	99
Total	127 (42%)	173 (58%)	300

3.3.1.3 Calving experience: assistance and numbers of calvings

Out of the 300 consenting students, one student (from 2017/18) did not complete the experience part of the BTQ so the data reported in this section is for 299 students. Twenty one percent of students had never observed a calving at all, 33% had never assisted with a calving and 87% had never calved a cow on their own with no help. The number of '0 calvings' responses in any of the experience questions did not differ between study years ($p > 0.05$). This is shown in Figure 3.3 Calving experience at each level (scenario) for all study years combined (numbers are total number of student responses for this number of calvings) (See appendix 5.7 for a breakdown of the calving experience data for each study year).

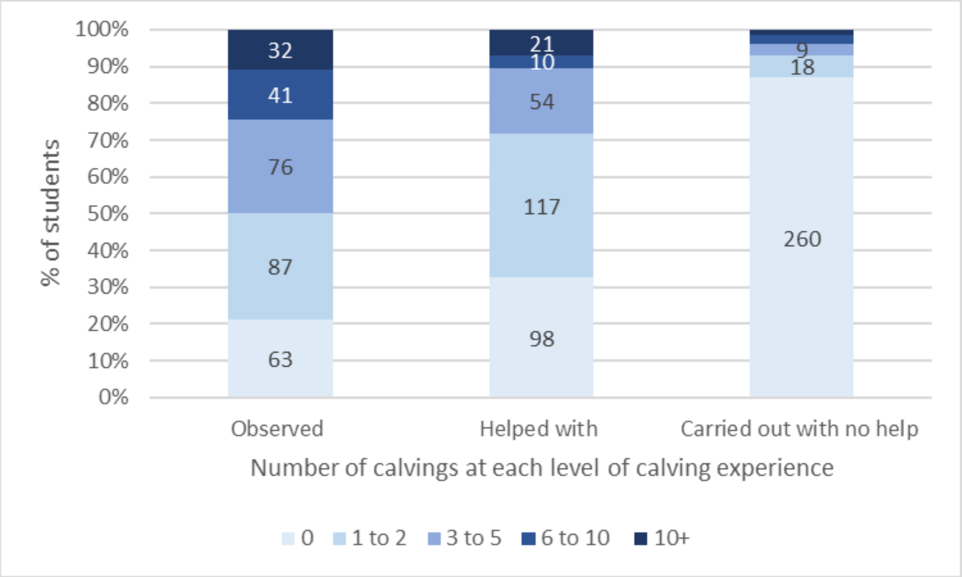


Figure 3.3 Calving experience at each level (scenario) for all study years combined (numbers are total number of student responses for this number of calvings)

3.3.1.4 Calving experience: total numerical score and further categorisation

When the calving experience numerical score for the three calving experience questions were added up to a total experience score for each student response, the mean total score was 6.7 (95% CI 6.00 to 7.37, SD +/- 6.03) out of a possible total of 24 across all three study years. The total experience score for each study year was 6.6 (95% CI 5.51 to 7.76, +/- 5.28), 6.6 (95% CI 5.42 to 7.73, +/- 6.21) and 6.8 (95% CI 5.56 to 8.14, +/- 6.48) for 2016/17, 2017/18 and 2018/19, respectively. There was no difference in the median total experience score between study years (p = 0.777). Figure 3.4 Histogram of total calving experience numerical score shows the number of students for each calving experience score.

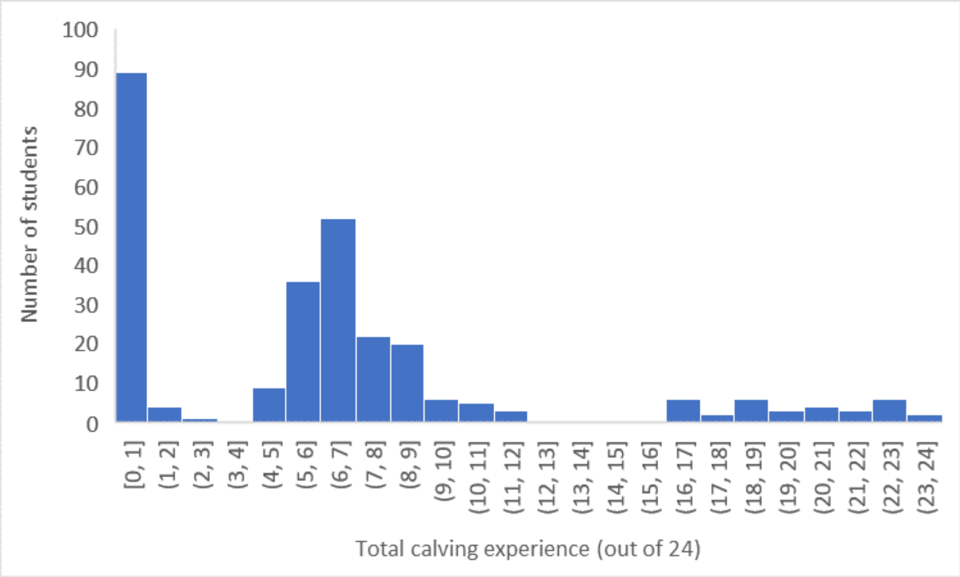


Figure 3.4 Histogram of total calving experience numerical score

Categorising the calving experience data showed that overall, 96 students (32%) of students had '*minimal' or 'no'* experience (total score 0 – 4 out of 24), 168 (56%) had '*some'* experience (total score 5 – 12 out of 24) and 35 (12%) had '*lots'* of experience (total score 13 – 24 out of 24). There was no difference in the number of students in these three calving experience categories between the study years (p = 0.320).

Following further categorisation of data for the purposes of logistic regression, with all three years combined, one third (96 students, 32%) had '*minimal'/'no'* experience and two thirds (203 students, 68%) had experience ('*some'* and '*lots'* combined). There was no difference in the proportion of students with and without calving experience between the three study years (p = 0.404).

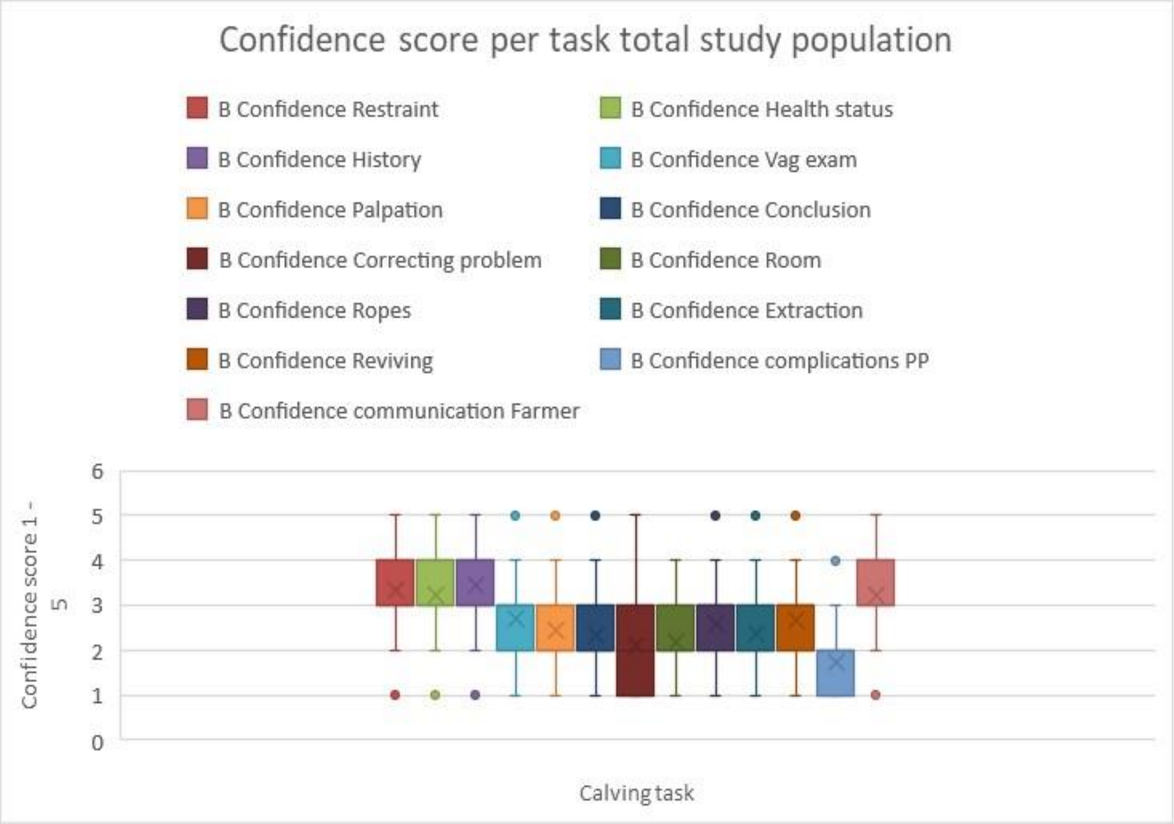
3.3.2 Calving confidence before teaching

Out of the 300 students, four students (two from 2017/18 and two from 2018/19) did not complete the confidence section of the questionnaire giving a total of 296 students for this part of the analysis.

3.3.2.1 Before teaching calving confidence per task

Each of the 13 individual tasks had a range of confidence ratings from 1 to 5, apart from ‘determining if sufficient room to extract the calf’ and ‘dealing with immediate post-partum complications in the cow’, where students only self-rated to a maximum of ‘4’= confident. The tasks that had the highest mean scores were ‘history taking’ (3.5, 95% CI 3.4 to 3.5, +/- 0.77) and ‘restraint’ (3.3, 95% CI 3.2 – 3.4, +/- 0.88), while the lowest mean scores were achieved by ‘dealing with immediate post-partum complications in the cow’ (1.7, 95% CI 1.6 to 1.8, +/- 0.78) and ‘correcting the problem’ (2.1, 95% CI 2.0 – 2.2, +/- 0.88). See results in Figure 3.5 Before teaching calving confidence per task for total study population (a table showing the mean, 95% confidence interval and +/- standard deviation can be found in appendix 5.1).

Figure 3.5 Before teaching calving confidence per task for total study population



The mean before teaching calving confidence for the six most practical tasks associated with calving was 14 (95% CI 13.53 – 14.57, +/- 4.55) out of a possible maximum score of 30. More students had a score of <18 (229/296, 77%) than had a score of >18 (67/296, 23%).

3.3.2.2 Total before teaching calving confidence score - numerical and categorical

When the scores for all 13 individual calving tasks were combined, the mean total BTQ calving confidence score was 34.3 (95% CI 33.41 to 35.29, SD +/- 8.23) out of a possible total of 65. The total mean scores for each study year were 33.7 (95% CI 31.99 - 35.48, +/- 8.18), 35.1 (95% CI 33.59 - 36.68, +/- 8.27) and 34.0 (95% CI 32.34 - 35.65, +/- 8.23), for the study years 2016/17, 2017/18 and 2018/19 respectively. There was no difference in the mean total BTQ calving confidence score between study years (p = 0.262).

Most students (over half) were allocated to the '*some confidence'* category, with another quarter being in the '*confident'/'very confident*' categories (see Table 3.4 Before teaching calving confidence category, all study years combined). There was no difference in the proportion of students in the '*little confidence*', '*some confidence*' or '*confident/very confident*' categories between study years (p = 0.949).

Table 3.4 Before teaching calving confidence category, all study years combined

Confidence Category	Number of students	categorisation for logistic regression
No confidence (self-rating 1, so 13 maximum)	0	NA
Little confidence (self-rating up to 2, so 14-26)	52 (18%)	52 (18%)
Some confidence (self-rating up to 3, so 27-39)	167 (56%)	244 (82%) ('*some or more confidence*')
Confident (self-rating up to 4, so 40-52)	71 (24%)	
Very confident (self-rating up to 5, so 53 - 65)	6 (2%)	
Total	296	

The data was further categorised for the purposes of logistic regression, into respondents categorised as having '*little confidence*' (n=52) versus those categorised as having '*some or more confidence*' (n=244); data from all three years were combined.

The percentage of students in each of the before teaching calving confidence categories *('little confidence', 'some confidence', 'confident'/'very confident'*) was similar between experimental teaching groups (p = 0.848) as seen in Figure 3.6 Before teaching calving confidence category for each teaching group.

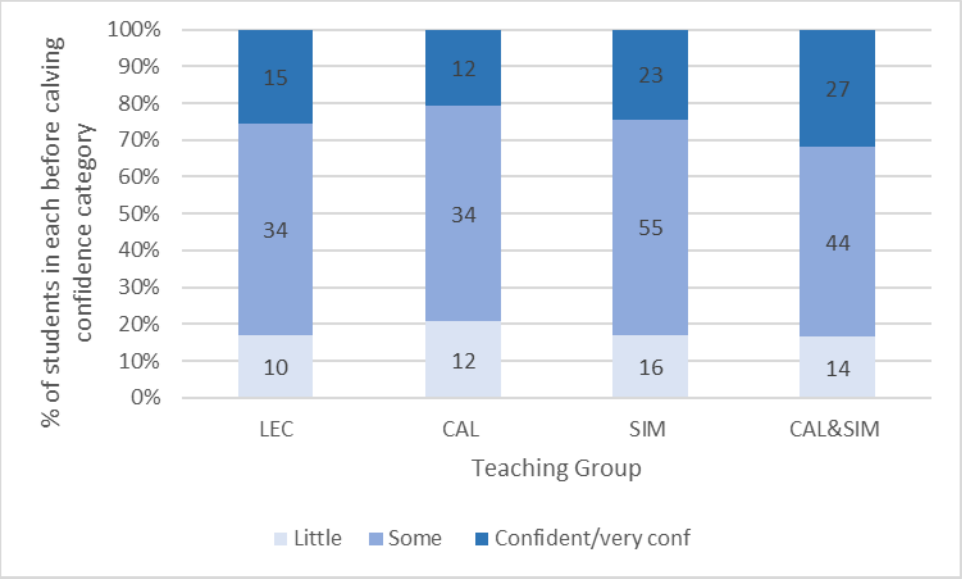


Figure 3.6 Before teaching calving confidence category for each teaching group

3.3.2.3 Qualitative results – what would increase student confidence in calving cows (before teaching)?

This question was only asked in 2017/18 and 2018/19 and not all students completed this section in the BTQ, however, there were data available from 207 students with 266 sections of text that were coded and grouped together into themes. The results can be seen in a table in Appendix 6.

The overwhelming theme was that students want more practice to increase their confidence (239/266 text sections). The main sub theme within the 'further practice' theme was a very general need for more practice with students mentioning getting hands on, actually calving cows and increasing numbers (163/239). Students that wanted more practice occasionally mentioned doing this on EMS (28/239) or using a simulator (29/239), and they also occasionally mentioned practice that just involved observing (11/239) and assisting/helping (8/239). Other interesting themes that were, however, only rarely mentioned, were students specifying that they would want more guidance, supervision and/or critique (13/266), and that further teaching (not including simulation) would also be useful (13/266).

Some example text responses are shown below;

‘Having seen more calving’s on EMS/being able to help with more calving’s’

‘The only way to improve confidence is to actually calf as many cows as possible. Simulators are not the same’

‘More experience with calving cows. Guidance on how to do it properly and how to rectify my problems’

‘The more opportunities I get the more confident I'll feel’

‘Practicing with the simulator will definitely help as well as farm clinical EMS’

3.3.3 Effects of demographics on before confidence

3.3.3.1 Univariant analysis

One student whose gender response was ‘would rather not say’ and six African students were removed from this part of the analysis as the low numbers in each of these demographic categories meant the final model would not converge if included, and they did not naturally sit with any other demographic. This meant 289 students were included in the regression analysis. The demographic variables that were included in the univariant analysis in addition to study year were age, gender, continent of origin, intention following graduation and calving experience. The Univariant analysis was investigating the effect of these variables on the binary categories of before teaching calving confidence, with have ‘*some or more confidence’* (‘some confidence’, ‘confident’ and ‘very confident’ combined) as the outcome of interest compared to ‘*little confidence’*. The results of the univariant analysis are shown in Table 3.5 Before teaching calving confidence univariant analysis results results.

Table 3.5 Before teaching calving confidence univariant analysis results

Variable		n = 289			Odds Ratio (95% CI)	P value
		Little Confidence	Some or more confidence*	Total		
		50 (17%)	239 (83%)	289		
Study Year	2016/17	14 (17%)	70 (83%)	84	Reference	-
	2017/18	19 (17%)	91 (83%)	110	0.96 (0.45 to 2.04)	0.911
	2018/19	17 (18%)	78 (82%)	95	0.92 (0.42 to 1.20)	0.828
Age	Mean [a] (95% CI, +/- SD)	24 95% CI 23.2 - 24.8 +/- 2.73	23.2 95% CI 22.7 - 23.6 +/- 3.27	23.4 95% CI 23.0 - 23.8 +/- 3.40	0.934 (0.87 to 1.02)	0.120
Gender	Female	42 (19%)	185 (81%)	227	Reference	-
	Male	8 (13%)	54 (87%)	62	1.53 (0.68 to 3.36)	0.304
Continent	AS	17 (47%)	19 (53%)	36	Reference	-
	EU	15 (9%)	144 (91%)	159	6.48 (2.44 to 17.17)	< 0.001
	NA	18 (19%)	76 (81%)	94	4.92 (1.76 to 13.71)	0.002
Intention	No cows	46 (28%)	121 (72%)	167	Reference	-
	Cows	4 (3%)	118 (97%)	122	11.22 (3.91 to 32.14)	< 0.001
Experience [b]	None/ minimal	29 (32%)	63 (68%)	92	Reference	-
	Something	21 (11%)	175 (89%)	196	3.84 (2.04 to 7.21)	< 0.001

[a] age outlier in the some confidence/confident group. Outlier age = 49.

[b] one student missing data

European and North American students were at six and a half and five times higher odds of being in the '*some or more confidence*' category compared to Asian students ($p < 0.05$). There was a larger proportion of students in the '*some or more confidence*' category in the group that intended to work with cows (11x higher odds of being in the '*some or more confidence*' category – this is the biggest effect) compared to those that did not want to work with cows ($p = < 0.001$). Almost 90% of students with some calving experience were in the '*some* *or more confidence'* category (four times higher odds of being in this category than students with none/minimal experience) compared to 68% of students with none/minimal calving experience (p = 0.000). The mean age in the '*little*' confidence category was slightly higher than the mean age of students in the '*some or more confidence*' category (p = 0.120).

When investigating for interactions between variables, one of the most relevant relationships identified was that the majority (86%) of students in the none/minimal experience category did not intend to work with cows, while over half of the students with some calving experience wanted to work with cows (p < 0.05) see Table 3.6 Interaction between calving experience levels of students in relation to intention to work with cows after graduation.

Table 3.6 Interaction between calving experience levels of students in relation to intention to work with cows after graduation

Experience	Intention: No cows	Intention: Cows	Total
None/minimal	79 (86%)	13 (14%)	92
Something	87 (44%)	109 (56%)	196

There also seemed to be an additional relationship involving continent with more European students wanting to work with cows and having more calving experience. Despite the fact these relationships were identified, all variables were still considered important and included in the multiple logistic regression.

The variables that were significant to p < 0.2 in the univariant analysis and were included in the multiple logistic regression were age, continent, intention following graduation and experience.

3.3.3.2 Multiple logistic regression

Continent and intention were the two variables that remained in the final model and the results of the final model are shown in Table 3.7 Before teaching calving confidence multiple logistic regression results. Students that intended to work with cows had 23 times the odds of being categorised as having '*some or more confidence*' before teaching, and this was independent of experience, which did not remain in the final model (p = 0.002). The effect of the background continent was confirmed, and EU and NA students were also more likely to be categorised as having '*some or more confidence*' compared to students from AS (p < 0.05).

Table 3.7 Before teaching calving confidence multiple logistic regression results

Variable		n = 289			Odds Ratio (95% CI)	P value
		Little Conf	Some or more conf	Total		
		50 (%)	239	289		
Continent	AS	17 (47%)	19 (53%)	36	Reference	-
	EU	15 (9%)	144 (91%)	159	5.36 (1.83 to 15.67)	0.002
	NA	18 (19%)	76 (81%)	94	3.50 (1.20 to 10.19)	0.021
Intention	No cows	46 (28%)	121 (72%)	167	Reference	-
	Cows	4 (3%)	118 (97%)	122	23.02 (3.03 to 174.88)	0.002

The area under the ROC curve was 0.750 and the Hosmer-Lemeshow p value was 0.158 which both indicated this model was a relatively good predictor of confidence outcome.

3.3.4 Calving Confidence After Teaching

Of the 300 consenting students, 295 completed the ATQ. Of these 295, 284 had also filled out the BTQ with consent and thus had a complete data set which could be used for analysis in this section. The breakdown of the number of students in each teaching group for ATQ confidence analysis is shown in Table 3.8 Number of consenting students with a complete data set for after teaching calving confidence analysis in each teaching group and in each study year. There were slightly more students in the SIM and SIM&CAL group in each study year due to the timing of the formative OSCE (see Chapter 3), but an overall chi-square test showed the difference in numbers of students in each teaching group in each study year was not significant (p = 0.739).

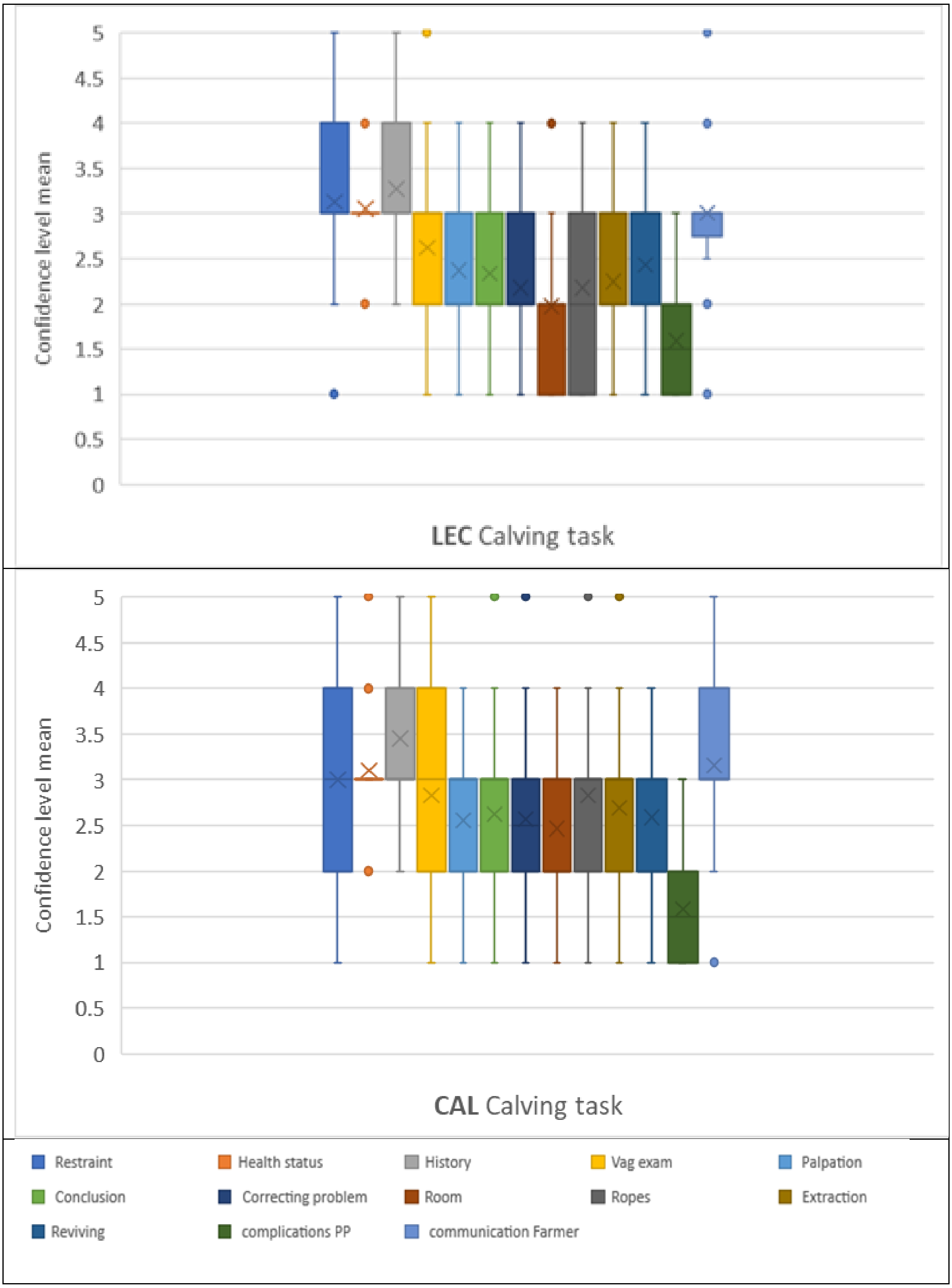
Table 3.8 Number of consenting students with a complete data set for after teaching calving confidence analysis in each teaching group and in each study year

Teaching Group	Study Year n (% of study year)			Total
	2016/17	2017/18	201819	
LEC	15 (19%)	20 (18%)	19 (21%)	54 (20%)
CAL	20 (24%)	24 (22%)	14 (15%)	58 (20%)
SIM	26 (31%)	33 (30%)	30 (33%)	89 (31%)
CAL&SIM	23 (27%)	32 (29%)	28 (31%)	83 (29%)
Total	84	109	91	284

3.3.4.1 After teaching calving confidence per task: effect of teaching mode

Box plots of after teaching calving confidence for each task in each teaching group are shown in Figure 3.7 Boxplots of after teaching calving confidence for each calving task in each teaching group.

The descriptive analysis of after teaching calving confidence per task for each teaching group for all three study years combined can be found in appendix 5.2.


Confidence level mean
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
LEC Calving task
Confidence level mean
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
CAL Calving task
Restraint
Health status
History
Vag exam
Palpation
Conclusion
Correcting problem
Room
Ropes
Extraction
Reviving
complications PP
communication Farmer

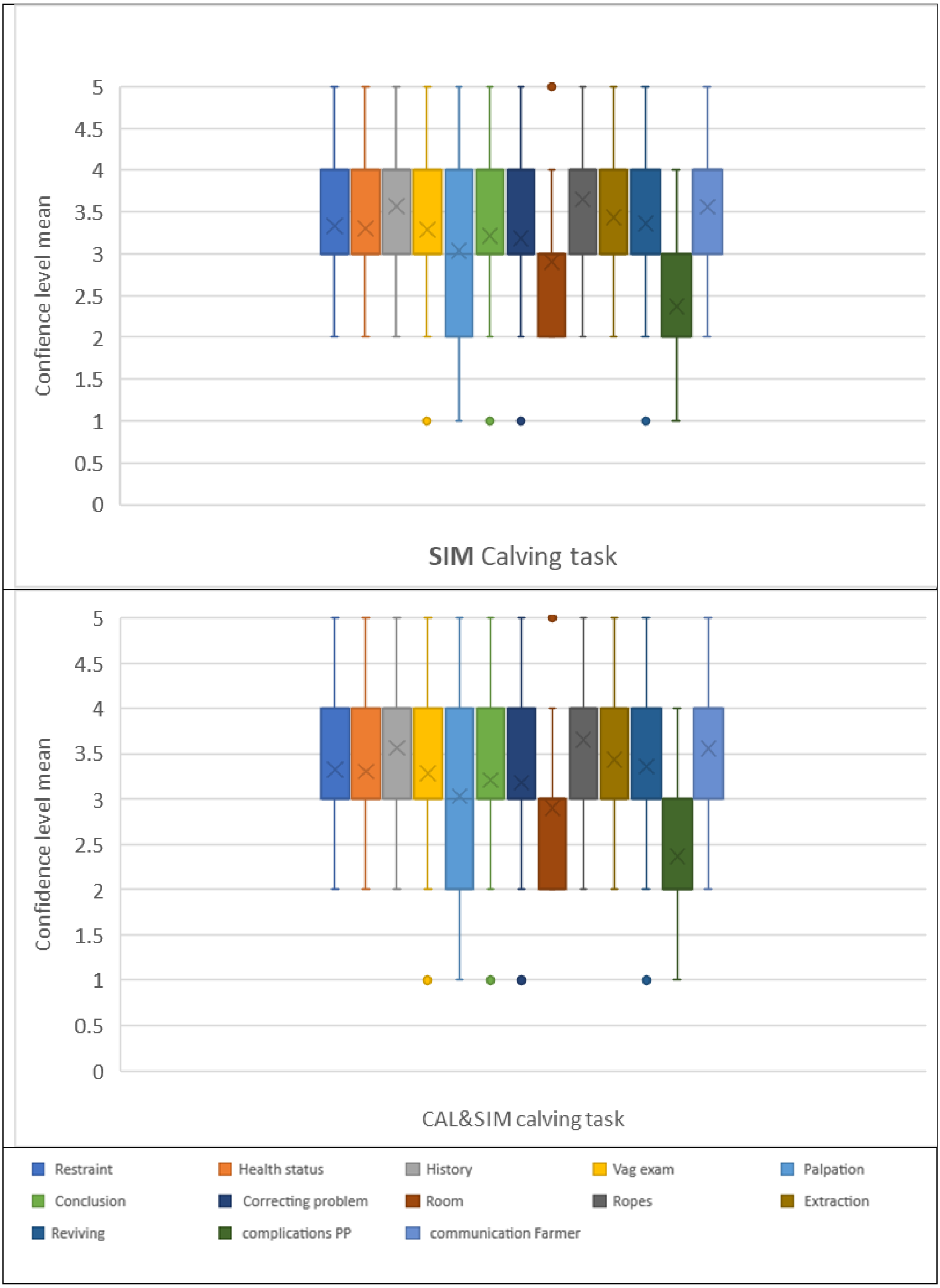


Figure 3.7 Boxplots of after teaching calving confidence for each calving task in each teaching group

Teaching mode led to a difference in after teaching calving confidence for all tasks ($p < 0.05$) apart from 'history' which almost reached significance ($p = 0.05$). The median after teaching confidence for each individual calving task was compared between each of the teaching groups and a summary of the pairwise task comparisons is presented below in Table 3.9 Calving confidence per task - comparing each teaching group with the each other (2nd teaching group has higher confidence ratings than 1st group). Details of the pairwise analysis is shown in Appendix 5.3.

Table 3.9 Calving confidence per task - comparing each teaching group with the each other (2nd teaching group has higher confidence ratings than 1st group)

Teaching group post-hoc comparison	**Calving tasks with statistically different means from ANOVA test**
LEC V CAL	Correcting the problem, assessing for room, applying ropes and extracting the calf
LEC V SIM	All tasks apart from restraint
LEC V CAL&SIM	All tasks
CAL V SIM	All tasks apart from establishing health status and history taking
CAL V CAL&SIM	All tasks apart from history taking and communication
SIM V CAL&SIM	Palpation, coming to a conclusion, assessing for room, applying ropes and extracting the calf

The descriptive analysis of the after teaching calving confidence results for the six tasks that were identified as the most important from a clinical and practical point of view (and also assessed in the formative OSCE) are shown in Table 3.10

After teaching calving confidence for the six most important calving tasks. Different superscripts indicate significant differences in median scores ($p<0.02$) between teaching groups. Calving confidence ratings increased ($p < 02$) sequentially with each addition of teaching material (from LEC to CAL to SIM to CAL&SIM).

Table 3.10 After teaching calving confidence for the six most important calving tasks. Different superscripts indicate significant differences in median scores (p<0.02) between teaching groups

	Mean for 6 calving tasks	95% confidence interval	SD	Median
LEC	13.5	12.28 - 14.67	+/- 4.37	14^{a}
CAL	15.7	14.57 - 16.88	+/- 4.38	15.5^{b}
SIM	19.5	18.75 - 20.32	+/- 3.73	20^{c}
CAL&SIM	20.8	20.10 - 21.56	+/- 3.33	21^{d}
Overall	18	17. 42 - 18.55	+/- 4.80	19

In addition, the number of students below 18 and the number of students with confidence at 18 and above (some confidence) for each teaching group is shown in Table 3.11 The number of students with a six-task calving confidence score below or above 18 in each teaching group.

Table 3.11 The number of students with a six-task calving confidence score below or above 18 in each teaching group

Teaching group	Number of students below 18	Number of students 18 and over
LEC	46 (85%)	8 (15%)
CAL	38 (66%)	20 (34%)
SIM	24 (27%)	65 (73%)
CAL&SIM	13 (16%)	70 (84%)

Increasingly more students achieved 18 and more with CAL, SIM, and CAL&SIM teaching compared with previous lectures alone (p = 0.016), and when SIM and CAL&SIM were compared to CAL (p < 0.001). Addition of the CAL to the SIM tended to lead to higher student numbers with 18+ ratings (p = 0.07).

3.3.4.2 Total numerical and categorical calving confidence after teaching: effect of teaching mode

When the confidence ratings after teaching for the 13 individual calving tasks were combined, the overall mean total score was 39.77 (95% CI 38.79 - 40.75, +/- 8.39). The mean total calving confidence for each study year was 38.74 (95% CI 37.12 - 40.36, +/- 7.46), 38.74 (95% CI 37.12 – 40.36, +/- 8.69) and 40.48 (95% CI 38.65 to 42.32, +/- 8.82) for the study years 2016/17, 2017/18 and 2018/19, respectively. There was no difference in means between study years (p = 0.383)

The calving confidence after teaching for all years combined and for each teaching group is shown in Table 3.12 After teaching calving confidence mean total ratings, 95% confidence interval and +/- standard deviation for each teaching group in each study year.

Table 3.12 After teaching calving confidence mean total ratings, 95% confidence interval and +/- standard deviation for each teaching group in each study year

Teaching Group	Study Year Mean (95% confidence interval CI, +/- standard deviation SD)			Total
	2016/17	2017/18	2018/19	
LEC mean CI SD	33.5 30.16 - 36.78 +/- 5.98	32.2 28.48 - 35.87 +/- 7.89	34.4 29.92 - 38.92 +/- 9.34	33.3^{a} 31.17 - 35.48 +/- 7.89
CAL mean CI SD	35.7 32.68 - 38.72 +/- 6.44	35.7 32.37 - 39.05 +/- 7.91	34.6 29.54 - 39.60 +/- 8.72	35.4^{a} 33.45 - 37.41 +/- 7.53
SIM mean CI SD	40.7 37.61 - 43.70 +/- 7.54	41.8 39.51 - 44.01 +/- 6.34	44.4 41.83 – 46.97 +/- 6.89	42.3^{b} 40.85 - 43.80 +/- 6.99
CAL&SIM mean CI SD	42.7 39.94 - 45.36 +/- 6.26	46.2 43.89 - 48.48 +/- 6.36	43.4 40.79 - 45.93 +/- 6.63	44.3^{b} 42.83 - 45.68 +/- 6.54

^{ab} Different superscripts indicate differences in mean ($p < 0.05$) between teaching groups

The difference in means for each teaching group between each study year was not significant ($p > 0.23$). The after teaching calving confidence for all study years combined for each teaching group is shown in Figure 3.8 Boxplot of total after calving confidence for each teaching group for the three study years combined (X = mean, line = median). ab Different superscripts indicate differences in mean ($p < 0.05$) between teaching groups.

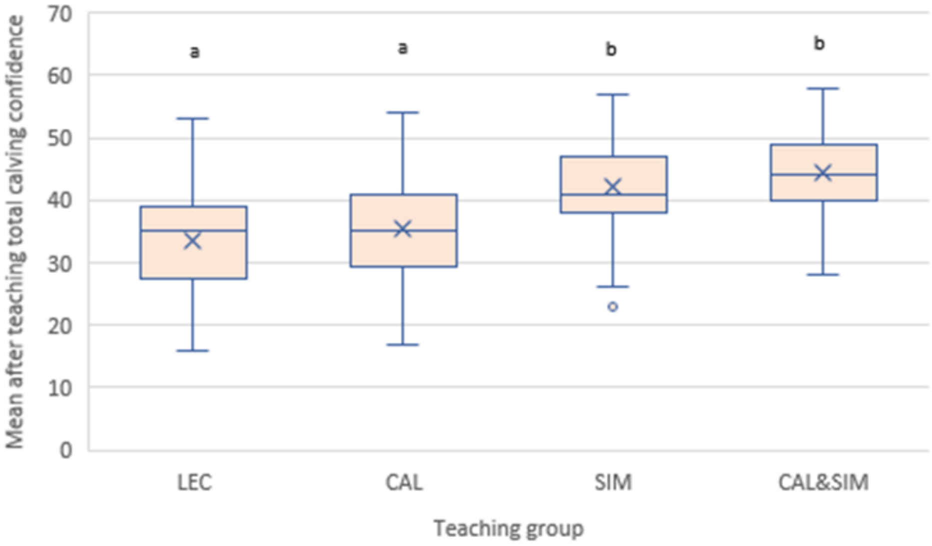


Figure 3.8 Boxplot of total after calving confidence for each teaching group for the three study years combined (X = mean, line = median). ab Different superscripts indicate differences in mean ($p < 0.05$) between teaching groups.

An overall significant difference was found between the means of the teaching groups using ANOVA ($p < 0.05$). Then, each teaching group was compared to the others using post hoc Tukey pairwise comparison. Students self-rated with higher confidence after exposure to the SIM alone or blended with the CAL when compared to both the LEC and CAL teaching groups. The difference in means was not significant between LEC and CAL and SIM & CAL&SIM teaching groups (see superscripts in Table 3.12 After teaching calving confidence mean total ratings, 95% confidence interval and +/- standard deviation for each teaching group in each study year.

The before and after teaching total numerical calving confidence score for each study group is shown graphically in Figure 3.9 Before and after teaching total calving confidence (CONF) for each teaching group (p values in brackets).

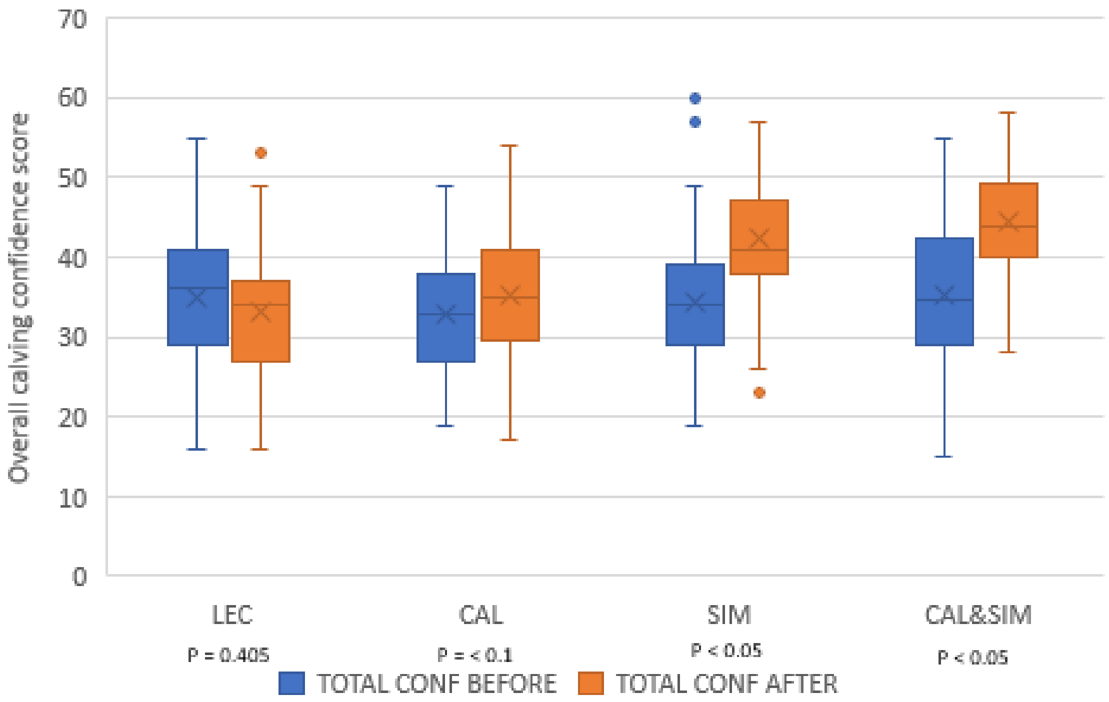


Figure 3.9 Before and after teaching total calving confidence (CONF) for each teaching group (p values in brackets).

There was a higher mean total confidence score after teaching compared with before teaching for students in the SIM and CAL&SIM teaching groups (p = 0.000). The delivery of the CAL also tended (p<0.1) to increase the total confidence score, while scores from students in the LEC teaching group did not change and were lower after teaching (p = 0.405).

There were students in every after teaching calving confidence category in every teaching group apart from the CAL&SIM group, where there were no students in the '*little*' confidence category see Figure 3.10 After teaching calving confidence category for each teaching group. A chi square test showed that the teaching groups differed overall in the number of students in each after teaching calving confidence category (p < 0.001).

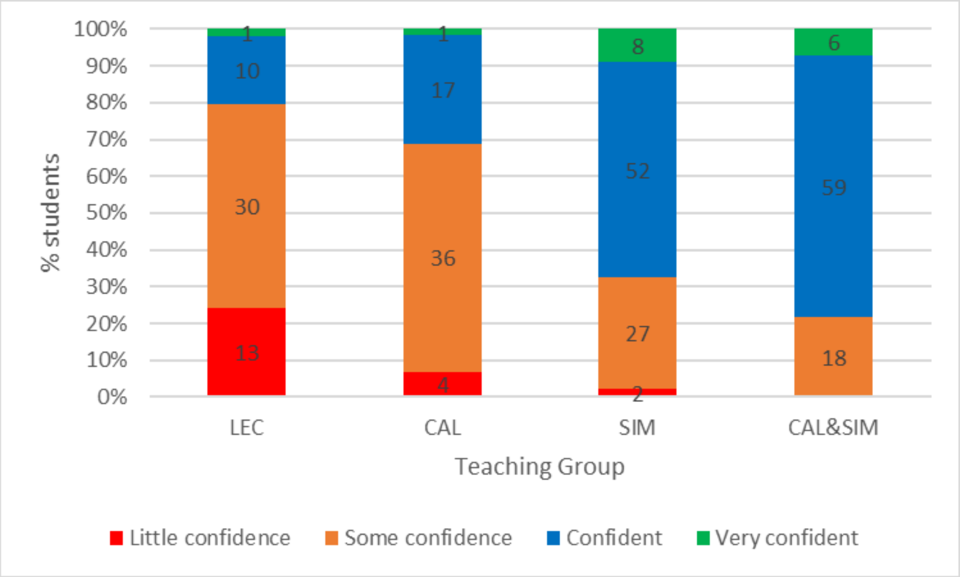


Figure 3.10 After teaching calving confidence category for each teaching group

To determine what affected being categorised as ‘*confident*’ / ’*very confident*’ following teaching delivery using logistic regression analysis, confidence categories were combined for each teaching group as shown in Table 3.13 After teaching calving confidence - regression categories for each teaching group.

Table 3.13 After teaching calving confidence - regression categories for each teaching group. Different superscripts^{ab} indicate significant differences in proportion of students in each confidence category between teaching groups

Teaching Group	Combined calving confidence after teaching category n (%)		
	'Little/some confidence'	*'confident/very confident'*	Total
LEC	43 (78%)	11^a (20%)	54
CAL	40 (69%)	18^a (31%)	58
SIM	29 (33%	60^b (67%)	89
CAL&SIM	18 (22%)	65^b (78%)	83
Total	130 (46%)	154 (54%)	284

Similar to the numerical rating results, teaching group affected the number of students categorised as '*confident*'/'*very confident*' (overall chi square test p = 0.000) after teaching. The exposure to the SIM (alone or in combination with the CAL) led to higher student numbers falling into the '*confident*'/'*very confident*' category when compared to LEC or CAL, while the addition of the CAL to the SIM tended to further increase '*confident*'/*very confident*' student numbers. The results from pairwise chi square tests comparing the teaching groups are shown in Table 3.14 After teaching calving confidence - chi square test result p values for comparing confidence categories.

Table 3.14 After teaching calving confidence - chi square test result p values for comparing confidence categories.

	LEC	CAL	SIM	CAL&SIM
LEC		0.198	0.000	0.000
CAL			0.000	0.000
SIM				0.109

The number of students in each combined calving confidence category (‘*little*’/’*some confidence*’ versus ‘*confident*’/’*very confident*’), before and after teaching was delivered was compared using a chi square test, separately for each teaching group. The results indicate that the number of students in the ‘*confident*’/’*very confident*’ category increased from before to after teaching in the SIM and CAL&SIM teaching (p = 0.000) but not after LEC or CAL delivery. See Table 3.15 Before and after teaching calving confidence categories for each teaching group and chi square p value.

Table 3.15 Before and after teaching calving confidence categories for each teaching group and chi square p value

		Little/some confidence	Confident/very confident	Total	Chi square p value
LEC	Before	44 (75%)	15 (25%)	59	0.524
	After	43 (80%)	11 (20%)	54	
CAL	Before	47 (80%)	12 (20%)	59	0.185
	After	40 (69%)	18 (31%)	58	
SIM	Before	71 (76%)	23 (24%)	94	0.000
	After	29 (33%)	60 (67%)	89	
CAL&SIM	Before	58 (68%)	27 (32%)	85	0.000
	After	18 (22%)	65 (78%)	83	

3.3.5 Effects of demographic on calving confidence after teaching

3.3.5.1 Univariate Analysis

For this part of the analysis, from the 284 consenting students that filled in the ATQ, data from respondents falling into demographic categories with very low numbers, specifically ‘*would rather not say’* for gender (only 1) and *African* students for continent of origin (only 6), were excluded from the univariate and multivariable regression analyses. This was because leaving them in the multivariable analysis as a separate category meant the final model did not converge and there was also no sensible way to combine them with another category. This left 277 students for this part of the analysis.

The demographic and confidence variables that were included in the univariant analysis in addition to teaching group and study year were age, gender, continent of origin, intention following graduation, calving experience and before confidence. The Univariant analysis was investigating the effect of these variables on the binary categories of after teaching calving confidence, with being ‘*confident*’/’*very confident*’ as the outcome of interest compared to having ‘*little*’ or ‘*some confidence’*. The results of the individual univariant logistic regression analyses are shown in Table 3.16 After teaching calving confidence univariant analysis.

Table 3.16 After teaching calving confidence univariant analysis

Variable		n = 277			OR (95% CI)	P value
		Little/ some confidence	Confident /very confident	Total		
		126 (45%)	151 (55%)	277		
study year	2016/17	42 (52%)	39 (48%)	81	Reference	-
	2017/18	47 (44%)	60 (56%)	107	1.38 (0.77 - 2.45)	0.282
	2018/19	37 (42%)	52 (58%)	89	1.51 (0.83 – 2.78)	0.180
Age [a]	Mean 95% CI +/- SD	23.3 22.78 – 23.77 +/- 2.80	23.4 22.81 - 24.06 +/- 3.88	NA	1.01 (0.95 - 1.09)	0.700
Gender [b]	Female	102 (48%)	112 (52%)	214	Reference	-
	Male	24 (38%)	39 (62%)	63	1.48 (0.83– 2.63)	0.181
Continent	AS	24 (67%)	12 (33%)	36	Reference	-
	EU	58 (38%)	93 (62%)	151	3.21 (1.49 – 6.90)	0.003
	NA	44 (49%)	46 (51%)	90	2.09 (0.93 – 4.69)	0.073
Intention	No cows	81 (51%)	79 (49%)	160	Reference	-
	Cows	47 (40%)	70 (60%)	117	1.45 (0.90 – 2.35)	0.129
Experience [c]	None/ minimal	55 (61%)	35 (39%)	90	Reference	-
	Something	71 (38%)	115 (62%)	186	2.55 (1.52 – 4.27)	0.000
Teaching Group	LEC	42 (81%)	10 (19%)	52	Reference	-
	CAL	38 (69%)	17 (31%)	55	1.88 (0.77 – 4.60)	0.168
	SIM	28 (32%)	59 (68%)	87	8.85 (3.89 – 20.16)	0.000
	CAL&SIM	18 (22%)	65 (78%)	83	15.17 (6.39 – 36.02)	0.000
Before Confidence [d]	Little	32 (67%)	16 (33%)	48	Reference	-
	Some or More	93 (41%)	132 (59%)	225	2.84 (1.47 – 5.47)	0.002

	confidence					

[a] Continuous data, not normally distributed, Mann Whitney

[b] 1 x WRNS removed

[c] 1 x no answer

[d] 4 x no answer

The CAL, SIM and CAL&SIM students were increasingly more likely to be in the '*confident'/'very confident'* category when compared to the lecture only teaching group, but only the delivery of the SIM (SIM, CAL&SIM) achieved significantly higher proportions of students in the confident/very confident category. Some experience and '*some or more confidence*' before teaching also led to significantly higher proportions of students in the '*confident'/'very confident'* category. To a smaller extent, students that intended to work with cows were also significantly more likely to be in the '*confident'/'very confident'* category after teaching when compared to students that did not want to work with cows, while the continent of origin also significantly influenced confidence ratings, resulting in more EU and NA students in the '*confident'/'very confident*' category when compared to AS students. Being male appeared to exert a small positive effect on the numbers categorised as '*confident'/'very confident'* ($p<0.2$), while study year and age did not exert any effects on the proportions ($p > 0.2$).

Similar relationships between variables to those found during analysis of the before teaching calving confidence were identified when looking for interactions i.e. between intention following graduation, experience and continent. Despite these interactions, all variables that were significant to $p < 0.2$ in the univariant analysis were included in the multiple logistic regression, specifically gender, continent, intention following graduation, experience, teaching group and before confidence.

3.3.5.2 Multiple logistic regression

The results of the multivariable backwards stepwise logistic regression are shown in Table 3.17 After teaching calving confidence multiple logistic regression, indicating that based on the final model, some experience, ‘*some and more’* before teaching confidence, and SIM teaching will significantly and independently increase the proportion of students allocated to the ‘*confident’/’very confident*’ category.

Table 3.17 After teaching calving confidence multiple logistic regression

Variable		n = 277			OR (95% CI)	P value
		Little/ some confidence	Confident/ very confident	Total		
		126 (45%)	151 (55%)	277		
Experience	None/ minimal	55 (61%)	35 (39%)	90	Reference	-
	Something	71 (38%)	115 (62%)	186	2.49 (1.34 – 4.64)	0.004
Teaching Group	LEC	42 (81%)	10 (19%)	52	Reference	-
	CAL	38 (69%)	17 (31%)	55	2.10 (0.83 - 5.36)	0.119
	SIM	28 (32%)	59 (68%)	87	10.89 (4.55 – 26.10)	0.000
	CAL&SIM	18 (22%)	65 (78%)	83	18.45 (7.44 - 45.76)	0.000
Before Confidence	Little	32 (67%)	16 (33%)	48	Reference	-
	Some or more confidence	93 (41%)	132 (59%)	225	2.915 (1.34 – 6.32)	0.007

Specifically, students that had access to the SIM or the CAL&SIM had 11 and 18.5 times the odds to be in the ‘confident’/’very confident’ confidence category after teaching than students in the LEC teaching group. Smaller effects were seen with some prior experience (2.5 times the odds) and some before confidence (3 times the odds to be in the ‘*confident’/’very confident’* category).

The area under the ROC curve was 0.808 and the Hosmer-Lemeshow p value was 0.745 which both indicated this model was a good predictor of after teaching calving confidence outcome.

3.3.6 Qualitative results – what would increase student confidence in calving cows (after teaching)?

This question was only asked in 2018/19 and not all students completed this section in the ATQ, thus there were data from 97 students. Within the data from these students, there were 129 sections of text that were coded and grouped together into themes. Results were very similar to the BTQ and are shown in Appendix 5.4.

The overwhelming theme was that students want more practice to increase their confidence (115/129 text sections). The main sub theme within the 'more practice' theme was a very general need for more practice with students mentioning getting hands on, actually calving cows and increasing numbers (67/115). In contrast to the BTQ responses, students never mentioned practice that involved assisting/helping and only 4/128 text sections mentioned practice that involved observing. Other themes that were rarely mentioned were students specifying that they would want more guidance, supervision and/or critique (5/129 text sections) and that further teaching (not including simulation) would also be useful (8/129 text sections). One text response also mentioned assessment. When themes were analysed in relation to teaching group, slightly less students in the CAL&SIM teaching group (79%) wanted more practice compared to the LEC (95%), CAL (100%) and SIM (97%) teaching group.

Some example responses are shown below;

'Practicals and specific calving classes/resources. Good videos to watch for revision'

'More practice (especially with real calvings, supervised with someone to ask questions to)'

‘More experience - both artificially and in real situations’

‘More PRACTICE! Not just watching but DOING’

‘Seeing more real life calvings (doing it on my own)’

‘Practising on simulator. Doing calving in real life with vet there’

3.4 Discussion

3.4.1 Key aims and results

The first aim of this study was to evaluate the level of confidence 4th year veterinary undergraduate students feel in relation to calving cows before and after distinct teaching interventions spanning blended approaches, whole class theoretical lectures and small group practicals. Results indicated that 4th year students had an overall calving confidence score of just over 50% of the total possible score before teaching was delivered. After teaching delivery, calving confidence scores and the likelihood to be confident increased when students had received the simulator practical. The difference in before and after teaching calving confidence was also greatest after exposure to the SIM, while the addition of the CAL video resources to the SIM practical (fully blended approach) only resulted in minor improvements. There was a tendency for a small increase in the odds of being categorised as ‘*confident/’very confident’* following exposure to the online videos (blended approach in conjunction with the lectures delivered in previous years) however, no increase in actual total confidence scores was seen.

These findings are generally supported by studies in the veterinary education literature (Badman et al., 2016; Eichel et al., 2013; Ferreira et al., 2021; Govaere Jan et al., 2012) and the medical literature (Dayal et al., 2009; S. Deering et al., 2006; Jude et al., 2006; Vadnais et al., 2012) which report an increase in student confidence following exposure to simulation classes. However, the present study with its unique teaching mode design (including blended approaches) and the large number of students over several years extends existing data from previous studies, and the variation in design, numbers of respondents, fidelity of simulators and comparisons of teaching modes will be discussed further below.

In the veterinary obstetrics education field Ferreira et al., 2021 reported that confidence improved and was less variable, for various elements of large animal obstetrics (equine and bovine) when a much smaller number, 29, 4th year students from a veterinary college in Brazil had access to a low fidelity simulator (obstetrics box and stuffed dummy) used with a competitive game approach to learning after four hours of theory (using images, videos and problem solving lessons). This latter study asked how students rated their confidence (with and without supervision) and, similar to the results of the current study, confidence was higher after they had used the simulator compared to before. There are other studies reporting improved confidence after students were exposed to simulators for learning other clinical skills such as feline ovariohysterectomy (Badman et al., 2016), and equine intravenous jugular injection (Eichel et al., 2013)both of which used a low cost, homemade simulator rather than something commercially available. In contrast, there was no difference in confidence between students that did or did not receive training in a canine ovariohysterectomy using a low fidelity simulator after performing a surgery on a live dog (MacArthur et al., 2021).

The current study also agrees with studies in the medical education field. They report the impact of obstetric simulation teaching (mainly using high fidelity simulators) for both students, residents and obstetricians and show an increase in confidence (Dayal et al., 2009; Jude et al., 2006) and comfort levels (S. H. Deering et al., 2006; Vadnais et al., 2012)after simulation teaching. None of the aforementioned studies evaluated a blended approach with the integration of both video material and simulation.

The video material tended to have a minor positive effect on student confidence. When studying the impact of video material, comparisons can be drawn to a study by (Govaere Jan et al., 2012)which evaluated the implementation of a 3D Digital Video Disk (DVD) resource for equine obstetrics in 178 5th year students. In contrast to the current study, Govaere showed improvements in self efficacy for knowledge and skills (especially if students were guided by staff when using the 3D resource). The video material in the current study was not guided by staff and had no 3D component, but the simulators did allow visualisation inside the cow which was captured on the video.

Although there was no strong difference (shown at the significance level of p = or less than 0.05) in the total calving confidence ratings after teaching between the SIM and CAL&SIM teaching groups, CAL&SIM students had higher levels of confidence compared to SIM students in some important individual calving tasks. Similarly, although there was no difference in the mean total calving confidence, some of the same important tasks also differed between LEC and CAL students, e.g. assessing for room, applying ropes and extracting the calf. While confidence was not increased overall after students used the CAL, this demonstrates the value of having the online video training resources to review specific elements of calving a cow that are very suitable to depict in a video.

No previous studies have investigated the impact of a blended approach to learning veterinary clinical skills on calving confidence, as they either evaluate simulation alone or video material alone. Other interesting elements of further teaching are presented in other published work however, such as the impact of having a staff member guide students through the video material (Govaere Jan et al., 2012), or the impact on student anxiety (MacArthur et al., 2021). It also may be important to note that many studies use lower cost thus lower fidelity simulators (Badman et al., 2016; Ferreira et al., 2021) than the one used in the current study.

The second aim of the study was to investigate the demographic factors which influence calving confidence before and after teaching, independent of teaching modality. Confidence before and after teaching delivery (based on higher self-ratings) appears to be influenced by similar variables. Consistently, continent of origin (students from EU and NA being more likely to be allocated to the more confident categories (s*ome or more confidence'* in the BTQ and '*confident'/'very confident'* group in the ATQ), intention following graduation (students wanting to work with cows were more confident), and calving experience (students with some calving experience were more confident) were the variables identified by the initial univariant regression analysis to be included in the multivariable model.

In fact, the final model for the before teaching calving confidence analysis showed that intention following graduation had a large effect, specifically, students that intended to work with cows were 23 times more likely to have '*some or more confidence'* compared to students that did not plan to work with cows. The final model for the after teaching confidence analysis showed a ten-fold smaller effect of experience, where students with some experience were two and a half times more likely to be *'confident'/'very confident'* after teaching. There were some interaction identified between the variables investigated, however, as students who wanted to work with cows also had more experience, this could be a reason why only one of them remained in the two final models.

It is no surprise that having an experience of calving a cow would lead to an increase in confidence, especially if the student was given the opportunity to get involved. However, although not demonstrated in this study the converse could also be true, students that have had experience of calving a cow might realise how difficult it could be and therefore have lower confidence (Dunning, 2011). Students might also underate their own confidence so as not to appear arrogant (Dunning, 2011). In other published studies, some researchers remove students if they have experience of carrying out the procedure in a live animal so that the study is only looking at the effect of simulation on students with no experience at all (Badman et al., 2016). This was not done in the present study but should be considered in future work.

Although the positive effect of teaching modality (simulation in particular) on student confidence has been reported quite extensively within the veterinary education literature (Badman et al., 2016; Eichel et al., 2013; Ferreira et al., 2021; MacArthur et al., 2021), literature on the demographic factors that influence confidence are much harder to find. A very relevant study looking at demographic variables unfortunately only investigated competence and not self-assessed confidence and is discussed in the next chapter (Annandale et al., 2018).

In the medical literature, the influence of demographics on self-rated confidence is also quite limited, especially for obstetrics. One study of 150 third year medical students in the Midwest region of North America measured knot tying and suturing confidence levels (as well as task competence after training) before and after 60 minutes of training (using video resources followed by hands on instruction) (Clanton et al., 2014). Unlike the current study, age was found to influence before confidence (younger students were less confident), experience was negatively associated with knot tying confidence before and after (in contrast to the current study), with experience in suturing not being associated with confidence before or after. Clearly, any demographic effects are very much background and task dependent, where age and experience do not necessarily follow each other.

It was interesting in the present study that no differences were detected when gender was investigated in relation to confidence self-ratings before or after teaching delivery, although gender was included in the logistic regression model exploring variables which influence being categorised as '*confident*'/'*very confident*' after teaching. It may be that any gender effects were linked to previous experience or even intention to work with cows, as traditionally, the majority of farm animal vets would be male (Kinnison et al., 2013). But as the demographic of the student population shows, the majority of vet students are female (77 – 79%), and the number of declared male veterinary undergraduate students is so small, it will be difficult to find independent effects of gender.

3.4.2 Other interesting results and comparisons

It was interesting that numerically some 4th year students still lose confidence even after exposure to SIM teaching, and that some students that got no further teaching (LEC students) still increased their calving confidence. It might be that some students are just inherently confident or not confident and regardless of further teaching, were never going to gain confidence from further teaching or were confident before teaching so were always going to be confident.

Although the SIM classes had the greatest effect on the main calving tasks, some of the calving tasks which are related to the live animal and cannot be simulated by a mannequin, such as '*revival of the calf*', also showed an increase in confidence after SIM exposure. This supports the format of the SIM class being contextual which is shown to enhance relevant student learning (Scalese & Issenberg, 2008). Teachers made the effort to use role play within the SIM class and incorporated history taking and after care of the cow and calf within their teaching. It seems that this approach paid off with almost all of the calving related tasks showing an increase in confidence even if they were not directedly linked to simulator practice.

The demographics were as expected in the main with the majority being female and from EU or NA within the student cohort. The number of students that wanted to work with cows showed a decreasing trend over the three study years. Gates et al., 2018 reported that 38% of final year students wanted to go into mixed practice and 6% wanted to do large animals only, in a study of final year students at time of graduation, very similar to this present study. It is well known that less students want to pursue a career in farm animal or mixed practice and various reasons have been proposed (Remnant, 2021). One of the key drivers for students considering a career in farm or mixed practice is having some experience in the sector and having a relationship with a farm or mixed practice vet (Lenarduzzi et al., 2009). Experience of calving cows appeared to be of relatively limited influence in the current study, while intention had a large influence on confidence, so encouraging students to undertake farm or mixed practice EMS placements and, likewise, encouraging practices to take on EMS students may encourage more graduates into the farm animal sector of the profession.

As it is widely reported that there is a lack of farm and mixed vets with no foreseeable improvement (Adam et al., 2019; Remnant, 2021), it was interesting to investigate this particular demographic in a bit more detail. There was no difference between the number of declared males and females that wanted to work with cows ($p > 0.05$) which is contrary to what previous research has published (Jelinski et al., 2009; Kinnison & May, 2013; Serpell, 2005), but agrees with some other studies (Amass et al., 2011). In the current study, students from EU are more likely to want to work with cows when compared to NA and AS students ($p < 0.05$). Students with more experience and higher before teaching calving confidence were indeed more likely to want to work with cows ($p = 0.000$). This contention is supported by a study by Lenarduzzi et al., 2009 who reported experience of farm animal work as a key driver for wanting to work in farm animal practice in an online survey of recently enrolled vet students and recent graduates in Texas. The current study, therefore, identified possible interactions between known variables which would influence whether a student wanted to work with cows, but other factors such a working conditions will also likely play a role.

No prior data exist on calving experience of veterinary students, but there are studies which show cow reproductive examination and small animal reproductive surgery experience of students in their later years of clinical training. The calving experience levels found in the current study are similar to what has been shown in one of these studies, where 68% of year four and five students of a Swedish veterinary programme had assisted with a feline ovariohysterectomy which is similar to the proportion of 4th year students (67%) in the current study that had assisted in a calving (Badman et al., 2016). In another study of final year veterinary students 44%, 54% and 64% of students had not performed a dog castration, cat spay or bitch spay unassisted, respectively, at time of graduation (Gates et al., 2018). The current study involved 4th year students that still had some time to acquire experience but a much higher percentage of students (87%) had never calved a cow unassisted, highlighting the need for production animal training in high stakes scenarios. A relatively recent study evaluating bovine rectal exam experience showed that 65% of 4th year students had no experience, but a direct comparison is difficult as this is not a task where side by side assistance can be given (Annandale et al., 2018). Experience levels are expected to vary considerably between students depending on their background, quality of EMS and the task itself.

Surprisingly the qualitative data analysis results from the BTQ and ATQ were very similar. The overriding theme in both was the need for more practice despite the fact many of them had received further teaching with the CAL and SIM. For a lot of students this was a very general response with many of them just writing the word ‘practice’ so it is hard to interpret what type or nature of practice they would find useful. As most universities would struggle to offer enough live animal practice to their ever-increasing number of undergraduate students, this finding puts pressure on students to seek out appropriate EMS and for EMS placement providers to make sure students are exposed to cows calving. With EMS already under strain (RCVS, 2021), this finding gives further evidence to the pressure EMS is under. It also gives evidence for exposing students continuously to the simulator, during prescribed teaching events and subsequent revision sessions throughout the curriculum.

3.4.3 Study design

The strengths of this study were the high questionnaire response rate by using paper questionnaires (rather than an online survey) that were collected during a lecture or formative OSCE day. This study also spanned multiple study years so that a year effect could be explored, giving credibility to the consistent results shown. The numbers of students in this study allowed enough statistical power for further tests to be carried out and used a published list of relevant calving tasks (Read & Baillie, 2013) which was constructed using proven methodology and agreed by experienced veterinarians.

The limitations are that the data underwent further categorisation to allow logistic regression which can dilute some of the detail within the results. Linear regression could have been used on the original confidence numerical data as an alternative statistical approach. The self-reported confidence ratings can be open to interpretation and the lack of more specific descriptors to go along with the self-assessment on the BTQ and ATQ may have meant students misinterpreted the meaning of the 1-5 scale. In addition, the gap between each of the five confidence categories may not have been even. Furthermore, how confident students feel after a lecture delivered several months back or just before a formative OSCE exam may be completely different to how confident they feel in the middle of the night when faced with a cow calving on their own.

3.4.4 Application, further work and conclusion

Knowing that access to a practical class involving the high-fidelity calving simulator independently results in increased student confidence and an over 10-fold higher odds of being confident about calving cows, could provide evidence for investment in similar models for other veterinary educational establishments. The limited effect of the CAL alone on confidence, despite being relevant as students are watching demonstration videos using the calving simulator, further supports the premise that physical practice with the simulator and associated aids are a key driver of calving confidence levels. Ascertaining the other variables that affect calving confidence before and after teaching delivery (experience and intention to work with cows, in particular, but also country of origin) allows educators to ensure students are encouraged to seek relevant practical EMS opportunities to gain confidence with calving cows in addition to the practical classes provided at university. Perhaps more students would consider going into farm or mixed practice, they just do not know it yet as they have not had the experience?

While this part of the study clearly indicates a benefit to student calving confidence with the use of a calving simulator, it would still be very useful to know if this confidence translates to confidence in the field when faced with a cow calving as a recent graduate. Assessing this in the field would be problematic due to the nature of farm animal work being remote and the fact that graduates disperse all over the world after graduation, but this would be a logical next step and is actively encouraged in the medical education literature (Bewley & O’Neil, 2013).

Chapter 4 Results - Calving competence and comparison with calving confidence

4.1 Introduction

The previous chapter reported the results of student confidence in calving cows following implementation of a calving simulator as part of a blended learning approach while this chapter is focusing on competence assessed by a formative OSCE exam. Veterinary undergraduates need to receive training in bovine obstetrics to equip them with the clinical skills and competence needed to approach such an emergency.

Like many aspects of veterinary medicine, seeing and being involved in an actual calving would be the best way for students to really appreciate what is involved (in addition to theoretical lectures). As many veterinary schools nowadays have limited resources for students in lower years to be exposed to clinical material, most students would rely on being exposed to a live calving cow experience during Extra Mural Studies (EMS).

In the medical field, looking at competence, video recorded assessment of shoulder dystocia showed higher successful delivery rate and speed of delivery after training with both low and high-fidelity models for teaching shoulder dystocia to doctors and midwives (Crofts et al., 2006). There was also an overall improvement in physician graded obstetrics scenarios for twenty obstetrics residents following training with a computerised robotic birthing simulator (Deering et al., 2006). The medical literature has also taken measuring simulation success a step further by assessing patient-based outcomes following simulation implementation, and researchers report less vaginal tears, reduced neonatal injury and less excessive traction following simulation training (Draycott et al., 2008; Gossett et al., 2016).

There is more limited evidence for the effect of obstetrics simulation in veterinary student competence carrying out the task. Ferreira et al., (2021) reported improved understanding of foetal position and obstetrics manoeuvres (assessed by a test), but not the effect on student clinical skills competence following the implementation of low fidelity equine obstetrics simulator. There are mixed reports on the effect of video material for developing competence in large animal obstetrics. Govaere Jan et al., (2012) reported improved skills acquisition and self-efficacy following the implementation of a three-dimensional (3D) equine obstetrics resource, especially when students were guided by a teacher. Following the implementation of a new teaching intervention for veterinary clinical skills, it is important to measure the impact it has on student learning and subsequent competence in the task.

The main aims of this study were to;

1. Investigate the impact on veterinary undergraduate student competence in calving cows following the implementation of a calving simulator as part of a blended learning approach.

2. Investigate the demographic factors that influence student competence calving cows following the implementation of a calving simulator as part of a blended learning approach.

4.2 Materials and Methods

Materials and methods are described in chapter 2.

4.3 Results

4.3.1 Student recruitment to the study

Of the 347 eligible 4th year students, 300 gave consent via the BTQ giving an overall initial response rate of 86%. Initial response rate varied slightly between study years with 2016/17 having the lowest (75%) and 2017/18 having the highest (95%). Of the 300 consenting students, 298 attended the formative OSCE and completed the ATQ (86% of all eligible students). Further information for each study year is summarised in Table 4.1 Student numbers for calving competence study. .

Table 4.1 Student numbers for calving competence study.

	Study year			All study years combined
	2016/17	2017/18	2018/19	
Number of students eligible to take part	116	120	111	347
Number of students that consented to take part in competence study	87 (75%)	114 (95%)	99 (89%)	300 (86%)
Number of consenting students that attended OSCE exam	87 (75%)	113 (94%)	98 (88%)	298 (86%)

The number of consenting students allocated to each teaching group that attended the OSCE is shown in Table 4.2 Number of consenting students in each teaching group that attended the formative OSCE exam. There were slightly more students in the SIM and CAL&SIM teaching groups compared to the LEC and CAL teaching groups due to the nature of scheduling the OSCE. The difference in the number of students in each teaching group in each study year was not statistically different (p = 0.906).

Table 4.2 Number of consenting students in each teaching group that attended the formative OSCE exam in each study year and overall

Teaching Group	Study Year			Total
	2016/17	2017/18	2018/19	
LEC	16	22	22	60
CAL	20	24	15	59
SIM	27	35	33	95
CAL&SIM	24	32	28	84
Total	87	113	98	298

4.3.2 Moderation, OSCE pass mark and global rating

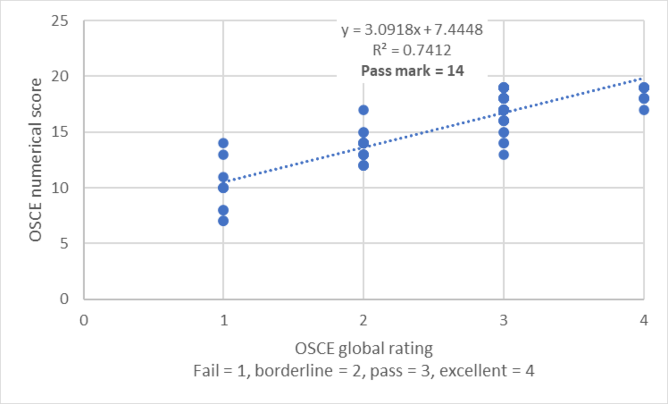
There were 76 moderations in total, 19, 39 and 18 moderations needed in each of the three study years 2016/17, 2017/18, 2018/19 respectively. In the 2018/19 study year, ten of the moderations were due to one examiner awarding split marks for a section that should have been awarded zero or four marks.

4.3.2.1 Borderline regression method (BRM) to determine the pass mark

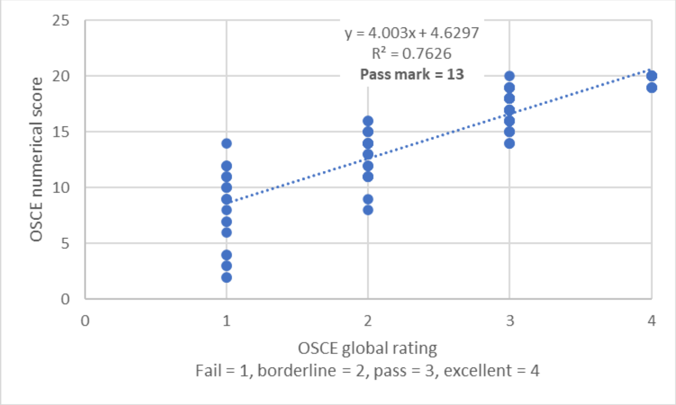
The BRM results and calculated pass mark are shown in Figure 4.1 Linear regression graphs used to establish OSCE pass mark for each study year. In 2018/19, the borderline global rating was split into borderline fail (1.5 on x axis of graph) and borderline pass (2.5 on x axis of graph).

Figure 4.1 Linear regression graphs used to establish OSCE pass mark for each study year

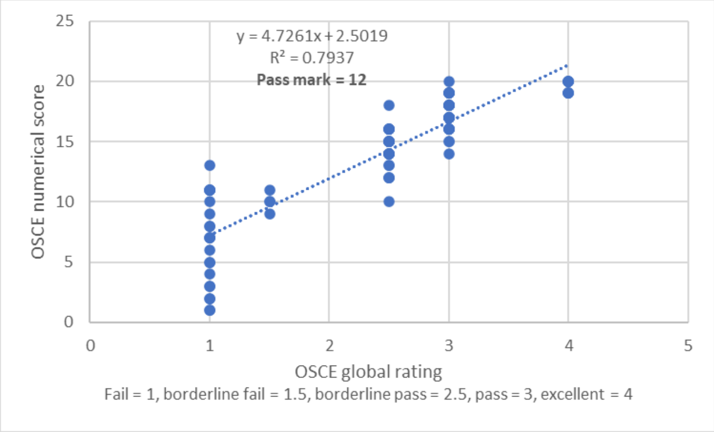
2016/17



2017/18



2018/19



Twenty-one, 28 and 30 changes were made to the moderated OSCE assessor global ratings in the 2016/17, 2017/18 and 2018/19 study years, respectively after the pass mark was established by BRM.

4.3.2.2 Descriptive statistics of moderated OSCE numerical score and final OSCE grade (outcome)

The mean, 95% confidence interval (CI) and standard deviation (SD) of the OSCE numerical score, categorised by final OSCE grade for each study year and overall is shown in Table 4.3 Mean OSCE moderated numerical score (95% CI and +/- SD) categorised by final OSCE grade. Further OSCE validation graphs showing the distribution of scores for each OSCE outcome in each study year can be found in appendix 6.5.

Table 4.3 Mean OSCE moderated numerical score (95% CI and +/- SD) categorised by final OSCE grade in each stydy year and overall

Study year	OSCE moderated numerical score mean (95% CI, +/- SD)		
	Fail	Pass	Excellent
2016/17	10.8	16.75	18.5
95% CI	9.87 – 11.92	16.29 - 17.21	17.99 – 18.92
SD	+/- 2.13	+/- 1.75	+/- 0.69
2017/18	8.75	16.3	19.5
95% CI	7.58 – 9.91	15.81 – 16.72	19.43 – 19.94
SD	+/- 3.24	+/- 1.83	+/- 0.48
2018/19	7.15	16.15	19.6
95% CI	5.77 - 8.52	15.65 - 16.64	19.15 – 19.96
SD	+/- 3.47	+/- 1.95	+/- 0.53
Total	8.7	16.4	19.2
95% CI	7.96 - 9.48	16.10 - 16.65	19.01 - 19.54
SD	+/- 3.38	+/- 1.85	+/- 0.78

4.3.3 Effect of teaching group on OSCE numerical Score

Overall, the mean OSCE numerical score (after moderation) was 14.7 (95% CI 14.23 to 15.22, +/- 4.34). The numerical OSCE score for each teaching group in all study years combined is shown in Figure 4.2 Boxplot of OSCE numerical score for each teaching group for all study years combined. ^{ab} Different superscripts indicate differences in mean ($p < 0.05$) between teaching groups

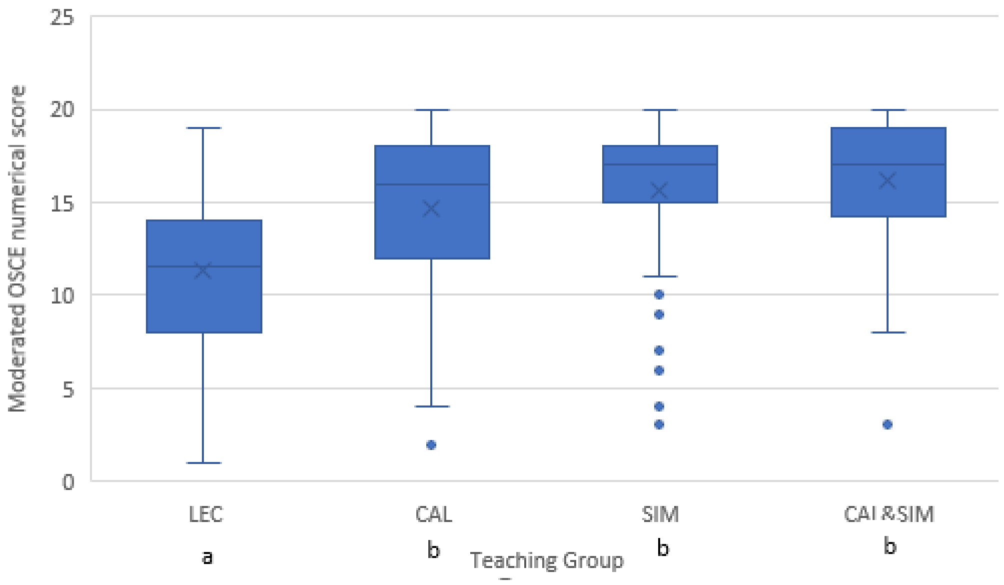


Figure 4.2 Boxplot of OSCE numerical score for each teaching group for all study years combined. ^{ab} Different superscripts indicate differences in mean ($p < 0.05$) between teaching groups

When all three study years were combined, there was an effect of teaching group on the median OSCE numerical scores overall (p = 0.000). Pairwise comparisons of medians showed that any additional teaching (CAL, SIM or CAL&SIM) to the previous lectures (LEC teaching group) resulted in a higher median OSCE score (p < 0.001). The addition of the SIM practical teaching to the online CAL tended to further increase the median numerical OSCE score (CAL vs CAL&SIM, p = 0.053), however, the addition of the CAL to the practical SIM teaching had no effect (SIM vs CAL&SIM, p > 0.4). This is shown in Table 4.4 Teaching group comparison P values for Mann Whitney test of OSCE numerical score.

Table 4.4 Teaching group comparison P values for Mann Whitney test of OSCE numerical score median

Teaching group	LEC	CAL	SIM	CAL&SIM
LEC		0.000	0.000	0.000
CAL			0.162	0.053
SIM				0.493

The OSCE numerical score for each teaching group per study year and for all study years combined is shown in Table 4.5 OSCE numerical score mean, 95% CI, +/- SD and median for each teaching group in each study year and overall.

Table 4.5 OSCE numerical score mean, 95% CI, +/- SD and median for each teaching group in each study year and overall

Teaching Group	OSCE moderated numerical score mean (95% CI, +/- SD) and median				P value for difference between years per teaching group**
	Study Year				
	2016/17	2017/18	2018/19	Total	
LEC 95% CI SD median	13.4^{a} 11.59 – 15.28 +/- 3.46 13.5	10.6^{a} 8.66 – 12.61 +/- 4.46 11.0	10.4^{a} 7.78 – 12.95 +/- 5.83 10.5	11.3^{a} 10.02 - 12.55 +/- 4.89 11.5	0.122
CAL 95% CI SD median	16.3^{b} 14.99 – 17.61 +/- 2.79 17.5	14.6^{b} 12.83 – 16.42 +/- 4.24 14.5	12.6^{ab} 9.76 – 15.43 +/- 5.12 13.0	14.7^{b*} 13.57 -15.79 +/- 4.25 14.7	0.076
SIM 95% CI SD median	15.9^{b} 14.72 – 17.06 +/- 2.95 17.0	16.2^{b} 14.87 – 17.47 +/- 3.79 17.0	15.0^{bc} 13.48 – 16.46 +/- 4.20 16.0	15.7^{b} 14.92 – 16.43 +/- 3.73 17.0	0.268
CAL&SIM 95% CI SD median	16.5^{b} 15.26 – 17.65 +/- 2.83 17.0	15.7^{b} 14.29 – 17.03 +/- 3.80 16.0	16.4^{c} 15.28 – 17.50 +/- 2.86 17.0	16.1^{b*} 15.43 -16.83 +/- 3.23 17.0	0.771
P value for overall difference between teaching groups in each study year	0.024	0.000	0.001	0.000	

^{abc} Different superscripts indicate differences in means ($p < 0.05$) between teaching groups determined for each study year separately (for each coloured column) using pairwise comparisons.

*CAL and CAL&SIM tended to differ ($p = 0.053$)

**Note that passmarks differed between study years (see above)

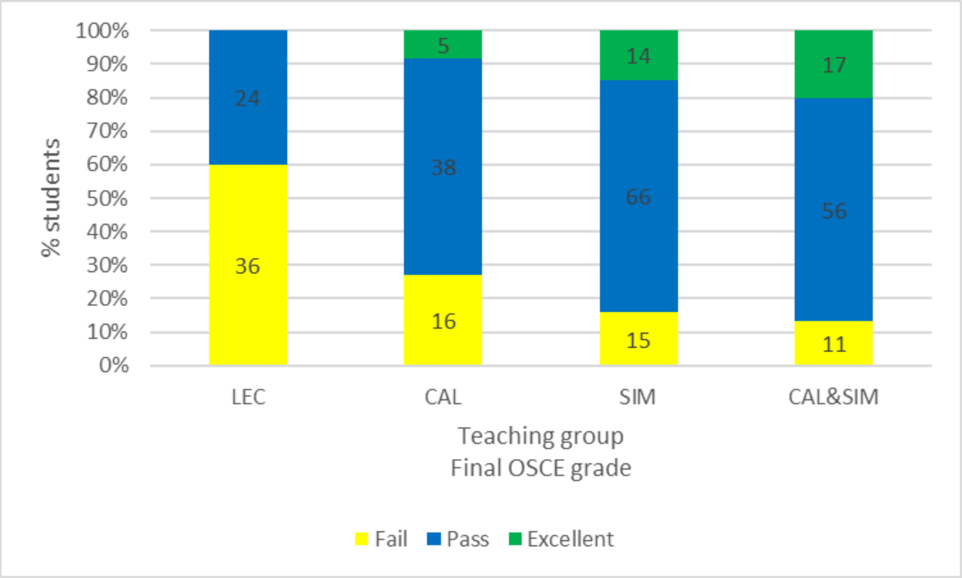
The median OSCE score for the same teaching group did not differ between study years, although the CAL results tended to be higher in 2016/17 compared to the other two years ($p > 0.07$). The OSCE numerical score generally increased from LEC to CAL to SIM and CAL&SIM, as teaching exposure increased. The medians of each different teaching group overall were different within each study year ($p < 0.05$).

When each teaching group was compared to the other within each study year, any further teaching (CAL, SIM or CAL&SIM) compared to lectures alone resulted in increased numerical OSCE score apart from 2018/19 where there was no difference between LEC and CAL ($P = 0.272$). In 2017/18 and 2018/19 SIM exposure tended to lead to higher OSCE scores compared to the CAL ($p = 0.1$), and the addition of the video resources (CAL) to the SIM practical (the fully blended approach) led to the highest OSCE scores ($p = 0.018$).

4.3.4 Effect of teaching group on OSCE grade (outcome)

Out of the 298 consenting students across all study years and in all teaching groups, 78 (26%) students failed and 220 (74%) passed the formative OSCE, with 36 of the 220 pass students achieving an excellent rating (12% of total students). The OSCE grade achieved by students allocated to each teaching group are shown in Figure 4.3 Proportion of students awarded each OSCE grade in each teaching group in total study population (data label = actual number of students).

Figure 4.3 Proportion of students awarded each OSCE grade in each teaching group in total study population (data label = actual number of students)



The number of students that failed or passed (combined pass/excellent) the OSCE in each teaching group for all study years combined is shown in Table 4.6 Number of students in each combined pass and excellent final OSCE grade for each teaching group. ^{abc} Different superscripts indicate differences in proportions of students passing the OSCE ($p < 0.05$) between teaching groups determined using pairwise comparisons.

Table 4.6 Number of students in each combined pass and excellent final OSCE grade for each teaching group. ^{abc} Different superscripts indicate differences in proportions of students passing the OSCE ($p < 0.05$) between teaching groups determined using pairwise comparisons.

	Fail	Pass and Excellent	Total
LEC	36 (60%)	24^{a} (40%)	60
CAL	16 (27%)	43^{bc} (73%)	59
SIM	15 (16%)	80^{b} (84%)	95
CAL&SIM	11 (13%)	73^{bc} (87%)	84
Total	78	220	298

The proportions of students awarded an overall pass differed by teaching group for the combined study year data (p = 0.000). The proportion of pass students in the LEC teaching group was lower compared to all other teaching groups. Like the numerical results, adding the SIM to the CAL also led to higher proportions of passes, but the proportions of passes were similar between the SIM and CAL&SIM groups (p 0.610). Having the SIM practical tended to lead to more students passing the OSCE compared with video resources alone (CAL).

Table 4.7 P value results for Chi Square tests for OSCE final grade comparing teaching groups with each other.

	LEC	CAL	SIM	CAL&SIM
LEC		0.000	0.000	0.000
CAL			0.088	0.035
SIM				0.610

The breakdown of OSCE grade by study year and per teaching group is shown in Figure 4.4 OSCE grade for each teaching group in each study year (data label = actual number of students). There was no difference in the proportion of students that passed (pass and excellent combined) or failed the OSCE in each teaching group between study years (p > 0.12).

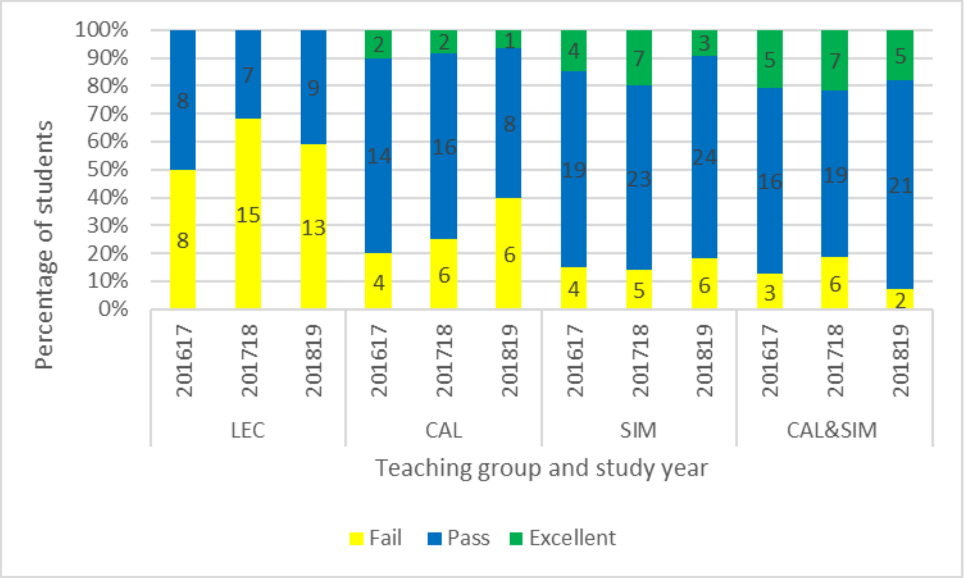


Figure 4.4 OSCE grade for each teaching group in each study year (data label = actual number of students)

4.3.5 Effect of OSCE assessor on OSCE results

There were seven different OSCE assessors during the three study years (the four peer final year assessors were combined into one OSCE assessor group). One assessor assessed 108 out of the 298 OSCE assessments (36%) over the three study years and all other assessors carried out between 20 and 51 assessments (7% to 17%) in total. Some .assessed in every study year and some only assessed in one study year.

4.3.5.1 Teaching Group

The breakdown of assessors by teaching group is shown in Table 4.8 Number of OSCE assessments in each teaching group carried out by each OSCE assessor. It could not be avoided that some assessors did not assess an even proportion of students in each teaching group. For example, of the 34 students that assessor three assessed, only three (9%) were in the CAL&SIM group and 12 (35%) were in the LEC group.

Table 4.8 Number of OSCE assessments in each teaching group carried out by each OSCE assessor

Assessor	Teaching group				Total	% of overall assessment
	LEC	CAL	SIM	CAL&SIM		
1*	16 (14%)	23 (21%)	33 (31%)	36 (33%)	108	36%
2	13 (25%)	10 (20%)	12 (24%)	16 (31%)	51	17%
3*	12 (35%)	6 (18%)	13 (38%)	3 (9%)	34	11%
4	4 (13%)	11 (35%)	10 (32%)	6 (19%)	31	10%
5*	9 (33%)	4 (15%)	6 (22%)	8 (30%)	27	9%
6	1 (3%)	4 (15%)	12 (44%)	10 (37%)	27	9%
7*	5 (25%)	1 (5%)	9 (45%)	5 (25%)	20	7%
Total	60	59	95	84	298	

*Clinical faculty vets

For statistical analysis, the OSCE assessors were condensed into two categories based on background:

1. Clinical faculty vets
2. Technical staff, external veterinarians and peer assessors.

The number of OSCEs assessed by members in each assessor category summarised for each teaching group is shown in Table 4.9 Number of OSCE assessments carried out by each OSCE assessor category for each teaching group

Table 4.9 Number of OSCE assessments carried out by each OSCE assessor category for each teaching group

Assessor	Numbers of students assessed in each Teaching group (% overall assessment carried out by assessor category)				Total	% of assessment overall
	LEC	CAL	SIM	CAL&SIM		
Clinical faculty vets	42 (22%)	34 (31%)	61 (32%)	52 (28%)	189	63%
% of teaching group assessed	70%	58%	64%	62%		
Technical staff, external vets and peer assessors	18 (17%)	25 (23%)	34 (31%)	32 (29%)	109	37%
% of teaching group assessed	30%	42%	36%	38%		
Total assessments	60	59	95	84	298	100%

This categorisation resulted in a relatively more even number of students in each teaching group assessed by each OSCE assessor category (chi square test p = 0.549).

4.3.5.2 Moderation and numerical OSCE score

Faculty vet staff had moderations in 54 out of 189 (28%) OSCE assessments and technical, external vets and peer assessors had moderations in 22 out of 109 (20%) OSCEs. The final mean OSCE numerical score for the clinical faculty vets was 13.80 (95% CI 13.16 - 14.44, +/- 4.48) and was higher, 16.32 (95% CI 15.64 - 17.00, +/- 3.58) for the technical, external vets and peer assessors ($p < 0.05$).

4.3.5.3 Final OSCE grade (outcome)

Table 4.10 Number of students awarded each final OSCE grade for each OSCE assessor category shows the final OSCE grade for each OSCE assessor category. Clinical faculty vets awarded 22% more fails and, conversely, technical, external veterinarians and peer assessors awarded 23% more passes and 10% more excellent grades. This difference in ratings (fail, pass and excellent) between OSCE assessor categories was found to be significant ($p < 0.001$).

Table 4.10 Number of students awarded each final OSCE grade for each OSCE assessor category

	Fail	Pass	Excellent	Total
Clinical faculty vets	65 (34%)	108 (57%)	16 (8%)	189
Technical staff, external vets and students	13 (12%)	76 (70%)	20 (18%)	109
Total	78	184	36	298

4.3.6 Effect of demographic and confidence variables OSCE grade

4.3.6.1 Univariant analysis

One student whose gender response was ‘would rather not say’ and six African students were removed from this part of the analysis as the low numbers in each of these demographic categories meant the final model would not converge if included, and there was no logical way to combine them with any other demographic. This meant 291 students were included in the regression analysis. The demographic and confidence variables that were included in the univariant analysis in addition to teaching group, assessor category and study year were age, gender, continent of origin, intention following graduation, calving experience, before teaching confidence and after teaching confidence. The Univariant analysis was investigating the effect of these variables on the outcomes of passing (pass and excellent combined) versus failing the OSCE. Passing the OSCE was the outcome of interest.

The results of univariant logistic regression are shown in Table 4.11 Univariant results of variables associated with final OSCE grade outcome (passing the OSCE).

Table 4.11 Univariant results of variables associated with final OSCE grade outcome (passing the OSCE)

Variable		N (%)			Odds Ratio (OR) (95% confidence interval)	OR P value
		Fail 76 (26%)	Pass 215 (74%)	Total 291		
Year	2016/17	19 (23%)	65 (83%)	84	Reference	-
	2017/18	31 (28%)	80 (72%)	111	0.75 (0.39 -1.46)	0.401
	2018/19	26 (27%)	70 (73%)	96	0.79 (0.40 - 1.56)	0.491
Age	Mean (95% CI, +/- SD)	23.5 (95% CI 22.7 – 24.2, +/- 3.2)	23.3 (95% CI 22.9 – 23.8, +/- 3.5)	23.4 (95% CI 23.0 – 23.8, +/- 3.4)	0.99 (0.92 - 1.06)	0.736
Gender	Female	65 (29%)	163 (71%)	228	Reference	-
	Male	11 (17%)	52 (83%)	63	1.89 (0.93 – 3.84)	0.081
Continent	AS	13 (36%)	23 (64%)	36	Reference	-
	EU	39 (24%)	121 (76%)	160	1.75 (0.81 – 3.79)	0.153
	NA	24 (25%)	71 (75%)	95	1.67 (0.74 – 3.81)	0.221
Intention	No cows	48 (29%)	119 (71%)	167	Reference	-
	Cows	28 (23%)	96 (77%)	124	1.38 (0.81 – 2.37)	0.238
Experience[a]	None/ minimal	27 (29%)	65 (71%)	92	Reference	-
	Something	49 (25%)	149 (75%)	198	1.26 (0.73 – 2.20)	0.408
Before confidence[b]	Little	15 (30%)	35 (70%)	50	Reference	-
	Some/ Confident/ very confident	60 (25%)	177 (75%)	237	1.32 (0.65 – 2.48)	0.494
After confidence[c]	Little/ Some	44 (35%)	82 (65%)	126	Reference	-
	Confident/ very confident	27 (18%)	124 (82%)	151	2.46 (1.42 – 4.29)	0.001

OSCE assessor	Clinical faculty vets	63 (34%)	121 (66%)	184	Reference	-
	technician, external, student	13 (12%)	94 (88%)	107	3.77 (1.96 – 7.25)	< 0.001
Teaching group	LEC	36 (62%)	22 (38%)	58	Reference	-
	CAL	14 (25%)	42 (75%)	56	4.91 (2.20 – 10.97)	< 0.001
	SIM	15 (16%)	78 (84%)	93	8.501 (3.96 – 18.30)	< 0.001
	CAL&SIM	11 (13%)	73 (87%)	84	10.86 (4.75 – 24.82)	< 0.001

[a] 1 student missing data

[b] 4 students missing data

[c] 14 students missing data

*outcome of interest

Investigations for interactions found that some variables were potentially interacting, but these were gauged to be of little significance on the OSCE outcome. The variables that had a p value of < 0.2 in the univariant analysis and were included in the multiple logistic regression model were gender, continent, after confidence, OSCE assessor and teaching group. Study year, age, prior experience, intention following graduation and before confidence self-rating did not affect the number of students passing the OSCE (p > 0.2).

4.3.6.2 Multivariable Analysis

Only two variables remained in the final model, and these were teaching group and OSCE assessor category. The odds ratio results, 95% CI and p values are shown in Table 4.12 Multiple logistic regression model results of variables associated with student final OSCE outcome (passing the OSCE).

Table 4.12 Multiple logistic regression model results of variables associated with student final OSCE outcome (passing the OSCE)

Variable		Odds Ratio	95% CI	P value
Teaching group	LEC	Reference	-	-
	CAL	5.11	2.12 – 12.32	< 0.001
	SIM	8.84	3.84 – 20.36	< 0.001
	CAL&SIM	11.79	4.85 – 28.66	< 0.001
OSCE Assessor	Clinical faculty vets	Reference	-	-
	Technical staff, external vets and peer assessors	4.22	2.04 – 8.73	< 0.001

The odds of passing the OSCE were 5 times higher with addition of the online video resources, which was doubled again, so nine times higher when the simulator practical was delivered, and odds were slightly higher again, twelve times higher, when students experienced the fully blended approach, video resources and simulator practical compared to the LEC group. Surprisingly, students assessed by a technician, external vet or peer assessor had almost four times the odds of passing when compared to students assessed by clinical staff.

The area under the ROC curve was 0.781 and the Hosmer-Lemeshow p value was 0.303 which both indicated this model was a relatively good predictor of OSCE outcome.

4.3.7 Comparing OCSE (competence) with Confidence

The proportion of students with ‘*little*’ confidence at the beginning of the experimental period (before teaching) that passed the OSCE (69%) was only slightly less than the proportion that passed that had ‘*some or more confidence*’ at that time (75%, p = 0.408). After teaching, a higher proportion of the ‘*confident*’/’*very confident*’ students passed the OSCE (82%) compared to the number of students with ‘*little*’/’*some confidence*’ (65%) (p = 0.001).

The pass rate for students in each after teaching calving confidence category defined by whether the students had the SIM (SIM and CAL&SIM) or did not have the SIM (LEC and CAL) is shown in Table 4.13 Number of students in each after calving confidence category that passed and failed the OSCE, further defined by SIM access. A higher proportion of ‘confident’/’very confident’ after teaching students in the LEC and CAL teaching group tended to pass the OSCE exam compared to students in the same teaching group that had ‘little’/’some’ confidence after teaching. But when practical training with a SIM was taken into account, the SIM training appeared to overcome any differences in after teaching calving confidence, and students with ‘little’/’some’ confidence after teaching were just as likely to pass the OSCE than ‘confident’/’very confident’ students.

Table 4.13 Number of students in each after calving confidence category that passed and failed the OSCE, further defined by SIM access

Teaching group	After confidence	Fail	Pass	Total	P value
No SIM	Little/some	39 (46%)	44 (54%)	83	0.068
	Confident/very confident	8 (28%)	21 (72%)	29	
SIM	Little/some	7 (15%)	40 (85%)	47	0.960
	Confident/very confident	19 (15%)	106 (85%)	125	

4.4 Discussion

4.4.1 Key results

The main aim of this study was to evaluate singular or blended approaches to bovine obstetrics teaching incorporating online video resources and a realistic calving simulator in their impact on a formative calving OSCE outcome, used as a proxy for acquiring competence in this important clinical skill. The study also aimed to evaluate the demographic factors that influenced the outcome of the OSCE exam independent of the type of teaching students received. The main finding was that teaching group did have an influence on OSCE outcome, with students that received no further teaching over and above their bovine obstetrics lectures in previous years having a much lower OSCE pass rate (40%) compared to students that had any type of further teaching (CAL (73%), SIM (84%) or CAL&SIM (87%)). The greatest difference was seen between the LEC and CAL&SIM teaching groups. These results suggest that relevant bespoke video resources can be successfully used to enhance calving competence, but the best skill acquisition occurs after a fully blended approach of practical tuition supported by online bespoke instruction materials. In addition to teaching group influencing OSCE pass rate, the effect of the OSCE assessor category was an interesting finding with students assessed by technical staff, external veterinarians and peer students nearly four times more likely to pass the OSCE compared to those assessed by clinical faculty vets. Surprisingly, other demographic factors investigated did not influence OSCE pass rate (age, gender, intention following graduation, continent of origin, calving experience), and even calving confidence after teaching delivery did not show independent effects on the OSCE pass rate.

These findings are supported by other studies reporting outcomes of obstetrics teaching from the veterinary and medical field. Although there are no reports in the literature regarding the use of bovine obstetrics simulators on calving competence (the OSCE outcome is used here as a proxy), a study of 29 fourth year vet students in Brazil taking part in teaching involving both theory and use of an equine obstetrics simulator showed that test scores (based on interpreting figures of malpresentations) improved after teaching with the simulator (Ferreira et al., 2021). In the current study the SIM and SIM&CAL groups had a higher OSCE pass rate than CAL. This contrasts with another study comparing OSCE scores in one group of final year veterinary students in Queensland; students had access to a video of real-life cardiac dissection or to a low fidelity model and no difference in OSCE scores was seen between simulation and video trained students (Allavena et al., 2017). In the latter study students were asked how they preferred to learn, and visual learners tended to choose the video and kinaesthetic learners chose the simulator. In contrast to the current study, the cardiac study did not report a ‘no further teaching’ negative control group, had used real-life video material rather than video of a simulator with no instructors for the simulator. In addition, it did not have a combination group to demonstrate the blended learning technique (which was found to have significant effects in the present study).

When considering the impact of video material on OSCE outcome, a relevant study involving 248 fifth year veterinary students found that access to a three-dimensional (3D) animated movie of equine pregnancy and parturition (with and without instructor guidance) resulted in improved multiple choice question test scores when compared to lectures only, especially if guidance from staff was provided (Govaere Jan et al., 2012). A similar effect, with improved exam results was seen in a study of 3rd year veterinary students after access to a 3D, interactive animation of equine parturition (and malpresentations) when compared to students that had traditional teaching methods (Gao et al., 2020). While not testing a skill competence by way of an OSCE and equine rather than bovine obstetrics, the results concur with our study where even just the two-dimensional videos achieved higher OSCE numerical scores and pass rates when compared to students in the LEC teaching group. This is further supported by the results of study looking at the impact online clinical skills videos to help prepare 3rd and 4th year medical students from 34 medical schools in Korea prepare for OSCEs. The study showed moderate association between the number of times the video was viewed and OSCE success (Jang & Kim, 2014). Contradictory results were observed in a study of undergraduate student nurses in Australia that were given access to OSCE video exemplars. While the student nurses had improved understanding of OSCE performance expectations, increased engagement and reduced anxiety after accessing the videos, the OSCE performance was no different in students that accessed the videos (Massey et al., 2017)

When comparing the results of our study to the medical literature, there are several studies reporting improved competence of student performance in obstetrics for vaginal, breach or shoulder dystocia scenarios following exposure to simulators of various types (Crofts et al., 2006; Dayal et al., 2009; Deering et al., 2006). Studies have shown improved management and neonatal outcomes in babies, such as reduced neonatal injury, less traction applied and the application of more obstetrical manoeuvres, following implementation of multi-disciplinary simulator training in shoulder dystocia by a hospital in Bristol (Draycott et al., 2008). Reductions in lacerations in mothers were also reported following resident training for forceps delivery using a high-fidelity simulator in a university teaching hospital in Chicago (Gossett et al., 2016). Positive patient-based outcomes are cited in medical reviews as being the best measure of success of simulation implementation, and educators are being encouraged to measure this outcome rather than performance in a simulator-based exam (Kessler & Burton, 2011).

The blended approach of combining simulator training with computer assisted learning (CAL&SIM) had a positive outcome on OSCE pass rate when compared to access to the CAL only. These results can be compared to a study of two cohorts of 225 first year veterinary students that received a mixture of lectures, demonstrations, e-learning and manikin sessions for learning cat clinical exam (Duijvestijn et al., 2021). The students that took part in the blended approach (which included a 45 minute lecture, a two hour e-learning module (including a quiz) and a two hour practical session using manikins and live cats) showed improved competence scores for some elements of the cat clinical exam (such as performing the physical exam, assessing if a cat is stressed and not hurting the cat), but a negative effect was seen with some other elements (being more afraid and being concerned about being wounded). This was put down to the Dunning-Kruger effect where students that are incompetent can overestimate their performance as they do not know enough to know any better; in other words, the students that received further teaching had a better perception of how difficult the task actually was and hence scored lower in the subjective elements investigated (Duijvestijn et al., 2021). In the present study, the total OSCE score was analysed, rather than each small task, and it is possible that students performed differently in certain elements of the OSCE depending on the teaching they had received.

4.4.2 Other results of particular note (and comparisons)

In addition to the effect of teaching group on OSCE outcome, the multivariable logistical analysis showed that OSCE assessor also remained as an independent effect. Technical staff, external veterinarians and peer assessors awarded a higher OSCE numerical score and more students assessed by that group passed the OSCE compared to clinical faculty veterinarians. On further analysis of the data, it was confirmed that the technical staff, external veterinarians and peer assessors were the extremes compared to the clinical faculty vets as the mean score of the technical, external vet and peer assessor category was more than three standard errors above the overall mean numerical score (Bartman et al., 2013). The magnitude of the OSCE assessor effect was surprising since all OSCE assessors received prior training in OSCE assessment and all OSCE results were moderated by two of the researchers. However, other studies have identified that assessors can influence OSCE outcome (albeit not as significant as in the current study) when assessing farm animal clinical skills, so this is something to be aware of in veterinary skills assessment (Schlesinger et al., 2021). It is likely that the clinical faculty vets were stricter in their assessment and are more comfortable with awarding lower marks for some of the more subjectively assessed skill aspects (an example from the OSCE sheet is the award of safety marks/assessment of roughness). Academic staff are more used to awarding across the range, including failing students, than technicians, external veterinarians and particularly peer assessors; this is reported in the literature as ‘hawks and doves’ with ‘hawks’ being strict assessors and ‘doves’ being lenient (Daly et al., 2017). The technical, external veterinarian and peer assessor category also gave less written feedback on the OSCE checklist form which may have reduced the amount of moderation that could be applied. Another point to note is that this was a formative exam, and perhaps the technical, external veterinarian and peer assessor category aimed to be more supportive and positive, while the faculty staff treated the assessment like any other (summative) OSCE. Fuller et al., 2017 suggests some ways in which assessor variability can be identified as genuine extreme assessors and accounted for it in post hoc analysis of OSCE outcomes, but also highlights that the issue might be within the station or checklist rather than the OSCE assessor itself. Another factor could be that clinical faculty vets assessed a higher proportion of LEC students than any other teaching group when compared to the technical staff, external veterinarians and peer assessors. In future studies, if multiple OSCE assessors are used, the number of students in each teaching group assessed by each assessor category should be the same or very similar.

Although declared males had a higher pass rate (83%) compared to declared females (71%) and gender was included in the multiple regression model, it did not remain in the final model. A study of similar clinical skills in fourth year veterinary students (sensitivity of pregnancy rectal examination) comparing training on a rectal examination simulator compared to live cows also found that gender was significant to a level to be included in the multiple regression ($p < 0.2$) but again it did not remain in the final model (Annandale et al., 2018). In order to identify a possible interaction between gender and prior experience or gender and the before confidence self-rating in our study, the male and female student groups were compared in their proportions with ’none/minimal’ or ’some/a lot’ experience, and in their proportions with confidence categories. There were no significant differences in the proportions of male and female students with some or more prior experience ($p = 0.65$) or in the proportions of male and female students self-rating as having ‘some or more confidence’ before teaching delivery ($p = 0.309$). Similarly, the proportions of male and female students with the intention of working with cows did not differ (p = 0.224). It is worth noting that, like other veterinary courses, the number of male students was (overall and specifically for fail students) very low (male numbers are almost only ¼ of the number of female students), which may reduce the strength of any associations.

In contrast to the univariant analysis of the present study, Annandale et al., 2018 found that prior experience (with a veterinarian, not if experience was non-veterinary) influenced rectal exam competence (sensitivity) with experienced students being twice as likely to be associated with higher rectal exam sensitivity in univariant analysis (p < 0.2). Annandale et al., (2018) also asked students about their background (if they were from the city, farm or mixed) and it was found to be significant in univariant analysis and remained in the final multivariant model. Although there was a slight tendency for students that intended to work with cows (and that had presumably more experience) to pass the OSCE, the student intention following graduation and calving experience was not significant in the univariant analysis and was not included in the final regression model of the current study. The results of the current study may raise an important point for students that so far had not expressed an intention to work with cows and/or do not have much experience. They could be re-assured that teaching, in particular with a blended approach, will help them pass the OSCE and that they are not at a disadvantage compared with other students with more experience and prior desire to work with cows.

The finding that SIM training overcame any effects of after teaching confidence on OSCE pass rate is re-assuring for students lacking in confidence, even if they have low confidence going into the exam, they can still pass the OSCE exam (if they had received SIM training). However, for students that did not have SIM training, having higher after teaching calving confidence did have a positive impact on passing the OSCE exam, giving further evidence to the usefulness of the SIM. The finding that students with more confidence after teaching had a higher OSCE pass rate was to be expected but the fact that SIM training negates the influence of after teaching calving confidence on passing the OSCE was an interesting finding. This finding is supported when looking at some individual student results. There were indeed four individual students that failed the OSCE but had a numerical after teaching calving confidence score of more than 53/65 (very confident). Of these students 3 had had SIM training and all of them had a calving experience score of > 18/24. It may be that these students were overconfident and as a result failed the OSCE due to being too fast and thus rough and inaccurate when moving the calf, risking perforation of the uterus. It is worth mentioning, that at the other end of the scale, of the 19 students with the lowest after teaching confidence score (all 26 or less out of 65), the majority had no SIM training (11 were in the LEC and three were in the CAL teaching group), but almost half of them (9/19) passed the formative OSCE. This means even with really low confidence, some students are still able to pass the skill exam. There was a mixture of experience scores within the lowest confidence students and similar experience ranges in students that passed (experience range 0 – 7) or failed the OSCE (range 0 – 8). So, experience did not explain why some of these students passed the OSCE despite having very low confidence.

4.4.3 Study design

This study involved a large number of undergraduate students over three academic years which allowed any potential year cohort effects to be determined in addition to giving more evidence for any independent factors identified as influencing skill acquisition. Despite there being some changes to the OSCE exam over the three study years, study year did not exert significant effect in any of the main data analyses. The OSCE pass mark was established using a recognised borderline regression method (Coombes & Silva-Fletcher, 2018; McKinley & Norcini, 2014) and was established separately for each study year which also allowed any year effect to be accounted for.

The response rate to the questionnaire (86%) was very high, and the fact that the BTQ was handed out in person using paper forms at the start of the teaching period, seemed to aid this. The student turn out for the formative OSCE was also excellent with only two out of 300 consenting students not attending, and as the

ATQ was delivered before the OSCE, also on paper, this meant there was also a very high response rate in the ATQ. The students likely saw the formative OSCE as a good opportunity to practise and receive feedback on their performance, even though some of them had not had any further teaching. Although this study design took quite a bit of planning in the start, it could be replicated in other veterinary school curriculums with a modular structure with the proviso that all students get the same teaching by the end of the module/teaching period.

During the three years of the study, the formative OSCE exam did change slightly. In the first study year a head back malpresentation was used and in 2017/18 and 2018/19 a leg back presentation was used. There were also some changes to the marking guide with some checklist items removed, other items added and the introduction of a split borderline pass and borderline fail global rating in 2018/19. It is common for OSCE checklists to be slightly edited as their performance is analysed (Coombes & Silva-Fletcher, 2018). Furthermore, although the OSCE checklist was designed by trained and experienced faculty staff, it had not been validated prior to use. Pilot testing and validation are advised to be important steps when developing a new OSCE (Davis et al., 2008; Hodges, 2006) and should be part of the OSCE preparation phase in the future.

It was thought that discussion of marking guides, moderation of the individual OSCE mark sheets and application of the BRM to establish the pass mark would account for any differences between study years and OSCE assessors, but the fact that OSCE assessor remained in the multiple logistic regression model indicated this was not sufficient. Further detailed investigation of this result did reveal that the clinical faculty veterinarians assessed more students in general but particularly more of the LEC students, with one clinical faculty veterinarian assessor examining a much higher proportion of students than any other which might go some way to explaining the OSCE assessor effect. Less feedback comments were written on the checklist form by the technical, external, peer student assessor category, which allowed only limited scope for moderation; additionally, a written marking guide was released only in the 2019/19 study year. For future studies, there needs to be a clear marking guide from the start (following testing and validation of the OSCE), and fewer assessors, two assessors at each station that agree, or filming the OSCE should also be considered. Filming a calving OSCE would be difficult however as much of the practical skills would be hard to visualise using a camera on a fixed point. Assessors also needed to specifically palpate the legs ropes for example to check if they were tight which would not be possible using a video recording.

The use of BRM to establish the pass mark for the OSCE has been reported to be effective to enhance consistency, but there was a reasonable number of students that had their global rating changed following the application of the calculated pass mark. It could be argued that changing the assessor awarded global rating is unjust as the assessor might have picked up on specific elements of student performance that warranted the global rating they had awarded. These assessor awarded global ratings are still useful as they are required for the pass mark calculations. In addition, the OSCE assessor variability can perhaps be mitigated by adding the Standard Error of the Mean (SEM) OSCE numerical score to the pass mark; this should negate the risk of false positive results and possibly harm to animals if students passed the exam when they were not in fact competent (Homer, 2021).

When using OSCEs for an end of year summative assessment, multiple OSCE station outcomes are combined so that the effect of assessor and variability of the station are accounted for, to a point (Brannick et al., 2011; Gormley, 2011; Turner & Dankoski, 2008). This is not possible with a study design such as this, as there was just one OSCE station. In addition, some students may not have performed to their best as they knew the assessment was formative and did not have any bearing on their final grade for the academic year. However, this attitude would not be specific to students from only one teaching group, and, if anything, may have reduced the performance gap between LEC students (who would try as hard as they can to complete the OSCE) and those having received further teaching (who perhaps were more relaxed about the task).

Another possible issue with the formative calving OSCE was that the students were not quarantined after the exam so that they could have shared scenario information with their peers. While this is entirely possible it has been suggested that this may not be too much of an issue in a practical skill-based examination (Gormley, 2011).

Unfortunately, the scope of the study did not allow us to assess student performance on a live animal in a real calving scenario. This is something the medical literature is striving for when assessing the effect of the implementation of a teaching intervention (Calvert et al., 2013). There are various logistical and animal welfare reasons why this would be very challenging to plan, hence it is still unknown if passing a formative OSCE translates to successful bovine obstetrics outcome in real life.

4.4.4 Application, further work and conclusions

This study suggests that, although access to the simulator training gives the best formative OSCE outcome, even access to the CAL is better than lectures alone. The ideal approach is one that is fully blended (LEC&CAL&SIM) but it is re-assuring that even bespoke videos of the simulator practical can be useful for calving competence, and this may be of interest for faculties that do not have the funds to invest in the calving simulator.

The next step in this work would be to assess if calving competence in a formative OSCE translates to summative achievements and then subsequent success in the field. There is also scope for further investigation into the assessor effect to explore the possible reasons for assessor variability with a view to improving consistency.

This study suggests that calving skill competence may be significantly improved following access to instructor-led bovine obstetrics simulator training when compared to conventional lecture based teaching or with lectures combined with video material. The blended learning technique works best but even just access to bespoke practical skill videos using the simulator will have positive effects on skill acquisition.

Chapter 5 Overall Discussion

5.1 Aim and Key results

The aims of this study were to investigate the implementation of a calving simulator as part of a blended learning approach (which uses multiple methods of learning both online and face to face) on veterinary undergraduate student confidence and competence in calving cows, and to investigate the demographic factors that influence student competence and confidence.

The study found that as students were exposed to more, and blended teaching, both calving competence and self-rated confidence increased. For competence, assessed in a formative OSCE, any further teaching (in addition to lectures received in previous years) had a positive effect on OSCE pass rate when compared to LEC. In fact, students that had access to the online CAL achieved almost similar pass rates to students that had access to the simulator practical. However, the intense input of face-to-face calving skills teaching using a simulator resulted in highest odds of passing through the addition of the online CAL (although the OSCE pass rate itself did not significantly improve with the CAL compared with the simulator practical alone). The OSCE assessor effect on pass rate of the OSCE was an unexpected finding that was discussed in Chapter 4 but also warrants further investigation.

Access to the simulator was also key for students self-rating as '*confident*'/'*very confident*' in calving cows. In contrast to the OSCE pass rate, access to the CAL itself did not increase confidence when compared to LEC alone. Once students had access to the SIM, there was only little further benefit to confidence levels with access to the CAL, but the fully blended CAL&SIM approach had a very positive impact on confidence and led to highest odds of being in the '*confident*'/'*very confident*' category after teaching.

This leads to the conclusion, that the fully blended approach is beneficial for acquisition of calving clinical skill competence and self-rated confidence, but once students have access to the SIM, the CAL has limited added value. As far as the researchers are aware, there are limited published studies that look at implementing simulator training using a blended approach in veterinary undergraduate teaching. One published study reported mixed results on student confidence for learning feline handling and clinical exam, after demonstration and practical using a blended approach which was compared to a control group (Duijvestijn et al., 2021). The authors reported that for some elements (competence in performing physical examination on a cat, ability to assess stress in a cat and less concerned would hurt the cat) the blended group had improved scores after teaching (from an online likert like questionnaire) compared to the control. For other elements (confidence dealing with cats, confidence handling animals and preparedness for feline skills training in their next year) the blended group had a lower score after teaching but this was also seen in the control (Duijvestijn et al., 2021). This was partly explained as the Dunning Kruger effect where those that are incompetent, overestimate their competence, and after doing further study and/or training, students realise how difficult a task can actually be (Dunning, 2011). This was not something that was observed in our study overall (some individual students may have shown this). In the current study, in contrast to Duijvestijn et al., (2021), students in the fully blended group (CAL&SIM) showed an increase in confidence for all calving tasks when compared to LEC. In the LEC group in fact, confidence decreased after the three and a half week experimental period, which may have been due to them being aware that they were getting less teaching than their peers so when asked just before an exam about their confidence, they would feel at a disadvantage. The current study did not have a live animal element however, so maybe if students had been exposed to a real calving during their practical session, even if they were in the CAL&SIM group, with the most teaching, they may have realised how difficult an actual calving could be and hence have lower confidence levels.

Success in the formative OSCE and a confident feeling just before the exam may not immediately equate to guaranteed success in the field and students expectations following training with a simulator need to be managed. While the SIM allowed students to practise in a safe environment where calving scenarios could be repeated, it did have limitations. Perhaps, we have lured the students into a false sense of security using the simulators without a prescribed live animal element. Students may think that if they can pass the formative OSCE skills test and feel more confident after the teaching sessions, they will be more capable calving cows in the real world which would be a dangerous assumption. There are limitations of the simulator with it being static and not able to mimic a real calving entirely (not all obstetrical malpresentations can be replicated), and there are a huge number of external factors that can influence a successful outcome in a real-life situation (such as a grumpy farmer, equipment that was not working properly or exhaustion from a busy weekend on call). In addition, the students could have become familiar with the simulator during the class as the same simulators were used for the class and OSCE.

It was stated in the class plan (in capital letters, see appendix 2.1) that students should be warned at the start of the SIM class that the session was only an introduction and that they would not be able to calve every cow after this class. It is reassuring that the qualitative analysis revealed that students recognise the importance of practise during a real-life clinical encounter to develop their confidence calving cows even after SIM training.

5.2 Other results of note

Experience levels were shown in our study to independently influence after teaching self-confidence but not OSCE outcome (or before teaching confidence). Although there are studies in the veterinary and medical educational literature reporting the impact of simulators (of different fidelity) on student skill competence or confidence (cited throughout this thesis), very few of them report the influence of demographic factors (in addition to teaching method) or prior clinical skill experience levels of the students. Annandale et al., (2018) does report the influence of demographic factors on rectal exam competence following training with two different methods (discussed in Chapter 4) but the influence of experience on competence (OSCE outcome) found in that study were not found in the current study. Students with less experience may need additional sessions, more bespoke resources, and more support during the practical small group class in order to boost their competence in the task even if they have a SIM class.

Interestingly, gender or future plans to work with cows were not independent factors determining confidence or competence. This is informative for certain groups of students such as females or those that do not intend to work with cows. They could be re-assured from the findings of the current study that they will likely still perform well in a calving competence-based assessment and/or have the potential to feel confident, especially if they are taught using the blended approach (CAL&SIM). Knowing the impact of these demographic factors is an important consideration when planning for the diverse student backgrounds that make up a veterinary undergraduate cohort. While the veterinary profession is recognised as lacking in diversity and not representing societal diversity, there is an active drive to increase diversity within the profession and it is important that veterinary faculty recognise the needs of all the different learners within the student population (Greenhill et al., 2015).

The relationship between confidence and competence was the subject of concept analysis discussed by Perry, (2011) and it raises some interesting points relating to both the over and under confident student both putting patients at risk. Ideally, confidence levels should match competence levels so that students carry out clinical procedures at the right point in their veterinary career without doing harm to the animal.

Another interesting point is that, although overall no effects of study year were seen, individual years differed in the effect of specific teaching groups. This is not surprising given the diversity of the students in each year group, and it reinforces the importance of showing consistent effects of variables independent of study cohort.

5.3 Study Design

This study involved a large number of student participants over three study years which allowed any study year effect to be accounted for. The response rate for the BTQ and ATQ was good overall (86%). Formative OSCE attendance was also very good leading to a very high percentage of consenting students/total per year group attending the exam. In a systematic review of studies involving health profession learners, 25% of participants were reported to drop out from simulator studies so the current study achieved higher response rates compared to others in the field (Cook et al., 2013). In addition to the good response rate, the questions seemed to be well understood by the students with none of the questions omitted from the analysis. This meant the data set was a reliable representation of the cohort of students involved.

The SIM class followed a prescribed plan which adhered to the majority of the ten principles of high-fidelity medical simulations suggested by Scalese & Issenberg, (2008) which were further backed up by a systematic review of the simulation education literature by Cook et al., (2013). This review found evidence in the literature that eight of the features reported by (Scalese & Issenberg, 2008) plus four additional features were worthwhile (the only feature that was not evidenced in the literature was group versus individual teaching during the class, something that was not compared in our study).

The study design which aimed to investigate teaching mode, distilling out the effect of the practical versus the bespoke video resources was quite unique but could be repeated in other contexts for example in other teaching modules investigating different clinicals skills to investigate implementation of different teaching modalities and simulators. While the scheduling of events was slightly challenging, the design meant that all students received the same teaching by the end of the six-week teaching period and were also offered a practical revision session at the end regardless of original teaching group, confidence levels or formative OSCE outcome.

The current study used a high fidelity commercially available simulator which was a realistic depiction of a cow/calf and could easily be purchased (albeit at a cost) by other veterinary faculties. The consistency of the simulator was great for equal teaching and ensured each student had a very similar OSCE experience. Although assessing students in a real-life situation by means of a DOPS would be a useful development for this study, it would introduce a huge amount of situational variety to the assessment. The formative OSCE design was based on a real-life clinical encounter and evaluated credible clinical skills that new graduates could be faced with on their first day in practice while ensuring consistency between students (Read & Baillie, 2013).

Ideally, all teaching groups should have had similar numbers of students, but unfortunately due to the limitations of the timing of the OSCE with other activities of the teaching modules, this was not possible leading to slightly more students in the SIM and CAL&SIM groups. In addition, a randomised block design that ensured that the demographics (e.g. gender, continent) were evenly split between each teaching group was not possible due to not obtaining this information via the BTQ before planning the timetable of events (students require much advanced notice of any practical allocation before each module). As participation was voluntary, it could be that a certain demographic of student was inadvertently selected for, however, the high response rate ensured we had representation from minority groups (declared male, non EU/NA continent).

While this study involved many students and response rate was very good, power calculations were not carried out at the planning stage of the study to help inform the numbers of students that would be required to show a statistical difference. Ideally further work could be conducted across other veterinary schools for perspectives of different clinical models, CALs and lecture activities to compare the variation within different veterinary degree curricula and to do this effectively, power calculations would be useful. Finally, there were some minor adjustments to the OSCE checklist and questionnaire each study year, but these changes were accounted for in the statistical analysis and an OSCE pass mark was calculated separately for each study year to allow for these changes.

Despite the fact a class plan was produced and shared between teachers, there could have been opportunity for content variation between SIM classes as not all classes were delivered by the same teacher. Furthermore, some students had already used the SIM during summer projects or during Glasgow Farm Animal Veterinary Society (GFAVS) extracurricular activities or may have swopped SIM sessions with another student without notification. This study relied on the good will of the students to inform the researcher if they had used the SIM before or swapped SIM sessions for teaching groups to be changed. This could have diluted the results somewhat if students that were allocated to the LEC or CAL group had in fact used the SIM previously and had not indicated that to the researchers. However, any previous SIM exposure may not have covered the same content as the class plan so this may not have been a huge factor.

The simulator was not validated as part of the study and other studies of veterinary simulators have reported this as a step in the methods (Anderson et al., 2021; Eichel et al., 2013; Lumbis et al., 2012). Although the simulators were deemed credible by staff members with experience, more formal validation involving vets or farmers that are experienced in calving cows, for example, being asked to use the simulator and grade it in terms of reality and application to a real-life scenario, would be beneficial. If they perceived the model as being realistic and of valuable quality, then this would give further credibility to the results.

For the CAL, at the time of the study there was no way of monitoring if CAL and CAL&SIM students had actually accessed the videos online, for how long they accessed them and how engaged they were with the material before the formative OSCE. As a result, although students were allocated to the CAL group, they may not have actually used the CAL and as a result be the equivalent of a CAL student. There was also no way of stopping CAL, SIM and CAL&SIM students sharing information they had learnt from their teaching groups with students that were in the LEC group. There was also no way of stopping students that were not allocated to have access to the CAL looking up other video material on calving cows online on platforms such as YouTube(GB) in addition to the recommended resources from previous years. The effect of this would be similar to what is described above for CAL students, LEC and SIM students could have had CAL access (albeit not what was prescribed to them) meaning they had access to additional teaching and diluting the differences between teaching groups. Although unlikely, it could be that just spending extra time in the practical on calving teaching improved competence and confidence in calving cows and it was not actually to do with access to the simulator.

Throughout the data cleaning process various numerical data were analysed and then categorised. This was to allow further statistical analysis to be carried out but some of the granularity of the data may have been lost during this process. This thesis describes the numerical data in detail before reporting the categorised results so hopefully gives enough background of the raw data before categorisation. A very small amount of data were also removed when the multiple logistic regression was carried out e.g. student questionnaires that included the '*would rather not say*' gender option or those that included African continent, as numbers were very low and there was no logical way to group these students with another category. This could mean that significant differences from some of the minority groups was not detected due to low numbers of these groups in the data set.

Despite interactions between explanatory variables being identified, all significant variables were still included in the multiple logistic regression and the automatic model building process in minitab decided what variables remained as it was difficult to account for all of the interactions identified. An alternative approach would be to decide what correlated variables to include at the start of the multiple logistic regression process. The statistical analysis used in this work could also be criticised due to the number of multiple comparisons conducted. The effect of this is that something significant could have been found when in fact it is not thus, leading to type 1 error, where the null hypothesis is rejected when it is actually true (Bland M., 2015).

5.4 Applications

The results from this study should help inform veterinary faculty regarding the investment in similar simulators to aid the training of their undergraduates in the high-stake, composite skill of calving cows. The study suggests simulator training has a very positive impact on student performance in a formative OSCE, increasing calving skill competence in a dystocia scenario, but in particular such training has a large effect on calving confidence. Furthermore, other stakeholder groups such as farmers and agricultural colleges may be interested in the findings as it is not just veterinarians that calve cows.

Finding that even just access to video material can be a useful addition to lectures when assessing calving competence, supports making use of the simulators in a digital format. Considering the Covid-19 pandemic in 2020 when face to face teaching in many teaching environments was converted into online learning, making use of the simulator in a CAL, allows educators to use what would have been a wasted resource otherwise. In addition, this study also gives evidence to support the blended (CAL&SIM) approach when learning how to calve cows, which could be integrated not only in veterinary teaching of other clinical skills but also can be transferred to similar fields such as medicine and dentistry.

A positive experience in learning a daunting task such as calving cows could equip undergraduates with the competence (clinical skills) and just as importantly the confidence, to ‘have a go’ while doing EMS. Many of them might feel overwhelmed with the prospect of being asked to do this while on EMS and with blended SIM training, they now feel more prepared. Exposing students to positive experiences on farm EMS then might encourage more of them into farm animal and mixed veterinary medicine which is currently suffering from a recruitment challenge (Lowe, n.d.; Ruston et al., 2016).

It is highly likely that many new veterinary graduates will graduate without having calved a real cow, but they could be asked to attend a calving as an emergency on their own. Upon graduation and faced with their first solo call to calve a cow, with exposure to a SIM class and the opportunity to review material with the CAL, it is hoped the graduates in this study will have the confidence in their competence and feel they are more prepared to deal with this stressful emergency. Having a successful outcome as a new graduate veterinarian and being perceived as ‘doing a good job’ by the farmer was identified as part of building the key trust relationship between vet and farmer in a qualitative study of farm veterinarians to investigate the challenges of being a farm animal vet (Ruston et al., 2016). Equipping graduates with practical farm animal skills and associated confidence also has a role in the issue of retention of farm veterinarians in practice. Reasons cited by veterinarians for leaving farm animal practice include the feeling that they are ‘not good enough’ or a ‘lack of confidence in dealing with emergencies’ based on the thematic analysis of 380 responses from an online survey of farm animal veterinarians that both stayed and left the profession (Adam et al., 2019).

5.5 Future work

An interesting discussion point following on from these results is what does any positive effect on veterinary student competence and confidence actually mean in terms of clinical significance to patients (the cows and their calves), which can be difficult to quantify (Cook et al., 2014). In other words, what does a significant 25% difference in mean after teaching calving confidence between CAL&SIM and LEC students actually equate to in a real life calving situation? Would the CAL&SIM students be more likely to have a go calving a cow on EMS, would they make less mistakes, would less patients be injured or die? These are definitely outstanding questions following this research which require further investigation. One approach would be to assess student competence calving a cow out in the field using patient-based outcome measures such as calf death rate, cow injury rate, drug usage, and cow death rate following blended simulation training and comparing this to a control. This would align with guidelines in the medical literature that ask for researchers to publish meaningful patient-based outcomes to measure the success of simulation implementation (Kessler & Burton, 2011).

Further research into what makes the SIM effective would also be worthwhile. It is perhaps no surprise that SIM trained students are more confident and competent compared to students with no further teaching beyond previous lectures, but it would be really interesting to look at what specific instructional design elements of a SIM class e.g. the effect of repetitive practice or what ratio of student and teacher would increase confidence and competence the most (Cook et al., 2013).

More quantitative data on student engagement with the CAL could also be investigated by looking at data extracted from the VLE regarding when and how long students engaged with the CAL. The CAL could also be further investigated by using qualitative research techniques (of students and experienced farm veterinarians) to find out what was missing from the CAL and what could make it better. It could be developed to include some quiz material with links to alternative resources rather than it just being a series of demonstration videos. This would make it more interactive such as the e learning module described for cat handling, restraint and physical exam by Duijvestijn et al., (2021). Digital material could also be shared between veterinary schools internationally so that schools that might not be able to afford to buy simulators could still benefit from some virtual resources made using the simulator.

Further analysis into influence of demographics on confidence and competence would also be worthwhile such as investigating the relationship between experience, intention to work with cows and before/after teaching confidence. It would also be interesting to explore why experience affects after teaching calving confidence, but did not affect before confidence or competence in final regression analysis. Knowing if the demographics explored in this study have a similar effect on other clinical skills would also be a logical next step for the study.

A general development of the study would also be to carry out further thematic analysis of the qualitative data gathered as part of the questionnaire to explore further what students are still worried about when it comes to calving a cow.

Some additional qualitative information could also be gathered, perhaps by semi-structured interview to investigate some of the findings of this study further, for example, why is it that experience of calving cows has such an effect on confidence but not necessarily on competence? Assessing how long the differences in calving competence and confidence levels between teaching groups are maintained for following the teaching reported in our study could also be interesting. The medical literature reports that evidence for how long clinical skills are retained for after SIM training is lacking (Alanazi et al., 2017), but a study of junior and senior doctors and midwives found that knowledge (assessed by Multiple Choice Questions (MCQ's) was retained for about a year following obstetrics simulation training (Crofts 2013).

5.6 Final conclusion

In conclusion, this study demonstrates that the implementation of a SIM as part of a blended learning approach to teaching students how to calve cows has a very positive impact on both self-assessed student confidence and on competence assessed by a formative OSCE exam. Making use of the simulator in video format is clearly beneficial to student competence and allows students to gain confidence in specific calving tasks. Results also show an important role of prior calving experience in how confident students feel after teaching and highlight the need for very consistent training and validation of staff in practical assessments. The clinical significance (in terms of the health, welfare and outcome for cows and calves in real calving scenarios) of the blended learning approach on students' calving confidence and competence, still warrants further investigation.

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Appendix

1. Student Teaching documents

1.1 Student CAL document

Modules 4.21 and 4.22:
4th year Cattle Obstetrics CAL

Introduction

Dealing with obstetrical emergencies is classed as a day one skill by the RCVS. Obstetrical emergencies are stressful for new graduates and during EMS Vets may be reluctant to let you 'have a go' in such a high stakes situation. Simulation models have been shown to help students learn day one skills without the issues of time or animal welfare. This is why we will be offering you a calving simulator practical.

To supplement this practical we would like you to watch the following videos.

Intended Learning Outcomes:

CP4.21 Module ILO

8. To demonstrate appropriate techniques with respect to undertaking key surgical or husbandry procedures in cattle and sheep

CP4.22 Module ILO

6. Demonstrate ability to deliver a calf normally, and identify and correct main malpresentations 'in vitro'

CAL ILO's
At the end of the video session the student will be able to:

1. Describe a normal versus a mal-presentation of a calf
2. Describe the application of calving ropes and a calving aid
3. Describe the correction of the most common mal-presentations

Examinable material:

- Calving OSCE

Research study

Teaching of obstetrics using a calving simulator is part of a research study that many members of the farm animal group are involved in. You will be fully informed about the study throughout and your participation is very much valued. Because of this study the access to this CAL will be restricted to approximately half the class until we have formatively assessed a Calving OSCE. Subsequently, everyone will get access and time to work through this CAL.

Please ask Jayne or Monika if you have any questions.

Youtube Video Links to watch and work through:

- https://www.youtube.com/watch?v=JlG7zWcBmS0 = Calving - equipment and placement of head/leg ropes

- https://www.youtube.com/watch?v=1SRTd16RmSc = Calving - Front vs back legs and head back presentation

- https://www.youtube.com/watch?v=SI3xAkYsvqs = Calving - anterior presentation with calving aid

- https://www.youtube.com/watch?v=WAV4eZzfp_o = Calving - backwards presentation with calving aid

- https://www.youtube.com/watch?v=g5YhY8g5LE4 = Calving - correction of breach presentation in uterus

1.2 Student simulator class document

Module 4.21 and 4.22: 4th Year Cattle Obstetrics Practical

Introduction

Dealing with obstetrical emergencies is classed as a day one skill by the RCVS. Obstetrical emergencies are stressful for new graduates and during EMS Vets may be reluctant to let you ‘have a go’ in such a high stakes situation. Simulation models have been shown to help students learn day one skills without the issues of time, animal welfare and risks of litigation. This class will run in parallel with the cattle rectal exam class.

Intended Learning Outcomes:

Module ILO

8. To demonstrate appropriate techniques with respect to undertaking key surgical or husbandry procedures in cattle and sheep

Practical ILO’s

4. To increase confidence in the clinical approach for a cow in obstetrical difficulties when the calf has a normal anterior presentation
5. To recognise a mal-presentation of a calf and be able to correct the mal-presentation safely

Clothing/appearance

- Waterproof trousers, waterproof top, wellington boots (boiler suit also suitable but you may get wet)
- Long hair tied back
- One stud earing acceptable

Preparation and suggested pre-reading material:

- Management of dystocia in cattle
  Neil Frame. In Practice 2006;28:8 470-476 doi:10.1136/inpract.28.8.470
- Review 3rd year lecture material
  CP 3.17.2 Practicalities of Bovine Obstetrics

Structure of the class:

- Focus on practical and hands on techniques
- 3 students per calving model for 1 hour 15mins
- The following should be covered

- Review of equipment required
- How to work out if front feet or back feet
- How to put leg and head ropes on
- Normal calving using a calving aid
- Correction of mal-presentations such as head only, head back, breach etc.

Examinable material:

- Calving OSCE

See the clinical skills leader (Lissann Wolfe) for more details.

Research study

Teaching of obstetrics is part of a research study that many members of the farm animal group are involved in. You will be fully informed about the study throughout and your participation is very much valued. Please ask Jayne or Monika if you have any questions.

2. Staff simulator class plan

Modules 4.21 and 4.22:
4th year Cattle Obstetrics Class Plan

Total time for class 1 hour 15mins

Set up

- ½ to ¾ bucket of warm water into uterus with power lube
- Lube, ropes, calving aid, gloves should all be set up by technician

Introduction (10mins)

- ILO is to get introduction to equipment, practice getting ropes on legs/head, ID malpresentations and try to fix them. THEY WONT BE ABLE TO CALF ALL COWS BY THE END OF THE CLASS.
- Advise of limitations of models (They have quite a lot of room, can't correct twisted uterus)
- Health and Safety
  - Gloves optional
  - Watch hands don't get trapped in mechanism of calving
  - Demonstrate H+S implications if cow swings when attached to calving aid in real situation
  - Beware when working from a height on the step ladders
- Looking after equipment
  - Calves very fragile, make sure they land on mat
  - Be careful when placing claves inside the model that the rubber doesn't get torn on the side of the cow
  - Wash calf and ropes (hang on banister to dry) after class with hose
  - Tip table up to empty water from inside uterus/cow
  - Remove air bags and set to side to allow drying
- Gauge experience of the group and try to mix abilities into 2 groups of 3 students

Leg ropes and head ropes (10mins)

- With the calf out of the model demonstrate assessing if front legs or back legs, putting ropes on in correct location and give tips on technique. Importance of ropes not slipping
- Give each student the opportunity to practice leg and head ropes
- Use of eye hooks

Calf a normal presentation with the calving aid (25mins)

- Calf into model in normal presentation
- One student should pose as a farmer and act out the history answering
- One student can view inside model (keep uterus 'open' so can view)
- One student is vet. Takes history from farmer (while palpation – learning to multitask). Palpates calf, confirm position and puts head and leg ropes on. Talk students through the calving process.
    - manual pull into birth canal, one leg at a time if possible
    - assess for room (hand over crown of head, hands up side of pelvic canal, stress in calf, pain in cow, legs crossing over and the importance of discussing farmers views)
    - attach calving aid and communicate with farmer what they want them to do
    - indicate the point of no return i.e. how far out the calf can be before it is too late to push it back in for a c section.
    - Remind equivalent force of 2 people is max amount of pressure
    - remove calf (traction when contractions from cow, using downward pressure with calving aid)
    - Discuss reviving the calf (sternal position, doxapram, acidosis/bicarbonate, checking umbilicus for haemorrhage, water in ears etc)
    - Discuss checks on the cow – tears, haemorrhage, another calf

Calf in abnormal presentation (25mins)

- Students take it in turns to leave the room while the other students set up malpresentation (should definitely cover head back, leg back, breach during class)
- Students alternate roles between farmer/vet/viewer as above
- Students should ID the problem, attempt to sort it (with guidance from the clinician) and deliver per vagina (each student should deliver one calf from beginning to end)
- During this section mention drugs that might be used during obstetrical procedures – Clenbuterol, epidural, oxytocin etc.
- Also mention importance of after care – NSAID, antibiotics (only if necc), watching for RFM, milk fever, ensuring calf gets enough colostrum etc

3. Consent and student information

3.1 Information for student’s document

Evaluation of calving simulator training in the veterinary undergraduate curriculum as part of a blended learning programme.

You are being invited to partake in a study which aims to assess veterinary undergraduate confidence and competence levels when dealing with a calving case, before and after you are exposed to various teaching methods which may include a calving simulator model. Before you decide if you want to take part it is important for you to understand why the research is being done and what will be involved. Please take time to read the following information carefully and discuss it with others if you wish. Please get in touch with Jayne Orr if there is anything that is not clear or if you would like more information.

Who is conducting the research?

Jayne Orr, Monika Mihm-Carmichael (both members of the farm animal division at GUVS) and Rob Kelly (past GUVS farm animal division staff member now working at the Royal (Dick) School of Veterinary Studies).

Why is this study important?

Teaching bovine obstetrics to veterinary undergraduates is difficult: you may not get sufficient exposure to appropriate cases when on farm or during EMS, and there are obviously animal welfare and risk of litigation issues when you are inexperienced. However, attending a difficult calving would be regarded as a Day 1 skill by the Royal College of Veterinary Surgeons. We have now purchased a caving simulator model and would like to assess if the introduction of a calving model practical increases skill level, increases the level of student confidence (students from all years) when dealing with this task and whether this confidence is reflected in the competence at actually performing the task during a formative OSCE exam (4th year students) and when faced with a live obstetrics (final year students).

What is involved?

You will be asked to complete a short questionnaire both before and after you are exposed to teaching material associated with bovine obstetrics. This will be completed on paper, it should take approximately 10 minutes to complete. If you are in forth year we will also be looking at the outcomes of your formative OSCE assessment. If you are in final year your competence when involved in a live obstetrics case while in first opinion practice may also be assessed by one of the vets at Clyde Vet Group. You will not be exposed to anything that you wouldn't be receiving as part of your normal teaching and every student will receive the same teaching methods (albeit at different times during a module). The only extra time involved for you would be completing the questionnaires.

Why should I take part?

Your responses will help inform teaching of future veterinary students at Glasgow University and may help justify investment in future simulators if benefits in confidence and competence in calving cows are identified with this study.

Is it anonymous?

Yes. In order to link your BEFORE and AFTER responses and the relationship of confidence with skill level (OSCE and live animal results) we need to identify you. This will not be by name but by the last 4 digits of your matriculation number and the first letter of your surname. The researchers will calculate and present summary statistics and have no intention of linking this number to your personal information. The researchers take data protection very seriously.

What will happen to the information?

We will use the information obtained from the questionnaires, formative OSCE and live obstetrics case to review and revise our current teaching of bovine obstetrics. It will also help inform us on the benefits of purchasing similar models in the future. We will plan to publish this research based on statistical analysis of the results in peer reviewed journals, and present findings at teaching and learning conferences to demonstrate evidence of good practice. Under no circumstances will the identification of any of the participants be revealed. We are also very keen to share the results with all of the participants i.e. you.

Do I have to take part?

No. Participation is entirely voluntary and if you initially enrol then decide you want to withdraw your responses you can do so by emailing Jayne Orr directly at any point.

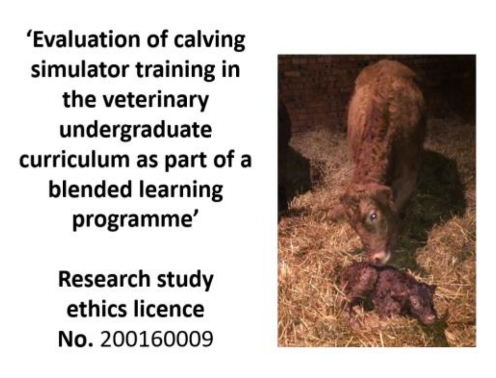
This project has been approved by the MVLS College Ethics Committee.

Contacts for Further Information

Jayne Orr	Jayne.orr@glasgow.ac.uk

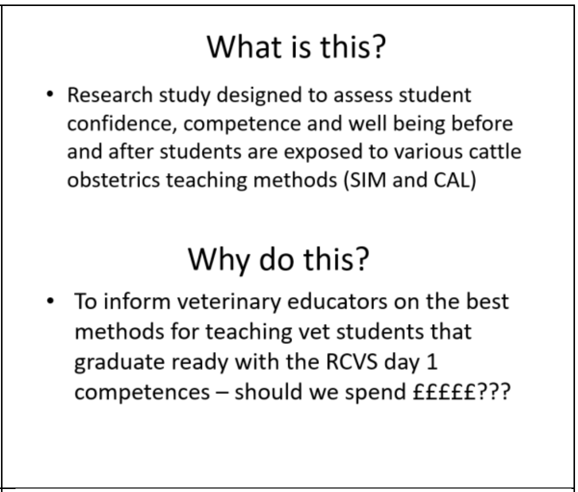
Many thanks for your participation

3.2 Power point study introduction presentation for students



'Evaluation of calving simulator training in the veterinary undergraduate curriculum as part of a blended learning programme'

Research study ethics licence
No. 200160009

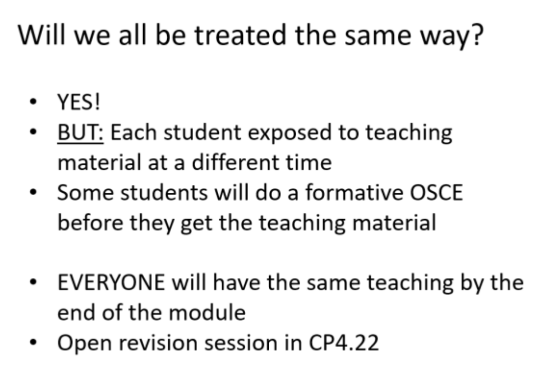


What is this?

- Research study designed to assess student confidence, competence and well being before and after students are exposed to various cattle obstetrics teaching methods (SIM and CAL)

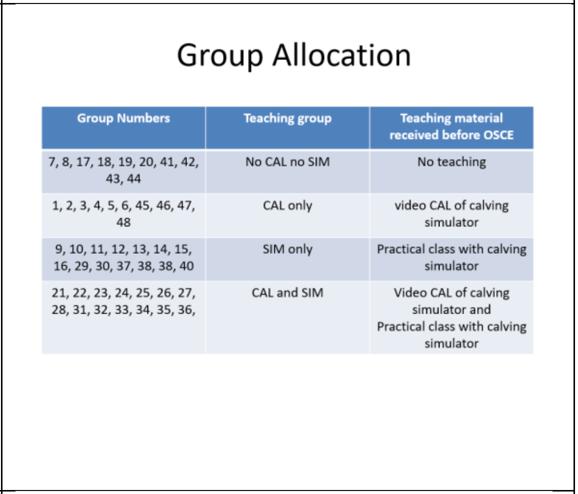
Why do this?

- To inform veterinary educators on the best methods for teaching vet students that graduate ready with the RCVS day 1 competences – should we spend £££££???



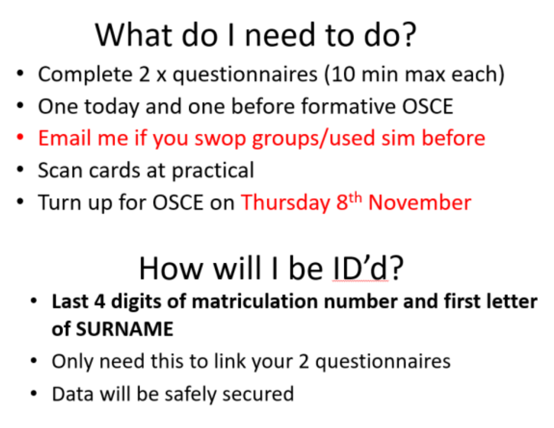
Will we all be treated the same way?

- YES!
- BUT: Each student exposed to teaching material at a different time
- Some students will do a formative OSCE before they get the teaching material
- EVERYONE will have the same teaching by the end of the module
- Open revision session in CP4.22



Group Allocation

Group Numbers	Teaching group	Teaching material received before OSCE
7, 8, 17, 18, 19, 20, 41, 42, 43, 44	No CAL no SIM	No teaching
1, 2, 3, 4, 5, 6, 45, 46, 47, 48	CAL only	video CAL of calving simulator
9, 10, 11, 12, 13, 14, 15, 16, 29, 30, 37, 38, 38, 40	SIM only	Practical class with calving simulator
21, 22, 23, 24, 25, 26, 27, 28, 31, 32, 33, 34, 35, 36,	CAL and SIM	Video CAL of calving simulator and Practical class with calving simulator

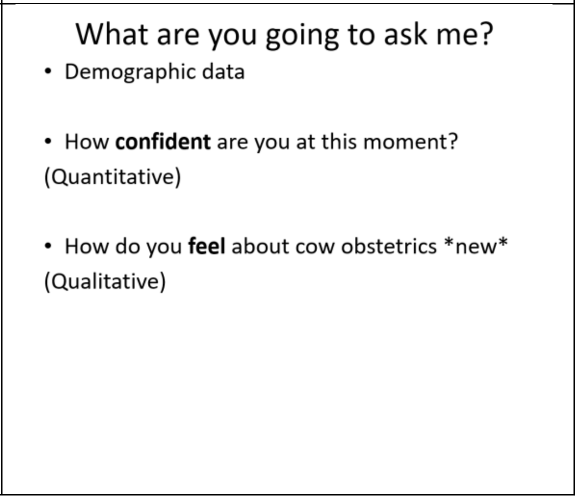


What do I need to do?

- Complete 2 x questionnaires (10 min max each)
- One today and one before formative OSCE
- Email me if you swop groups/used sim before
- Scan cards at practical
- Turn up for OSCE on Thursday 8th November

How will I be ID'd?

- **Last 4 digits of matriculation number and first letter of SURNAME**
- Only need this to link your 2 questionnaires
- Data will be safely secured

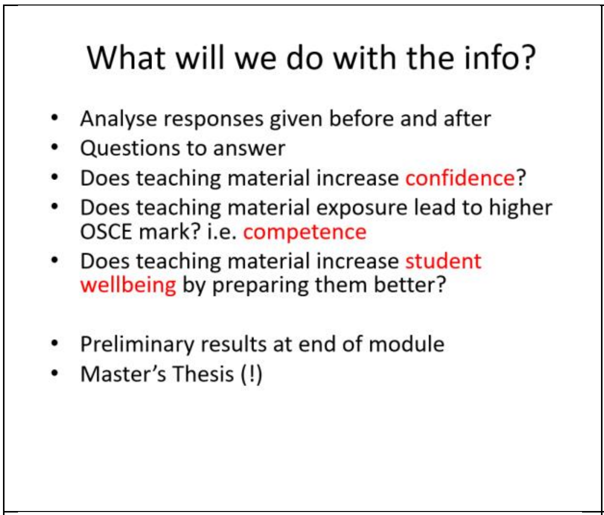


What are you going to ask me?

- Demographic data

- How **confident** are you at this moment?
(Quantitative)

- How do you **feel** about cow obstetrics *new*
(Qualitative)



What will we do with the info?

- Analyse responses given before and after
- Questions to answer
- Does teaching material increase confidence?
- Does teaching material exposure lead to higher OSCE mark? i.e. competence
- Does teaching material increase student wellbeing by preparing them better?

- Preliminary results at end of module
- Master's Thesis (!)

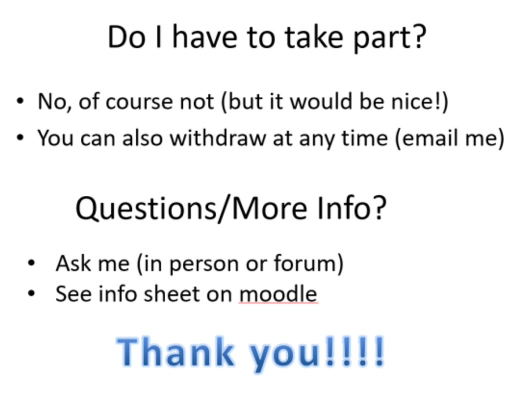
Who is organising the study?

You know most of us:

Jayne Orr,
Veterinary Clinician
in FA

Monika Mihm
Carmichael
Senior Lecturer in FA
Reproduction

Rob Kelly, Veterinary
Clinician in FA at UoE



Do I have to take part?

- No, of course not (but it would be nice!)
- You can also withdraw at any time (email me)

Questions/More Info?

- Ask me (in person or forum)
- See info sheet on moodle

Thank you!!!!

4. Questionnaire

4.1 Before teaching questionnaire (BTQ)

Evaluation of calving simulator training in the veterinary undergraduate curriculum as part of a blended learning programme

Consent

I give consent for my anonymized data to be used and understand that a unique identification number will only have to be used to match before and after questionnaires.

I understand that my skills may be assessed in a formative OSCE (BVMS4) or by the practice vet (BVMS5).

I understand I can withdraw at any time.

I have read the information sheet/attended information lecture and have taken the opportunity to ask any questions if necessary.

☐ Tick box

Section A Background Information

ID number________________________________

(Last 4 digits of Matriculation number and <u>first</u> initial of <u>surname</u>)

Gender (please circle)

Male Female Other Would rather not say

Year of birth___________________________________

Continent of origin (please circle)

Asia Australasia Africa Europe North America South America

What is your intention following graduation? (please circle)

Small Equine Farm Mixed Non-clinical Don't know

Section B Confidence level self-assessment

How confident do you feel with the following tasks (a – m) when calving a cow? (Please tick one box for each of the listed tasks)

	Confidence level				
Tasks	**No confidence**	**Little Confidence**	**Some confidence**	**Confident**	**Very confident**
	1 **(not confident)**	**2**	**3**	**4**	**5** **(very confident)**
a) Restraint of the cow					
b) Evaluating the cow's current health status					
c) History taking					
d) Preparing the cow for vaginal examination					
e) Palpation of vagina/cervix/fetus					
f) Coming to a conclusion about the obstetrical problem					
g) Correcting the obstetrical problem					
h) Determining if sufficient room to extract the calf					
i) Applying the head rope, leg ropes and calving aid					
j) Extracting the calf					
k) Reviving the calf					
l) Dealing with immediate postpartum complications in the cow (eg. bleeding)					
m) Communicating with the farmer					

Section C Previous Experience:

How many calvings needing assistance have you **observed** (Didn’t get to do anything practical)? (please circle)

0 1-2 3-5 6-10 10+

How many calvings needing assistance have you **helped** with (with some direction from vet/teacher/farmer)? (please circle)

0 1-2 3-5 6-10 10+

How many calvings needing assistance have you **carried out with no help** (i.e. no direction from vet/teacher/farmer)? (please circle)

0 1-2 3-5 6-10 10+

Section D Student Opinion

What aspects of calving a cow do you **look forward to** as a new graduate?

What aspects of calving a cow **concern you** as a new graduate?

What do you think would increase your **confidence** in calving cows?

What do you think would increase your **technical ability** in calving cows?

Any other comments?

4.2 After teaching questionnaire (ATQ)

ID number______________________________

(Last 4 digits of Matriculation number and first initial of surname)

Section B Confidence level self-assessment

How confident do you feel with the following tasks (a – m) when calving a cow?

(Please tick one box for each of the listed tasks)

	Confidence level				
Tasks	**No confidence**	**Little Confidence**	**Some confidence**	**Confident**	**Very confident**
Numerical Score	**1**	**2**	**3**	**4**	**5**
n) Restraint of the cow					
o) Evaluating the cow's current health status					
p) History taking					
q) Preparing the cow for vaginal examination					
r) Palpation of vagina/cervix/fetus					
s) Coming to a conclusion about the obstetrical problem					
t) Correcting the obstetrical problem					
u) Determining if sufficient room to extract the calf					
v) Applying the head rope, leg ropes and calving aid					
w) Extracting the calf					
x) Reviving the calf					
y) Dealing with immediate postpartum complications in the cow (eg. bleeding)					
z) Communicating with the farmer					

Section D Student opinion

What aspects of calving a cow do you look forward to as a new graduate?

What aspects of calving a cow concern you as a new graduate?

What do you think would increase your **confidence** in calving cows?

What do you think would increase your **technical ability** in calving cows?

Any other comments about cattle obstetrics teaching?

Did you change practical class, if so please detail below (if not already informed Jayne Orr)

5 Confidence results

5.1 Before teaching calving confidence per task

Calving confidence before teaching for 13 calving related tasks - mean, 95% confidence interval (CI) and standard deviation (SD)

Calving Task	**Mean**	**95% CI**	**SD**
Restraint	3.3	3.2 to 3.4	+/- 0.88
Establishing health status	3.2	3.1 to 3.3	+/- 0.67
History taking	3.5	3.4 to 3.5	+/- 0.77
Vaginal exam	2.7	2.57 to 2.82	+/- 1.11
Palpation	2.5	2.3 to 2.6	+/- 1.04
Coming to a conclusion	2.3	2.2 to 2.4	+/- 0.91
Correcting the problem	2.1	2.0 to 2.2	+/- 0.88
Assessing for room	2.2	2.1 to 2.3	+/- 0.87
Applying ropes	2.6	2.5 to 2.7	+/- 1.00
Extracting the calf	2.4	2.3 to 2.5	+/- 0.96
Reviving the calf	2.7	2.6 to 2.8	+/- 1.00
Dealing with post-partum complications	1.7	1.6 to 1.8	+/- 0.78
Communication with the farmer	3.2	3.1 to 3.3	+/- 0.89
Total score	34.3	33.4 to 35.2	+/- 8.23

5.2 After teaching calving confidence per task for each teaching group

Calving confidence after teaching for 13 calving related tasks in each teaching group - mean, 95% confidence interval (CI) and standard deviation (SD)

	Teaching mode group (n=total, combined data from all 3 years of study)				Total mean (all groups combined)
Task	LEC (n=54)	CAL (n=58)	SIM (n=89)	CAL&SIM (n=83)	
Restraint 95% CI SD	3.1 (2.9 – 3.3) +/- 0.80	3.0 (2.8 - 3.2) +/- 0.84	3.3 (3.2 – 3.5) +/- 0.80	3.5 (3.3 – 3.7) +/- 0.81	3.3 (3.2 – 3.4) +/- 0.82
Establishing health status	3.1 (2.9 – 3.2) +/- 0.63	3.1 (3.0 – 3.2) +/- 0.55	3.3 (3.2 – 3.4) +/- 0.58	3.4 (3.3 – 3.5) +/- 0.54	3.2 (3.2 – 3.3) +/- 0.58
History taking	3.3 (3.1 – 3.5) +/- 0.67	3.4 (3.3 – 3.6) +/- 0.73	3.6 (3.4 – 3.7) +/- 0.72	3.6 (3.5 – 3.7) +/- 0.66	3.5 (3.4 – 3.6) +/- 0.69
Vaginal exam	2.6 (2.4 – 2.9) +/- 0.93	2.8 (2.5 – 3.1) +/- 1.08	3.3 (3.1 – 3.5) +/- 0.88	3.5 (3.3 – 3.7) +/- 0.88	3.1 (3.0 – 3.2) +/- 0.99
Palpation	2.4 (2.1 – 2.6) +/- 1.01	2.6 (2.3 – 2.8) +/- 0.96	3.0 (2.8 – 3.2) +/- 0.96	3.3 (3.1 – 3.5) +/- 0.84	2.9 (2.8 – 3.0) +/- 0.99
Coming to a conclusion	2.3 (2.1 – 2.6) +/- 0.83	2.6 (2.4 – 2.9) +/- 0.88	3.2 (3.0 – 3.4) +/- 0.85	3.5 (3.3 – 3.6) +/- 0.77	3.0 (2.9 – 3.1) +/- 0.93
Correcting the problem	2.2 (2.0 – 2.4) +/- 0.85	2.6 (2.4 – 2.8) +/- 0.75	3.2 (3.0 – 3.3) +/- 0.79	3.3 (3.2 – 3.5) +/- 0.74	2.9 (2.8 – 3.0) +/- 0.90
Assessing for room	2.0 (1.8 – 2.2) +/- 0.79	2.5 (2.2 – 2.7) +/- 0.90	2.9 (2.8 – 3.0) +/- 0.70	3.2 (3.0 – 3.3) +/- 0.70	2.7 (2.6 – 2.8) +/- 0.88
Applying ropes	2.2 (1.9 – 2.4) +/- 0.91	2.8 (2.6 – 3.1) +/- 0.98	3.7 (3.5 – 3.8) +/- 0.75	3.9 (3.7 – 4.0) +/- 0.69	3.3 (3.2 – 3.4) +/- 1.0
Extracting the calf	2.2 (2.0 – 2.5) +/- 0.91	2.7 (2.5 – 2.9) +/- 0.82	3.4 (3.3 – 3.6) +/- 0.68	3.6 (3.5 – 3.8) +/- 0.68	3.1 (3.0 – 3.2) +/- 0.93
Reviving the calf	2.4 (2.2 – 2.7) +/- 0.87	2.6 (2.4 – 2.8) +/- 0.86	3.4 (3.2 – 3.5) +/- 0.89	3.6 (3.4 – 3.8) +/- 0.82	3.1 (3.0 – 3.2) +/- 0.97
Dealing with post-partum complications	1.6 (1.4 – 1.8) +/- 0.65	1.6 (1.4 – 1.8) +/- 0.65	2.4 (2.2 – 2.5) +/- 0.79	2.5 (2.3 – 2.6) +/- 0.81	2.1 (2.0 – 2.2) +/- 0.84

Communication with the farmer	3.0 (2.8 – 3.2) +/- 0.81	3.2 (2.9 – 3.4) +/- 0.85	3.6 (3.4 – 3.7) +/- 0.75	3.5 (3.3 – 3.7) +/- 0.90	3.3 (3.2 – 3.4) +/- 0.85

5.3 P values from Mann-Whitney test for task after confidence comparing each teaching group with the other

Calving task	Overall Kruskal-Wallis	LEC V CAL	LEC V SIM	LEC V CAL&SIM	CAL V SIM	CAL V CAL&SIM	SIM V CAL&SIM
		P value from Mann-Whitney test					
Restraint	0.011	0.545	0.154	0.017	0.041	0.003	0.248
Health	0.008	0.797	0.041	0.006	0.058	0.007	0.357
History	0.050	0.232	0.021	0.010	0.340	0.225	0.779
Vaginal exam	0.000	0.240	0.000	0.000	0.026	0.000	0.061
Palpation	0.000	0.328	0.000	0.000	0.008	0.000	0.043
Conclusion	0.000	0.112	0.000	0.000	0.000	0.000	0.048
Correction	0.000	0.023	0.000	0.000	0.000	0.000	0.131
Room	0.000	0.004	0.000	0.000	0.005	0.000	0.015
Ropes	0.000	0.001	0.000	0.000	0.000	0.000	0.043
Extracting	0.000	0.014	0.000	0.000	0.000	0.000	0.024
Reviving	0.000	0.490	0.000	0.000	0.000	0.000	0.117
Complications	0.000	0.991	0.000	0.000	0.000	0.000	0.733
Communication	0.000	0.282	0.000	0.007	0.007	0.100	0.381

5.4 Qualitative thematic analysis results

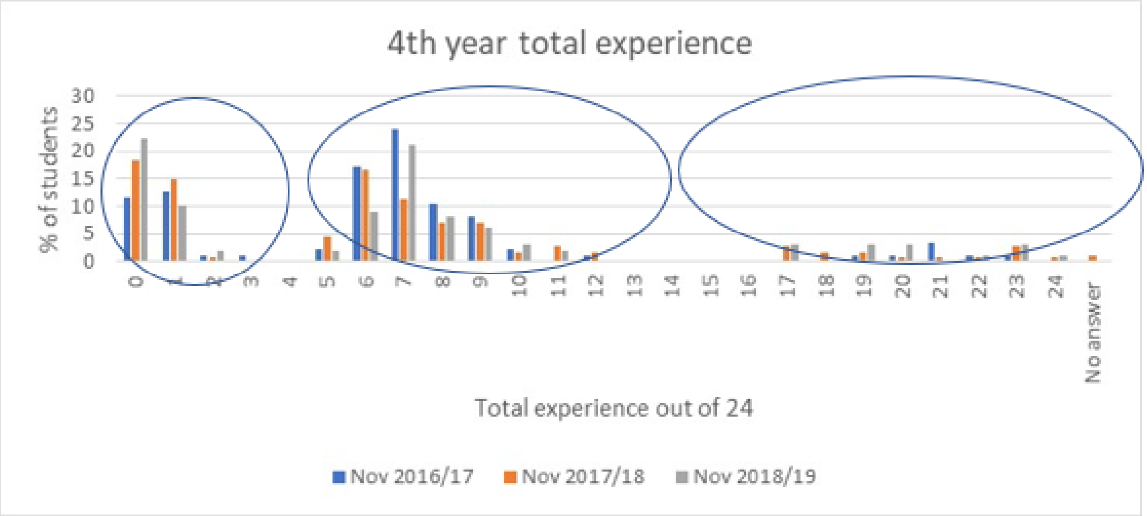
Thematic analysis results from the BTQ question - What would increase your confidence calving cows?

Code	Description	Number of sections of text	Higher level theme	Number of sections of text
1	Practice – general, calving cows, hands on, experience, numbers	163 (61%)	Further practice	239 (90%)
2	Practice – EMS, real life,	28 (11%)		
3	Practice – SIM, practicals	29 (11%)		
4	Practice – numbers	Combined with 1		
5	Practice – Assisting/helping	8 (3%)		
6	Practice - Observing	11 (4%)		
7	Critique/guidance/supervision	13 (5%)	Critique/ guidance/ supervision	13 (5%)
8	Further teaching (not SIM/practical) – lectures, visual aids, videos, personal study	14	Further teaching (not SIM/practical)	14 (5%)
Total		**266**		

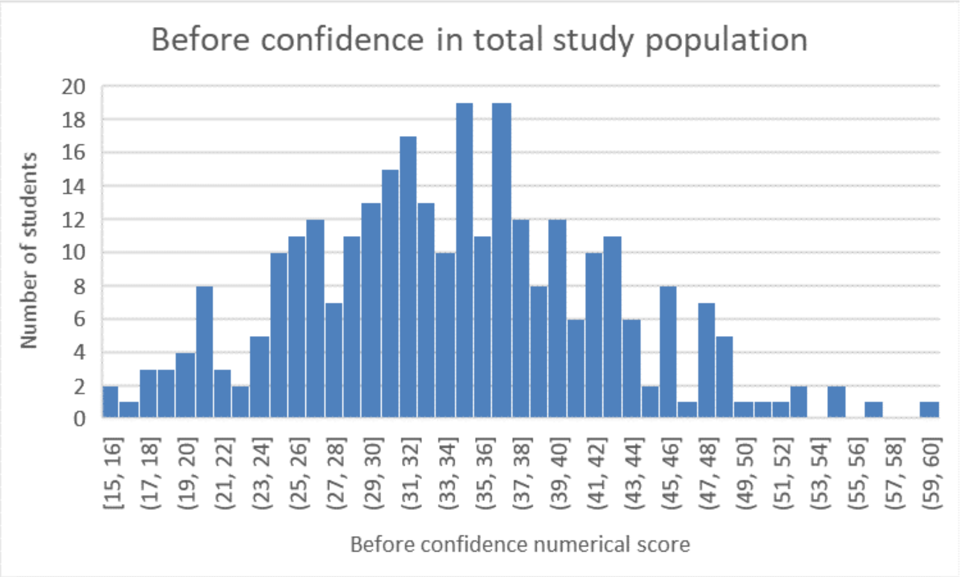
Thematic analysis results from ATQ question - what would increase your confidence in calving cows?

Code	Description	Number of sections of text	Higher level theme	Number of sections of text
1	Practice – general, calving cows, hands on, experience, numbers	67 (52%)	`Further practice	115 (89%)
2	Practice – EMS, real life, final year rotation	23 (18%)		
3	Practice – SIM, practicals, rotations	21 (16%)		
4	Practice – numbers	0		
5	Practice – Assisting/helping	0		
6	Practice - Observing	4 (3%)		
7	Critique/guidance/supervision	5 (4%)	Critique/ guidance/ supervision	5 (4%)
8	Further teaching (not practical/SIM) – lectures, visual aids, videos, personal study	8 (6%)	Further teaching (not practical/SIM)	8 (6%)
9	Assessment	1 (1%)	Assessment	1 (1%)
Total		**129**		**129**

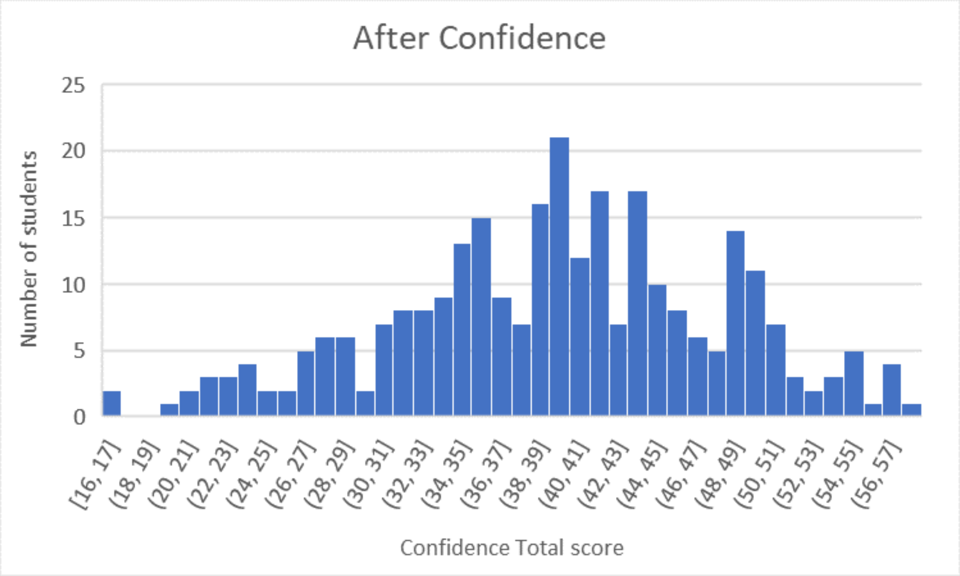
5.5 Histogram of calving experience before teaching used to establish categories for further analysis (blue circles indicate patterns of distribution of data and the 3 experience categories used)



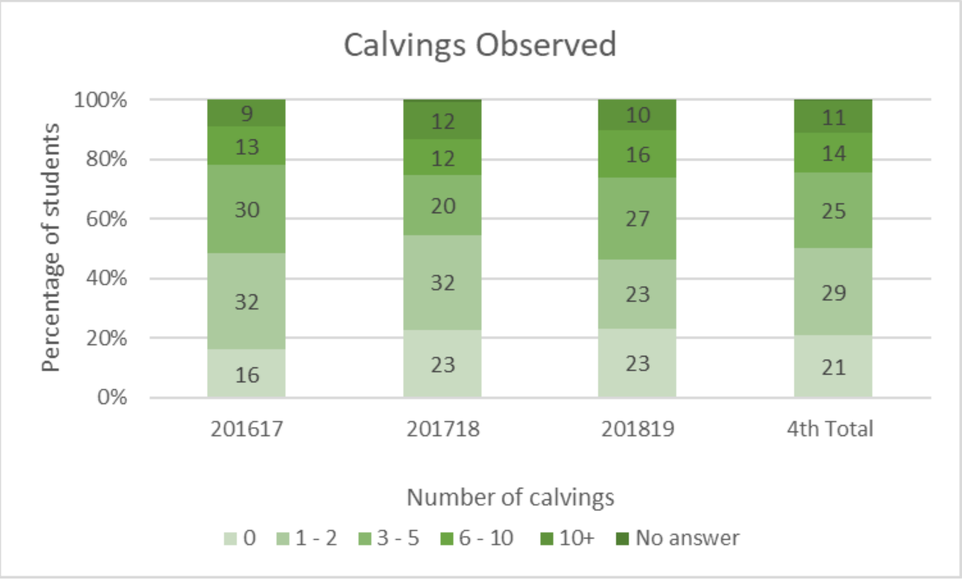
5.6 Histogram of before teaching calving confidence results which showed no obvious pattern in the data for further categorisation (hence the Likert type categories used in the questionnaire were applied)

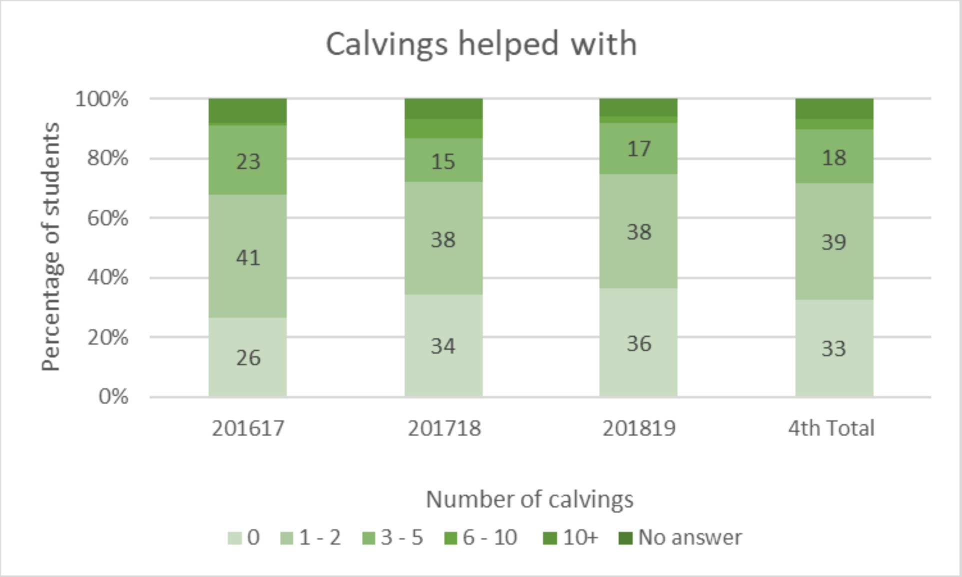


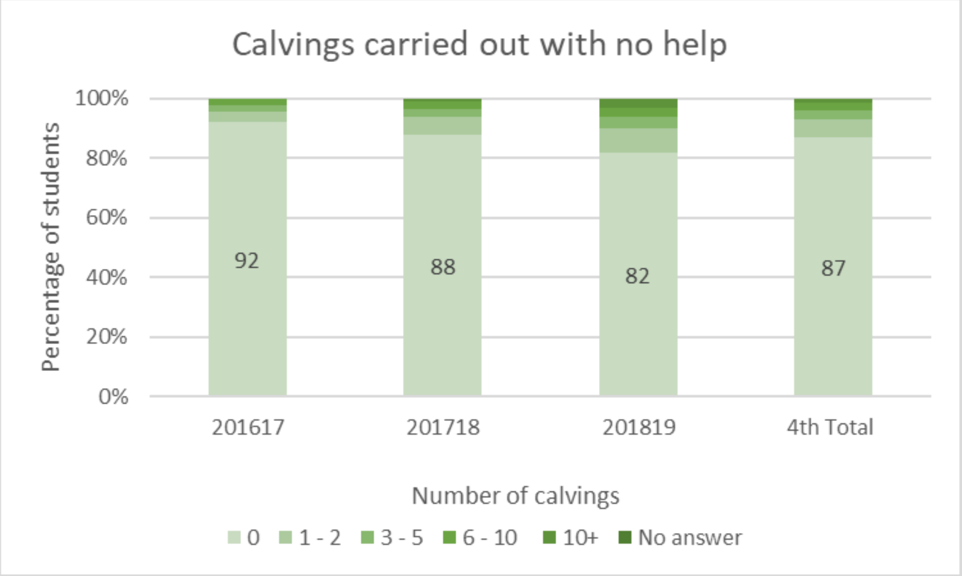
Histogram of after teaching calving confidence results which showed no obvious pattern in the data for further categorisation (hence the Likert type categories used in the questionnaire were applied)



5.7 Calving experience before teaching for each of the three experience categories for each study year (numbers are %)




Calvings helped with
Percentage of students
100%
80%
60%
40%
20%
0%
23
41
26
15
38
34
17
38
36
18
39
33
201617
201718
201819
4th Total
Number of calvings
0
1 - 2
3 - 5
6 - 10
10+
No answer


Calvings carried out with no help
Percentage of students
100%
80%
60%
40%
20%
0%
92
88
82
87
201617
201718
201819
4th Total
Number of calvings
0
1 - 2
3 - 5
6 - 10
10+
No answer

6 OSCE

6.1 Marking guide used for moderation of OSCE

IF ANY DOUBT – GO WITH EXAMINERS MARKS ON THE DAY

- **Fail**
  Too rough and high chance would have perforated the uterus OR no attempt to correct the position OR calf not corrected OR No ropes placed OR ropes in unsafe position (head rope round the neck) OR consider if student only manages to correct head, then ran out of time for anything else

- **Autofail** 2016/17 and 2017/18 only – calf corrected but '**too rough**' or head rope round the neck.

  201718 - Don't award 'reposition legs' (3 marks) or 'successfully applies a head rope in a safe position' (2 marks) and 'carries out procedure in efficient and safe manner (1 mark)

  201617 – Don't award 'correctly reposition calf head (3 marks) or 'successfully applies a head rope in a safe position' (2 marks) and 'carries out procedure in efficient and safe manner (1 mark)

  (201819 – separate safety mark added so NA)

- **Borderlines**

201617 and 201718

  - **Borderline (Pass) - any** mention of 'rough' or didn't push back and should have (but if 'too' rough should be fail) OR issues with both leg ropes OR issues with 1 x leg and head rope OR issues with 1 leg and no calving aid OR considerable hesitation/took a long time

201819 – (separate safety mark added)

  - **Borderline fail** – Calf corrected but **moderate chance** would have damaged the uterus (didn't push back-should have) OR serious issues (x3 of the following) with head/leg ropes/calving aid (they didn't run out of time to do this) OR considerable hesitation.
  - **Borderline pass** – Calf corrected but very **slight chance** would have damaged the uterus OR position corrected but took a long time/some hesitation OR moderate issues (x2) with head/leg ropes (they didn't run out of time to do this).

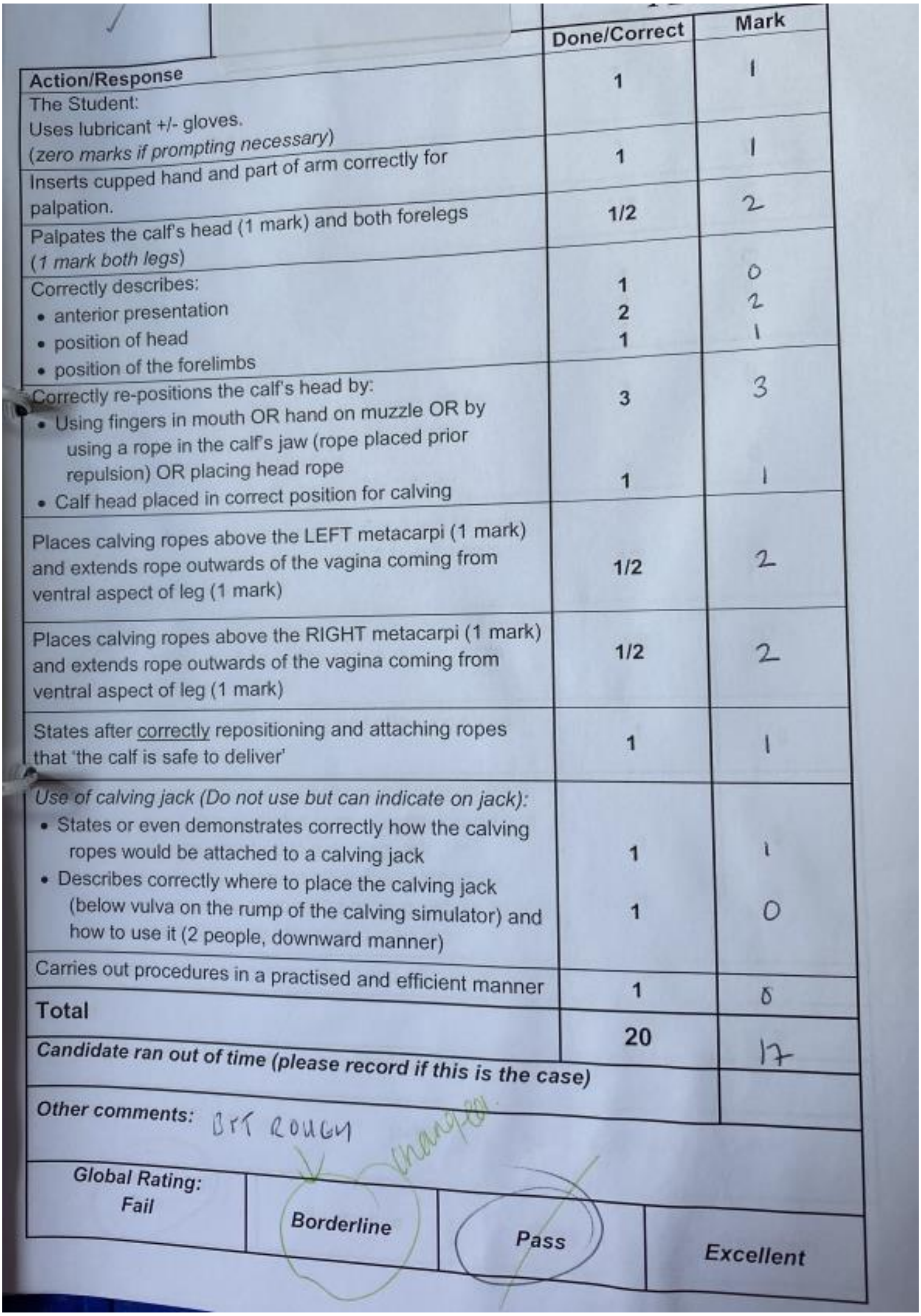
- **Pass** – Calf manipulated safely AND position corrected AND confident approach AND no/minor rope/calving aid issues. Head rope not essential.

- **Excellent** – confident approach AND calf manipulated safely (pushing back should have been performed) AND position corrected AND ropes correct (legs and head) AND good dexterity AND no hesitation.

NB

- Safety mark at end, used in 201819 only, should be 0 or 4 (changed anything from 1-3 to a 4)
- Green = August and November 2020 final moderation by JO and MMC
- Pink = August 2019 initial moderation by JO

6.2 2016/17 OSCE checklist



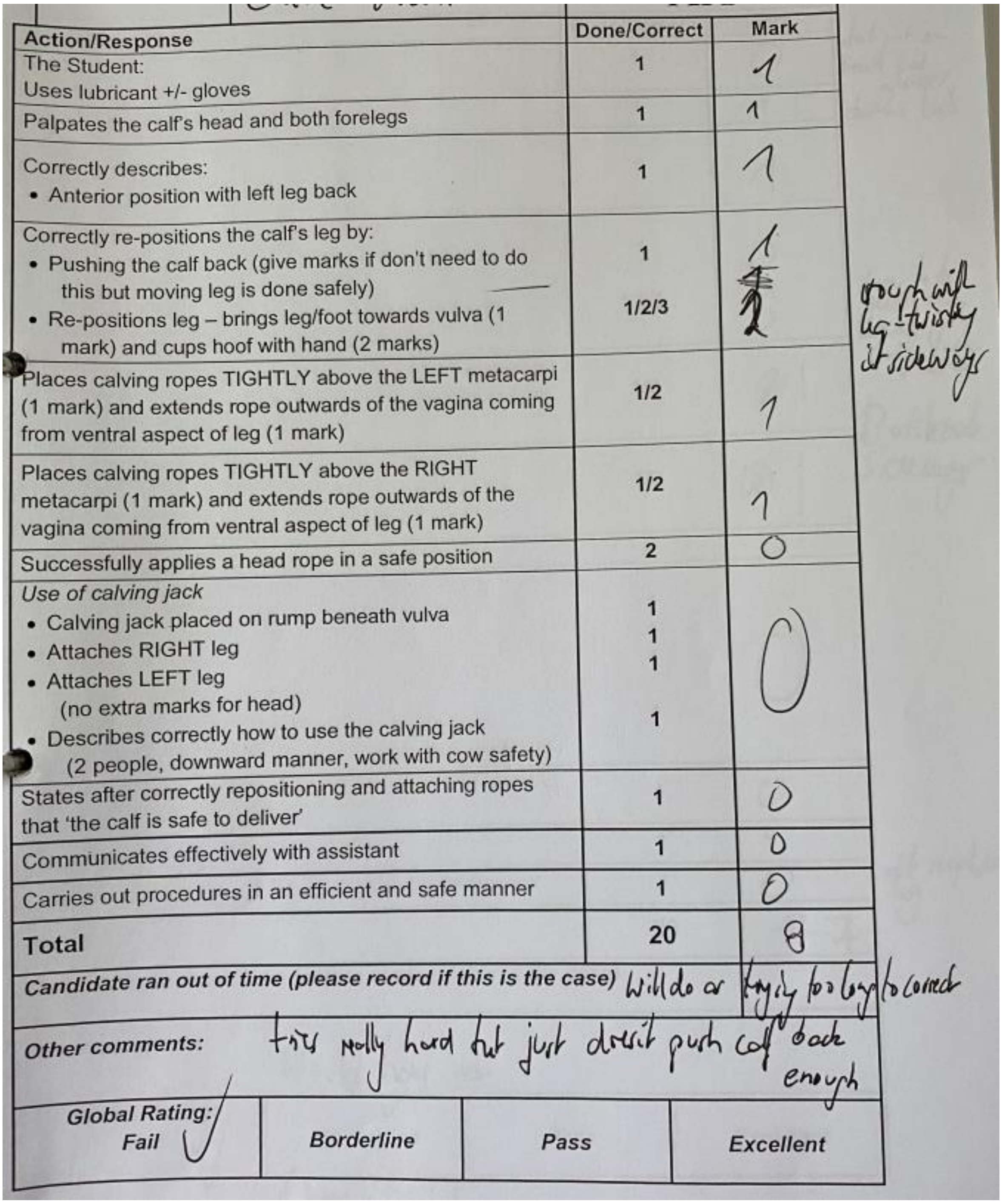
Action/Response	Done/Correct	Mark
The Student: Uses lubricant +/- gloves. *(zero marks if prompting necessary)*	1	1
Inserts cupped hand and part of arm correctly for palpation.	1	1
Palpates the calf's head (1 mark) and both forelegs *(1 mark both legs)*	1/2	2
Correctly describes: • anterior presentation • position of head • position of the forelimbs	1 2 1	0 2 1
Correctly re-positions the calf's head by: • Using fingers in mouth OR hand on muzzle OR by using a rope in the calf's jaw (rope placed prior repulsion) OR placing head rope • Calf head placed in correct position for calving	3 1	3 1
Places calving ropes above the LEFT metacarpi (1 mark) and extends rope outwards of the vagina coming from ventral aspect of leg (1 mark)	1/2	2
Places calving ropes above the RIGHT metacarpi (1 mark) and extends rope outwards of the vagina coming from ventral aspect of leg (1 mark)	1/2	2
States after correctly repositioning and attaching ropes that 'the calf is safe to deliver'	1	1
Use of calving jack (Do not use but can indicate on jack): • States or even demonstrates correctly how the calving ropes would be attached to a calving jack • Describes correctly where to place the calving jack (below vulva on the rump of the calving simulator) and how to use it (2 people, downward manner)	1 1	1 0
Carries out procedures in a practised and efficient manner	1	0
Total	20	17
Candidate ran out of time (please record if this is the case)		

Other comments: BIT ROUGH

changed

Global Rating: ***Fail*** | [✓ ***Borderline***] | ~~[✓ ***Pass***]~~ | ***Excellent***

6.3 2017/18 OSCE checklist



Action/Response	Done/Correct	Mark
The Student: Uses lubricant +/- gloves	1	1
Palpates the calf's head and both forelegs	1	1
Correctly describes: • Anterior position with left leg back	1	1
Correctly re-positions the calf's leg by: • Pushing the calf back (give marks if don't need to do this but moving leg is done safely) • Re-positions leg – brings leg/foot towards vulva (1 mark) and cups hoof with hand (2 marks)	1 1/2/3	1 ~~1~~ 2
Places calving ropes TIGHTLY above the LEFT metacarpi (1 mark) and extends rope outwards of the vagina coming from ventral aspect of leg (1 mark)	1/2	1
Places calving ropes TIGHTLY above the RIGHT metacarpi (1 mark) and extends rope outwards of the vagina coming from ventral aspect of leg (1 mark)	1/2	1
Successfully applies a head rope in a safe position	2	0
Use of calving jack • Calving jack placed on rump beneath vulva • Attaches RIGHT leg • Attaches LEFT leg (no extra marks for head) • Describes correctly how to use the calving jack (2 people, downward manner, work with cow safety)	1 1 1 1	0
States after correctly repositioning and attaching ropes that 'the calf is safe to deliver'	1	0
Communicates effectively with assistant	1	0
Carries out procedures in an efficient and safe manner	1	0
Total	20	8

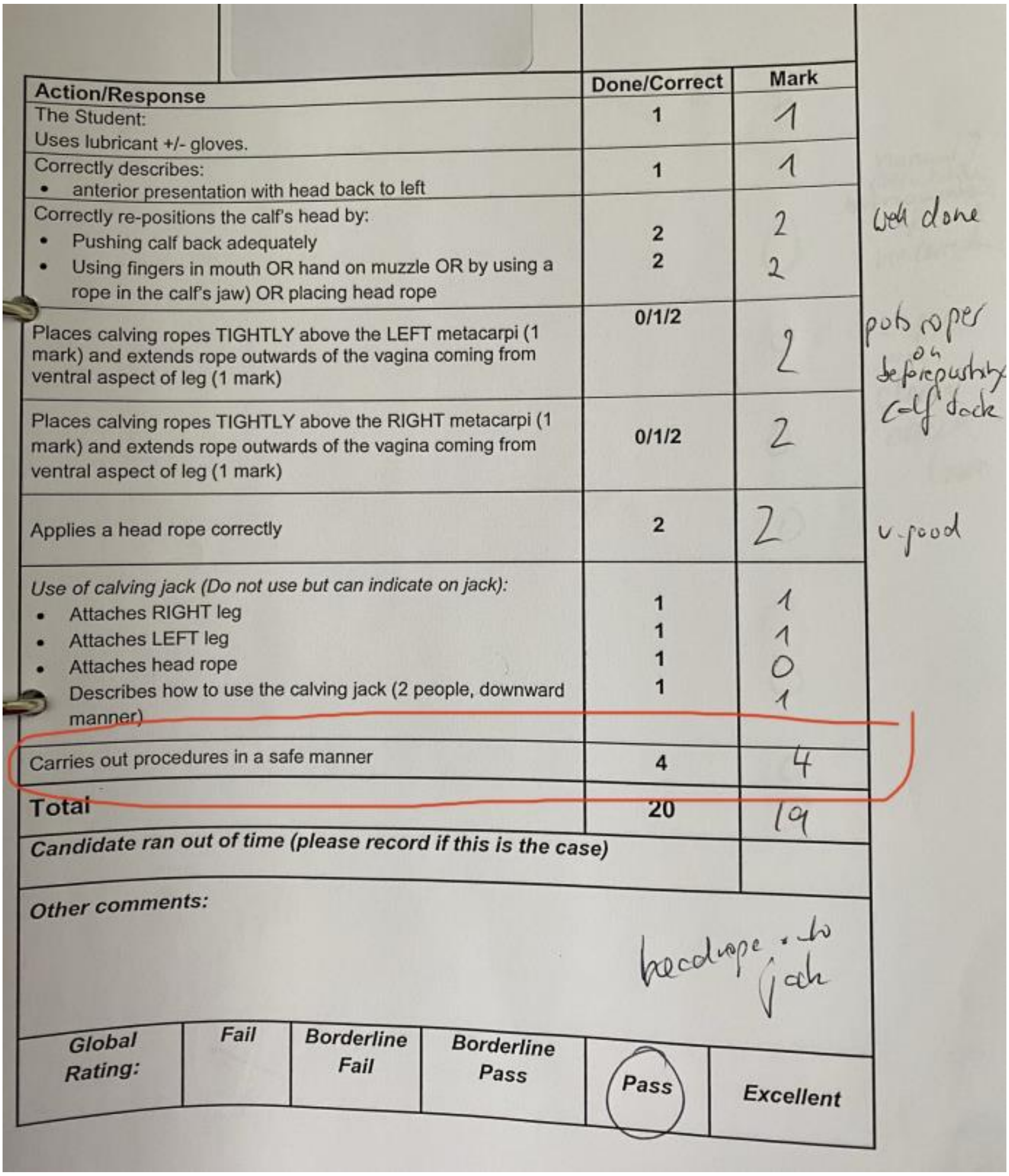
rough with leg - twisting it sideways

Candidate ran out of time (please record if this is the case) Will do as trying too long to correct

Other comments: tries really hard but just doesn't push calf back enough

Global Rating: ***Fail*** ✓	***Borderline***	***Pass***	***Excellent***

6.4 2018/19 OSCE checklist



Action/Response	Done/Correct	Mark	
The Student: Uses lubricant +/- gloves.	1	1	
Correctly describes: • anterior presentation with head back to left	1	1	
Correctly re-positions the calf's head by: • Pushing calf back adequately • Using fingers in mouth OR hand on muzzle OR by using a rope in the calf's jaw) OR placing head rope	2 2	2 2	well done
Places calving ropes TIGHTLY above the LEFT metacarpi (1 mark) and extends rope outwards of the vagina coming from ventral aspect of leg (1 mark)	0/1/2	2	puts ropes on before pushing calf back
Places calving ropes TIGHTLY above the RIGHT metacarpi (1 mark) and extends rope outwards of the vagina coming from ventral aspect of leg (1 mark)	0/1/2	2	
Applies a head rope correctly	2	2	v.good
Use of calving jack (Do not use but can indicate on jack): • Attaches RIGHT leg • Attaches LEFT leg • Attaches head rope • Describes how to use the calving jack (2 people, downward manner)	1 1 1 1	1 1 0 1	
Carries out procedures in a safe manner	4	4	
Total	20	19	
Candidate ran out of time (please record if this is the case)			

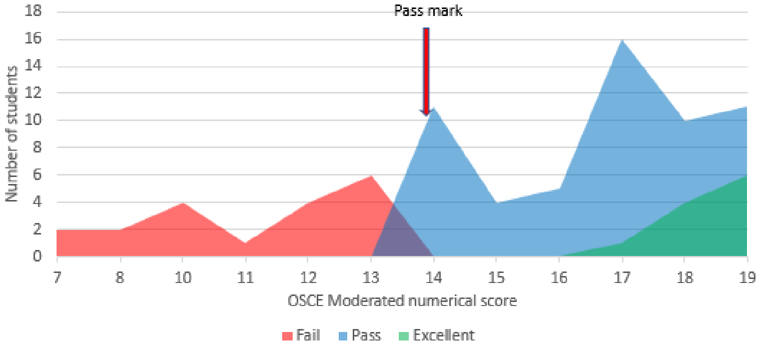
Other comments: headrope • to jack

Global Rating:	***Fail***	***Borderline Fail***	***Borderline Pass***	[✓ ***Pass***]	***Excellent***

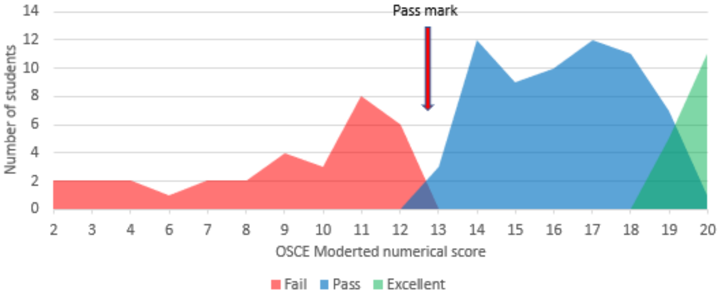
6.5 OSCE validation graphs

These graphs showed there was an overlap of three OSCE marks between pass and excellent final OSCE grade in 2016-17 (compared to just 2 in 2017-18 and 2918-19), and in each of the BVSM 4 study years there was one OSCE mark overlap between pass and fail final OSCE result. As fail was compared to pass and excellent combined for further statistical analysis, the pass and fail overlap was considered to be the most important overlap, and it was concluded that it was minimal. In conclusion, the OSCE was shown to be valid based on these tests.

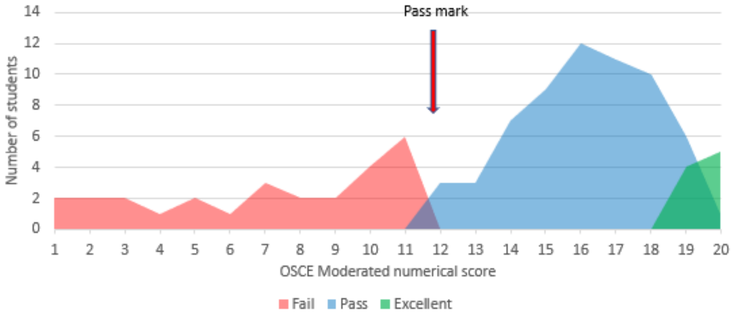
2016/17



2017/18



2018/19



6.6 Formative OSCE exam day schedule 2018/19

Time	*Event*
8.30am	Assessors, assistants (see below) and supervisors gather to set up and discuss the exam
8.45am	Student registration open. Students asked to register 15 minutes before exam time. Students complete ATQ
9am	Session 1 - Exam starts (40 students split over two streams)
11am	Tea/coffee break and opportunity for assessor discussion
11.30am	Session 2 - Exam starts again (30 students split over two streams)
1pm	Lunch break and opportunity for assessor discussion
2pm	Session 3 - Exam starts again (20 students split over two streams)
3pm	Tea/coffee break and opportunity for assessor discussion
3.30pm	Session 4 - Exam starts again (22 students split over two streams)
4.30pm	Exam finishes