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Tierklinik für Fortpflanzung
des Fachbereiches Veterinärmedizin
der Freien Universität Berlin

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Inaugural-Dissertation
zur Erlangung des Grades eines
Doktors der Veterinärmedizin
an der Freien Universität Berlin

vorgelegt von
Samira Luise Schlesinger
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To my dad, for teaching me that everything is interesting if you just ask the right questions. To all the other members of my giant, chaotic family and to those who have become family over the years.

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1. INTRODUCTION

Veterinary medical education institutions across the globe have made it their mission to develop the independent, professional veterinary graduate. These individuals transition into practice and are expected not only to harbor a broad base of factual and theoretical knowledge, but also to be able to provide high-quality patient care using specific clinical skills. Acquiring clinical skills involves learning how to perform certain movements (procedural knowledge), learning why one should do so (underlying basic science knowledge) and learning to interpret relevant findings and outcomes (clinical reasoning) (Michels, Evans, & Blok, 2012).

Teaching simulators represent a popular modality for delivering content in clinical skills teaching (Qayumi et al., 2014). Early records show that simulation-based education in the health professions dates back to at least the 17th century (Dilly, Read, & Baillie, 2017; McGaghie, Issenberg, Petrusa, & Scalese, 2010). In veterinary education, simulation technology has become increasingly popular in recent years and is currently regarded as a central component of many curricula (Baillie, 2007; Dilly et al., 2017). Opportunities for learners to practice in a safe and forgiving environment, although an essential aspect of clinical skills training (Duvivier et al., 2011), are often limited in daily clinical practice (Halliwell, 2006; Hubbell, 2008; Magnier, Wang, Dale, & Pead, 2014). Teaching simulators can provide some alleviation, helping to shape knowledge and prepare students for real-life scenarios while adhering to ethical standards regarding animal welfare and patient safety (Martinsen & Jukes, 2005; McGaghie et al., 2010). Cost effectiveness (Valliyate, Robinson, & Goodman, 2012) and the positive student attitudes repeatedly associated with the use of teaching simulators (Dilly et al., 2017; Eichel et al., 2013; Rösch et al., 2014) undoubtedly add to their popularity. Moreover, multiple studies have shown that simulation-based teaching has the potential to outperform teaching approaches such as traditional lecture-style presentations and video-based skill training (Aulmann et al., 2015; Baillie, Crossan, Brewster, Mellor, & Reid, 2005; Eichel et al., 2013; Giese, Ehlers, Gundelach, Geuenich, & Dilly, 2016; Read, Vallevand, & Farrell, 2016) as well as providing opportunities for lifelike assessment (Scalese & Issenberg, 2005).

The benefits of simulation-based education have thus become increasingly clear and the raison d’être for this teaching method is irrefutable. So how can we, as educators, put teaching simulators to use in the most effective way? In veterinary education facilities, teaching simulators are most commonly integrated in clinical skills laboratories, the ideal curricular integration of which has received substantial research attention (Baillie et al., 2015; Valliyate et al., 2012). Findings consistently indicate that practice and feedback are among the top influential factors when it comes to effective motor skill learning and retention (McGaghie et al., 2010; Wulf, Shea, & Lewthwaite, 2010). However, faculty shortages, time restraints and increasing cohort sizes are the norm in many educational facilities (Halliwell, 2006; Magnier et al., 2014) and an increasing pressure exists to provide effective opportunities for self-directed learning (**SDL**). Although definitions vary (Ainoda, Onishi, & Yasuda, 2005), in the articles presented here, self-directed learning refers to a learning strategy, which allows individuals to take charge of their own learning in an unsupervised environment.

Researchers also agree that reflecting on experiences is a vital component of learning (Blatt, Plack, Maring, Mintz, & Simmens, 2007; Loughran, 2016; Mann, Gordon, & MacLeod, 2009; Winkel, Yingling, Jones, & Nicholson, 2017) and is therefore accepted as a cornerstone in simulation-based education (Husebø & O'Regan, 2015). However, the reflective capacities of individual learners cannot be generalized and can certainly not be taken for granted (Mann et al., 2009). Hence, activities to promote reflection have found their way into many curricula across the health professions (Mann et al., 2009). "Debriefing" learners during or after a simulation experience represents one such activity and has been referred to as "possibly the most important component of simulation-based learning" (Hall & Tori, 2017). Debriefing takes place in a supportive and motivating environment and usually involves active participation of learners in a bidirectional conversation or discussion and some level of facilitation or guidance (Fanning & Gaba, 2007; Garden, Le Fevre, Waddington, & Weller, 2015; Sawyer, Eppich, Brett-Fleegler, Grant, & Cheng, 2016). Specific methods of debriefing are as diverse as they are abundant but research suggests that overall, debriefing is an effective tool for improving learning achievements in simulator-based teaching (Dufrene & Young, 2014; Fanning & Gaba, 2007; Levett-Jones & Lapkin, 2012; Sawyer et al., 2016).

The overall objective of this thesis was to explore the roles of practice, supervision and debriefing in simulation-based clinical skills training for veterinary medicine students. In the first study, 150 veterinary students took part in instructor-led practice (supervised) or self-directed practice (unsupervised) at a selection of four learning stations in a veterinary clinical skills laboratory. An objective structured clinical examination (**OSCE**) was used to compare participants' clinical skill performance between learning stations. We were able to show that practice had a significant positive effect on OSCE scores at 3 out of 6 available learning stations. At an instructor to student ratio of approximately 1:8, supervision had no effect on OSCE scores at 4 out of 6 learning stations. At the remaining two learning stations, self-directed practice resulted in better learning achievements than instructor-led practice. The concepts of self-direction and self-regulation associated with SDL have previously been linked to better skill retention, more stable long-term performance, increased autonomy and more accurate self-assessment (Brydges, Carnahan, Safir, & Dubrowski, 2009; Brydges, Dubrowski, & Regehr, 2010; Brydges, Nair, Ma, Shanks, & Hatala, 2012; Murad, Coto-Yglesias, Varkey, Prokop, & Murad, 2010). In light of these findings, we speculated that the combination of self-directed practice and post-event debriefing could reap the benefits of both teaching methods and have the potential to outperform traditional instructor-led practice regarding learning achievements. Therefore, in the second study, we set out to examine the effect of structured post-event debriefing sessions in simulator-based veterinary clinical skills training. Nineteen Namibian veterinary students took part in instructor-led practice, self-directed practice with structured post-event debriefing and self-directed practice without debriefing (control) at three different learning stations in a veterinary clinical skills laboratory. We were able to show that the choice of practice model had no significant effect on learning achievements overall. However, at individual learning stations, different practice models showed significant differences regarding effect on learning achievements. Students generally preferred practice sessions with some form of instructor involvement but the importance of instructor guidance was rated differently at each individual learning station. Results of these studies were published in the Journal of Veterinary Medical Education (Impact Factor: 0.38).

Self-directed learning presupposes that students are able to apply “self-direction” or “self-directedness” to a learning situation in order to regulate their own learning (Ainoda et al., 2005). Many attempts have been made to define the concept of self-direction in learning and there is some consensus that it can be viewed both as a behavior seen in instructional method processes and as a personality characteristic of the individual learner (Stockdale & Brockett, 2010). A learner’s ability to exhibit self-direction is associated with having some level of autonomy or control over the learning situation, being motivated to engage with the learning materials and having the self-efficacy or confidence to execute the tasks (Stockdale & Brockett, 2010). The roles of and relationships between learner motivation and learner autonomy in engagement and performance have been researched extensively (Cook & Artino, 2016; Ryan & Deci, 2000). Increased learner autonomy is said to increase intrinsic motivation, which has positive effects on learning experience and increases learning achievements (Kusurkar, Croiset, & Ten Cate, 2011; Núñez & León, 2015; Reeve, Nix, & Hamm, 2003; Schneider, Nebel, Beege, & Rey, 2018). In a third, tangential study, we delved a little deeper into learning theory and set out to explore the controversially discussed role of choice in increasing learner autonomy and, in turn, increasing engagement and performance. The resulting article was formatted according to the guidelines of the Journal of Veterinary Medical Education and is included in this thesis as additional, unpublished data.

2. PUBLICATION I

Comparison of Self-Directed and Instructor-Led Practice Sessions for Teaching Clinical Skills in Food Animal Reproductive Medicine

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2.1. Abstract

While the use of simulator-based clinical skill training has become increasingly popular in veterinary education in recent years, little research has been done regarding optimal implementation of such tools to maximise student learning in veterinary curricula. The objective of this study was to compare the effects of supervised and unsupervised deliberate practice on clinical skill development in veterinary medicine students. One hundred and fifty veterinary students took part in instructor-led practice (supervised) or self-directed practice (unsupervised) at a selection of 4 learning stations in a veterinary skills laboratory. Each learning station consisted of a teaching simulator, materials required to complete the task and a standard operating procedure (**SOP**) detailing how to execute the task. Students used Likert scales to self-evaluate their clinical skills before and after practice sessions as well as evaluating their motivation to practice a given task. An objective structured clinical examination (**OSCE**) was used to compare participants' clinical skill performance between learning stations. We were able to show that practice had a significant positive effect on OSCE scores at 3 out of 6 available learning stations. Motivation ratings varied between learning stations and were positively correlated with increase in self-perceived clinical skill. At an instructor to student ratio of approximately 1:8, supervision had no effect on OSCE scores at 4 out of 6 learning stations. At the remaining two learning stations, self-directed practice resulted in better learning outcomes than instructor-led practice.

2.2. Keywords

veterinary education, simulation, clinical skills, deliberate practice, feedback, self-directed learning, motivation

2.3. Introduction

The use of teaching simulators has become increasingly popular in veterinary education in recent years (Baillie, 2007; Dilly et al.). Major advantages include the ability to increase knowledge, provide opportunities for deliberate and safe practice, and shape and assess the development of clinical skills (Dilly et al., 2017; Hart, Wood, & Weng, 2005; Scalese & Issenberg, 2005). In various fields of veterinary training, simulator-based teaching scenarios have been found to outperform teaching approaches such as traditional lecture-style presentations or video-based skill training (Aulmann et al., 2015; Baillie et al., 2005; Eichel et al., 2013; Giese et al., 2016; Jones, Rinehart, & Englar, 2018; Read et al., 2016).

While there is still some debate on the transferability of manual skills to real life scenarios (Hamstra, Brydges, Hatala, Zendejas, & Cook, 2014; Jones et al., 2018; Lynagh, Burton, & Sanson-Fisher, 2007; Sturm et al., 2008; Zendejas, Brydges, Wang, & Cook, 2013), researchers have repeatedly reported positive student attitudes towards the use of teaching simulators in veterinary curricula (Dilly et al., 2017; Eichel et al., 2013; Fox, Sinclair, Bolt, Lowe, & Weller, 2013; Langebaek et al., 2012; Langebaek, Toft, & Eriksen, 2015; Rosch et al., 2014). Cost effectiveness, ethical standards and time and resource management have led to simulator-based teaching being regarded as a central component of veterinary education, which is here to stay (Baillie, 2007; Crowther, Booth, Coombes, & Baillie, 2013; Dilly et al., 2017; Hart et al., 2005; Kneebone & Baillie, 2008; Valliyate et al., 2012).

Deliberate practice, a term describing highly structured training activities, explicitly aimed at improvement of skills (Ericsson, 2008), is widely accepted as indispensable in the process of learning and perfecting manual skills (McGaghie, Issenberg, Petrusa, & Scalese, 2006). Availability of increasingly elaborate educational technologies, such as simulation and virtual patients, have diversified opportunities for deliberate practice as well as providing ample opportunity for self-directed learning (**SDL**) in medical education and related fields (Baillie, 2007; Brydges et al., 2010; Valliyate et al., 2012). Although definitions vary, SDL describes learning scenarios in which learners themselves are largely responsible for deciding what, how and for how long they learn (Ainoda et al., 2005; Murad et al., 2010).

The increased popularity of SDL, simulators and skills laboratories among clinical educators may well be related to the fact that presence of an instructor appears optional (Baillie, Shore, Gill, & May, 2009; Brydges et al., 2010; Dilly et al., 2017; LeFlore, Anderson, Michael, Engle, & Anderson, 2007). Researchers agree, however, that the power of SDL cannot be generalized and is heavily context-, content-, and concept-specific (Brydges et al., 2009; Brydges et al., 2010; Greveson & Spencer, 2005). With supervision in SDL scenarios ranging from mere presence of an instructor to different degrees of interaction between learners and instructors, the question arises as to what aspects of supervision lead to effective learning. Next to teacher knowledge, students in the medical field rate feedback and communication to be the most important teacher characteristics (Kelly, 2007). Particularly in motor skill learning, feedback is argued to be among the most important factors affecting learning and retention (Issenberg & Scalese, 2007; McGaghie et al., 2010; Wulf et al., 2010). Type, frequency and timing of feedback can have a substantial impact on learning outcomes (Branch, 2002; Wulf et al., 2010). Research has also been dedicated to the exploration of motivational properties of feedback (Kuhn et al., 2008; Lewthwaite & Wulf, 2010) in an attempt to better understand the complex role that motivational factors play in manual skill learning.

Students are unlikely to gain proficiency in clinical skills without practice. Thus, veterinary faculties are faced with the challenge of designing effective practice sessions in educational settings where faculty shortages, time restraints and increasing cohort sizes are the norm (Halliwell, 2006; Magnier et al., 2014). Therefore, the objective of this study was to compare self-directed and instructor-led practice sessions in simulator-based clinical skill training for fifth year veterinary students. The following hypotheses were tested:

1. Students who are given the opportunity for deliberate practice at a given learning station will obtain higher OSCE scores than students who are not.
2. OSCE scores obtained by students at a given learning station will be higher if an instructor supervises the practice session.
3. Students' self-perceived motivation to practice at a given learning station will be positively correlated with OSCE scores obtained at that learning station.

2.4. Materials and Methods

2.4.1. Participants

A total of 150 students participated in this study. All participants were undergraduate veterinary students in their 5th year of education at the Faculty of Veterinary Medicine, Freie University of Berlin. The study was conducted in the Clinic for Animal Reproduction. All data were handled anonymously. The study protocol was approved by the Ethics Commission, Charité University Clinic, Berlin (EA4/033/18). Informed consent was obtained from all participants.

2.4.2. Learning Stations

Six learning stations, which are components of the clinical skills laboratory, were utilized in this study. Each learning station consisted of a teaching simulator, a corresponding standard operating procedure (**SOP**) and materials required to complete the task. The SOPs were developed by clinical educators of the veterinary skills laboratory and presented to students in the tried-and-tested format of one image and a short textual instruction for the execution of each step (Hesse et al., 2019 (in print)). Safety instructions, background information, and remarks about clinical relevance were included where applicable. Some learning stations were further equipped with a quick response (**QR**) code linking to an online video tutorial, hosted by YouTube (Google Ireland, 2019, Dublin, Ireland).

Before initiation of the study, a team of three employees at the Clinic for Animal Reproduction revised and updated all SOPs to reflect best practice based on current literature. SOPs were additionally pilot tested internally by a team of clinical educators and PhD students. Detailed descriptions of learning stations are included in Appendix A.

2.4.3. Objective Structured Clinical Examination

Learning outcomes were evaluated using objective structured clinical examinations (**OSCEs**). The OSCEs constituted a mock examination, preparing students for their final examinations but did not contribute to formal grading. All OSCE checklists were designed by clinical educators of the veterinary skills laboratory with a minimum of two years' experience in bovine theriogenology and a certificate for university teaching. The OSCE tasks consisted of one theoretical question and a clinical task. The evaluation of verbal answers and clinical skill performance took place using the prepared OSCE checklists. OSCE checklists consisted of 10 to 13 items, weighted with 1 – 2 points according to complexity. The checklists directly reflected the steps of task execution, which were described in the respective SOPs. At each learning station, students could attain a maximum checklist score of 15 points, with a maximum of 2 points allocated to the theoretical question. A sample OSCE checklist is included in Appendix B.

A first round of pilot testing was performed amongst clinical educators of the Clinic for Animal Reproduction. After adjustments, a second round of pilot testing was performed on one rotation group. All examiners were employees of the Clinic for Animal Reproduction, who were familiar with all the utilized learning stations and had a minimum of one year's experience in clinical education. During a two-hour training session, all potential examiners were introduced to the examination technique and three OSCE demonstrations were performed. During examination, examiners were randomly allocated to learning stations by drawing lots.

2.4.4. Study Design

Throughout the 2-week clinical rotation 'Animal Reproduction', veterinary students took part in practically oriented seminars and hands-on activities on a variety of topics related to reproductive medicine. Median group size was eight students. The six learning stations were integrated in these seminars and used to demonstrate and practice clinical skills relevant to each topic. Where applicable, clinical skills were also demonstrated on live patients. This study was conducted throughout the academic year 2017/2018 with a total of 20 participating rotation groups.

The second Wednesday afternoon of each rotation was reserved for a 2-hour practice session during which students were presented with a selection of four learning stations for independent practice. The four learning stations were randomly selected using the random number function in Microsoft Excel (Office 2016, Microsoft Deutschland Ltd., Munich, Germany) before the initiation of the study. Students worked in pairs and spent approximately 30 minutes at each learning station, using the provided materials and SOPs. Additionally, each rotation group was randomly assigned to either unsupervised (*n* = 76) or supervised practice sessions (*n* = 74).

Unsupervised practice sessions began with an instructor (i.e. first author or co-author) giving a 7-minute oral introduction to the exercise. The instructor followed a standardized script, which was written before the study began. The tasks, the available learning materials and the time available for the exercise were stated concisely and any questions were answered. Students were subsequently left alone for self-directed practice at the available learning stations. Students independently decided how much time they spent at each learning station. At the end of the 2-hour practice session, a staff member collected the evaluation forms and dismissed the students.

Supervised practice sessions began with an identical introduction to the exercise. The same instructor (i.e., first author [a]) was responsible for supervision of all supervised practice sessions during the study. The median instructor: student ratio was 1:8. The instructor was present for the entire practice session, rotating among learning stations and observing students' activities. In case of obvious or repeated errors in performing a clinical skill, the instructor provided verbal pointers on how to improve performance. Upon request, individual steps from the SOPs were demonstrated and discussed.

Before practice sessions, students used a 6-point grading scale (1 = excellent, 2 = good, 3 = satisfactory, 4 = fair, 5 = unsatisfactory 6 = very poor) to self-evaluate their competence to perform a task at a learning station, their motivation to learn the task and their competence to perform the task in a real life scenario. The self-evaluation was repeated after each practice session. Additionally, students were able to rate the concept of the veterinary skills laboratory as a whole using a set of statements and corresponding 5-point Likert scales (1 = fully applies, 2 = largely applies, 3 = partially applies, 4 = does rather not apply, 5 = does not apply at all).

Two days after each practice session, learning outcomes were evaluated using **OSCEs** in a mock examination setting. During examination, students were presented with one learning station and the corresponding task at a time. The SOP for the learning station, however, was not accessible during examination. Each student was tested on a total of 3 learning stations i.e., 2 practiced and 1 unpractised learning station (Figure 1). The three learning stations were randomly allocated as described above. Students were given one minute to read the task and 7 minutes to complete it. Theoretical knowledge questions had to be answered verbally. Examiners were not permitted to engage with students in any way during the examination. After exam completion, all students were given the opportunity to receive their OSCE scores and a short performance feedback at each learning station.

2.4.5. Statistical Analyses

Data from evaluation forms and OSCE checklists were transferred into Microsoft Excel (Office 2016, Microsoft Deutschland Ltd., Munich, Germany) spreadsheets. Statistical analyses were performed using SPSS for Windows (Version 25.0, SPSS Inc., IBM, Ehningen, Germany). To evaluate the effect of deliberate practice and supervision on OSCE scores and self-perceived increase in clinical skills, different linear mixed-effects models were constructed using the LINMIXED function of SPSS. The outcome variable in analyses 1 through 3 was OSCE score. Directed acyclic graphs software (DAGitty Version 2.3, 2015) was used for covariate selection in order to rule out confounding. In analysis 1, the effect of deliberate practice and learning station on OSCE score and interaction between deliberate practice and learning station was determined. Bonferroni post-hoc tests were used to compare OSCE results between learning stations. In analysis 2, the effect of supervised practice sessions on OSCE scores and interaction between supervision and learning station were determined. In analysis 3, further plausible factors affecting OSCE scores such as rotation group and examiner were explored. In analysis 4, the effect of supervision, rotation group, and motivation on self-evaluated increase in clinical skill was determined. The outcome variable was self-perceived increase in clinical skill. In analysis 5, a one-sample t-test and descriptive statistics were used to compare students' self-perceived clinical skill competences (after practice sessions) with actual OSCE outcomes. Odds ratios and 95% CI were reported for all analyses and significance was set at $p < 0.05$.

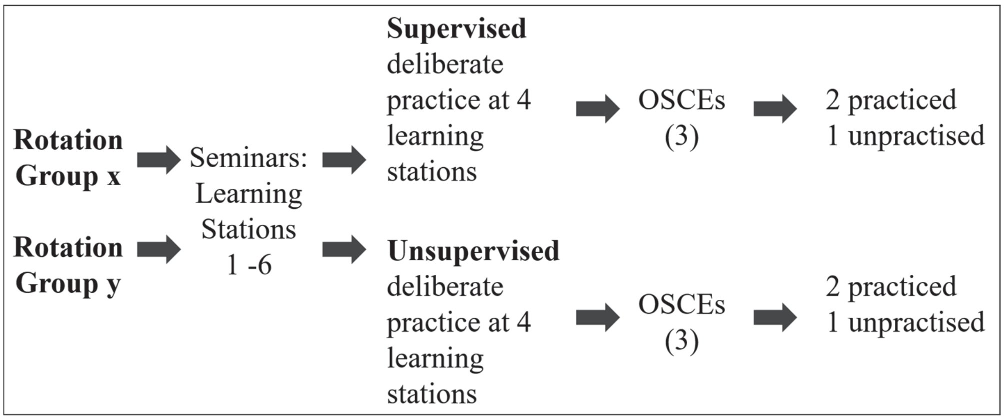

Figure 1. Schematic timeline of the study design.

2.5. Results

During clinical rotations between October 2017 and August 2018, 150 students participated in this study, resulting in 900 independent outcomes. One hundred and thirty-four students took part in the 2-hour practice sessions and filled out self-evaluation questionnaires for each practiced learning station. A total of 133 students completed the 3-station OSCE 2 days after practice sessions. After exclusion of participants who were absent on the day of the practice session the dataset consisted of 350 valid OSCE scores from 117 participants. The mean OSCE score achieved was 11.3 ± 2.98 with a minimum of 0.5 and a maximum of 15 points. Descriptive statistics for learning stations and respective OSCE scores are depicted in Table 1.

2.5.1. Analysis 1

Overall, deliberate practice had a significant effect on OSCE scores with students scoring 2.33 points higher (p < 0. 001, n = 350) at practiced learning stations (11.82 ± 0.35) than at unpracticed learning stations (9.49 ± 0.43). A significant interaction effect was found between practice and learning station (p < 0. 001, n = 350). Table 2 demonstrates the effect of deliberate practice at individual learning stations. (Place Table 2 here). Even after practice, OSCE scores were 1.36 points lower (p = 0.024, n = 130) at learning station 3 (11.39 ± 2.33) than at learning station 2 (12.76 ± 2.43). OSCE scores did not differ significantly between other practiced learning stations (Figure 2). In Figure 2, outliers are defined as any data points more than 1.5 interquartile ranges below the first quartile or above the third quartile.

2.5.2. Analysis 2

At practiced learning stations, supervision had no significant effect on OSCE scores overall (p = 0.369, n = 236). However, a significant interaction existed between supervision and individual learning station (p = 0.003, n = 236) with supervision negatively affecting OSCE scores at learning stations 2 and 5 (Table 3).

2.5.3. Analysis 3

Rotation group significantly affected OSCE scores obtained by students (p < 0.001, n= 350). On average, students of rotation group 15 achieved lower OSCE scores (7.4) compared to the other groups (9.7 – 12.8, p < 0.001 – 0.043). The examiner had a significant effect on

OSCE scores overall ($p = 0.006$, n = 350) but pairwise comparisons did not show significant differences between individual examiners.

2.5.4. Analysis 4

One hundred and thirty-four students self-evaluated their clinical skills at learning stations before and after practice sessions. Descriptive statistics of students' self-perceived development of clinical skills are depicted in Table 4. Rotation group, learning station and self-perceived motivation before practice session had a significant effect on increase in self-perceived clinical skill after practice. Pairwise comparisons showed that self-perceived clinical skill increased by 2.2 ± 1.06 points at learning station 2, which was significantly higher than at any other learning station (Likert scale, $p < 0.001 – 0.02$, n = 236). Students who rated their motivation as very high (1 on the 6-point scale) prior to practice sessions, subsequently showed a 0.7 ± 0.22 point ($p = 0.013$, n = 236) larger increase in self-perceived clinical skills than students who rated their motivation as low (4 on 6-point grading scale).

2.5.5. Analysis 5

Two hundred and thirty-six OSCE examinations were conducted at practiced learning stations with preceding self-evaluations. In three cases, the self-evaluated score for one clinical competence after practice session was illegible or left blank, resulting in 233 valid outcomes. On average, students perceived their clinical skills to be good after practice sessions (1.87 ± 0.72). Interestingly, self-perceived competences and actual OSCE outcomes differed significantly ($p < 0.001$, n = 233). Over a third (35.5%) of students obtained the same OSCE score as they had predicted after practice sessions. While 43.2% of students underestimated their ability to perform a clinical skill at a teaching simulator, 21.4% of students overestimated their clinical skill competences.

Table 1. Frequencies of tested learning stations and respective objective structured clinical examination scores.

Learning Station	***n***	**%**	**Cumulative Percent**	**Mean OSCE Score ± SD**	**Range**
1	50	14.3	14.3	11.13 ± 2.44	5.5 – 15.0
2	59	16.9	31.1	12.09 ± 3.22	1.0 – 15.0
3	71	20.3	51.4	11.04 ± 2.76	0.5 – 15.0
4	64	18.3	69.7	11.68 ± 3.22	1.0 – 15.0
5	59	16.9	86.6	11.47 ± 2.58	3.0 – 15.0
6	47	13.4	100.0	10.48 ± 3.45	3.0 – 15.0
Total	350	100.0			

Table 2. The effect of deliberate practice on objective structured clinical examination scores at different learning stations.

Learning Station	**OSCE Score ± *SD* unpracticed**	**OSCE Score ± *SD* practiced**	**Increase in OSCE score with practice ± *SD***	***n***	***p***
1	10.08 ± 2.55	12.18 ± 1.76	2.09 ± 0.80	50	<0.05
2	7.88 ± 4.52	12.76 ± 2.43	4.83 ± 1.07	59	<0.05
3	7.67 ± 4.73	11.39 ± 2.33	1.97 ± 1.22	71	0.11
4	11.17 ± 3.59	12.18 ± 2.70	0.86 ± 0.72	64	0.23
5	11.00 ± 3.00	11.56 ± 2.48	0.94 ± 0.84	59	0.27
6	8.80 ± 3.50	12.75 ± 1.62	4.30 ± 0.83	47	<0.05
Total	9.93 ± 3.56	12.02 ± 2.37	2.33 ± 0.35	350	<0.05

Table 3. The effect of supervision on objective structured clinical examination scores at different learning stations after practice.

Learning Station	Odds ratio	*SD*	Confidence Interval (95%)	*n*	*p*
1	-0.54	0.95	-2.42 – 1.34	25	0.57
2	-1.36	0.62	-2.59 – -0.13	51	< 0.05
3	1.06	0.58	-0.75 – 2.20	65	0.07
4	-1.30	0.87	-3.01 – 0.42	31	0.14
5	-1.76	-0.67	-3.08 – -0.44	44	< 0.05
6	1.50	0.98	-0.42 – 3.43	20	0.13

Table 4. Students' self-perceived development of clinical skills during practice sessions.

Self-perceived development of clinical skills during practice	*n*	%	Cumulative Percent
0.5 – 2 points decrease	15	2.9	2.9
Unchanged	126	24	26.9
< 1 point increase	6	1.1	28
1 – 2 points increase	308	58.7	86.7
> 2 points increase	70	13.3	100.0
Total	**525**	**100.0**	

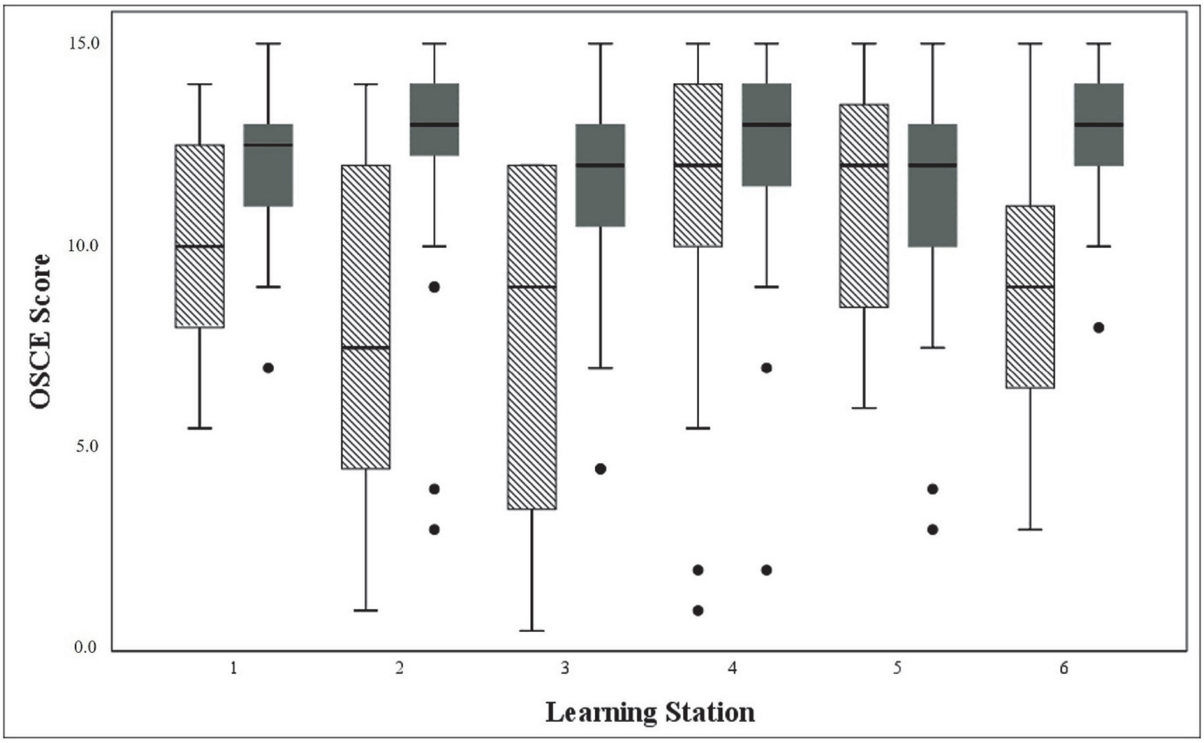

Figure 2. Objective structured clinical examination scores obtained at practiced (solid) and unpracticed (hatched) learning stations.

2.6. Discussion

The present study explored the effect of self-directed and instructor-led deliberate practice on simulator-based clinical skill development in food animal reproduction tasks. In accordance with previous findings (McGaghie et al., 2006), results demonstrated a strong positive effect of deliberate practice on learning outcomes in veterinary clinical skill training.

Contrary to our second hypothesis, our study demonstrated that instructor-led practice sessions were not significantly superior to self-directed practice sessions. In fact, supervision had a negative effect on OSCE scores at learning stations 2 and 5. Studies directly comparing instructor-led and self-directed learning scenarios are scarce in the field of medical education and altogether absent in veterinary education research. LeFlore et al (2007) compared instructor-led practice (1 instructor: 6 students) to self-directed practice with and without facilitated debriefing (LeFlore et al., 2007). While student confidence and behavioral performance were better in instructor-led practice groups, the study showed no significant differences between groups in knowledge and technical performance. In a similar study by Brydges et al (2012), student performance improved equally in instructor-led and self-directed practice settings (Brydges et al., 2012). This mirrors our findings at learning stations 1, 3, 4 and 6 and implies that unsupervised simulator-based skill training can be as effective as instructor-led skill training in veterinary education.

There is general agreement that teaching of psychomotor skills is most effective in small group settings (Snider, Seffinger, Ferrill, & Gish, 2012). Optimal learning outcomes have been documented at an instructor: student ratio of 1: 4 (Dubrowski & MacRae, 2006), which is in line with learners' preferences (Shanks, Wong, Roberts, Nair, & Ma, 2010). We can argue therefore, that in our study, the instructor: student ratio was insufficient for effective supervision. Researchers also agree that feedback is among the most important factors affecting motor skill learning and retention (Issenberg & Scalese, 2007; Scalese & Issenberg, 2005; Wulf et al., 2010). Feedback after successful trials, rather than unsuccessful ones, has been argued to create a greater success experience for learners, resulting in better learning outcomes (Chiviacowsky & Wulf, 2007). Error information may not only be superfluous, as learners may already have a good sense of how well they have performed, but it also has the potential to be demoralizing (Wulf et al., 2010). The negative effect of supervision on OSCE scores in our study is congruent with these findings and indicates that our feedback approach may have been detrimental to training effect at particular learning stations. Although further research is warranted, these findings indicate the importance of developing structured, well-defined feedback schemes for effective practice sessions. Additionally, one might speculate that time dedicated to feedback and discussion in instructor-led practice sessions may mean less time dedicated to actual practice, which may result in lower learning outcomes.

Further, learners benefit when they can tailor a practice experience to their individual needs or preferences (Chiviacowsky & Wulf, 2002; Post, Fairbrother, & Barros, 2011). Supervision during practice sessions removes the degree of self-control, which students inherently possess in unsupervised practice sessions. Motivation ratings before practice sessions were particularly high for learning stations 2 and 5. In an unsupervised environment, students may have spent more time at these particular learning stations, resulting in increased OSCE scores. Unfortunately, the study design did not permit measurement of students' practice duration at each learning station. In an unsupervised learning environment, rather than relying on an instructor to provide immediate answers, students are forced to find their own solutions to problems encountered during the practice session. This may enable a more profound interaction with the topics and lead to better retention and learning outcomes. Post-practice questionnaires revealed that students who were supervised during practice sessions were more likely to strongly agree with the statement 'An instructor should always be present during practice sessions' than students who were not supervised. This implies that unsupervised students developed a stronger feeling of independence and confidence to complete tasks on their own. Research from the domain of peer-assisted learning suggests that learners feel more relaxed and confident to make mistakes in a setting without clinical educators (Baillie et al., 2009; Bates, Warman, Pither, & Baillie, 2016). A positive learning atmosphere, imperative to achieving desired learning outcomes (Duhl Glicken, 2004), may have been impaired by instructor presence in our study, leading to lower learning outcomes at some learning stations.

Motivational factors play an important role in learning processes (Doucet, Vrins, & Harvey, 2009; Mikkonen & Ruohoniemi, 2011), particularly of motor skills (Wulf & Lewthwaite, 2016; Wulf et al., 2010). At the beginning of a given practice session, participants in our study were asked to rate their motivation to practice at each available learning station. As hypothesized, we were able to find a striking association between motivation ratings and OSCE results. Students rated their motivation to be 0.4 points lower at learning station 3 than at learning station 2, which is reflected in the differences in OSCE scores at these learning stations. We assume that lower self-perceived motivation leads to a lower training effect and, in turn, lower learning outcomes.

Other factors affecting OSCE scores included learning station and rotation group. Social dynamics within a group arise from many different factors such as method of selection, group size and pre-existing social structures (Bacon, Stewart, & Elizabeth, 2001; Chapman, Meuter, Toy, & Wright, 2006; Colliver, Feltovich, & Verhulst, 2003). These factors could not be controlled for in our study and it is not surprising therefore, that the rotation group itself influenced learning processes and learning outcomes. The positive effect of practice varied between learning stations, revealing a particularly strong influence at learning stations 2 (“Surgical suture (Buhner) of the vulva in small ruminants”) and 6 (“Analysis of sperm vitality”). Students perceived their clinical skills before practice sessions to be significantly lower at learning station 2 than at any other learning station (3.7 ± 1.1). A lower baseline level of competence at learning station 2 would explain the considerably larger training effect at this particular learning station. Self-perceived increase in clinical skill was highest at learning station 2, additionally supporting this theory. However, studies have shown that students’ ability to self-assess their competences is limited (Eva, Cunnington, Reiter, Keane, & Norman, 2004; Root Kustritz, Molgaard, & Rendahl, 2011). In keeping with these findings, our study showed that only 35% of students were able to accurately assess their ability to perform a given task. Research indicates, however, that self-efficacy is a key element in self-directed learning (Eva et al., 2004) and achieving competent performance is linked to realistic self-appraisal and self-efficacy (Mavis, 2001). Integrating self-directed simulator-based teaching in the veterinary curriculum should therefore incorporate self-assessment training throughout the course of education in order to achieve optimal results.

The OSCE method for assessments is widely accepted in medical education (Beyer, Dreier, Kirschner, & Hoffmann, 2016; Brannick, Erol-Korkmaz, & Prewett, 2011; Turner &

Dankoski, 2008) and has been described as highly relevant to veterinary clinical skill assessment (Davis, Ponnamperuma, McAleer, & Dale, 2006; Hodges, 2006). Although clinical skill evaluations are considered reliable (Brannick et al., 2011), approximately 10 – 12 stations are necessary for an adequate level of reliability (Hecker et al., 2010). In our study, the OSCE examination consisted of only 3 stations, which is a distinct limitation of the study. Rater reliability is a frequent cause for concern when using OSCEs (Turner & Dankoski, 2008). In our study, the examiner had a significant effect on OSCE scores, although significant differences were not found between any combinations of two examiners.

Further limitations of this study include the fact that the same learning stations were used for training and testing. Reproducing a task at a familiar learning station may confound participants' true ability to retain and apply clinical skills learned during practice sessions. The fact that the OSCE examination in our study was a practice exam, which did not contribute to students' final grades, has to be stated as a further limitation as students may not have been motivated to do their very best. This may have affected our ability to detect differences between groups. The 2-day period between practice sessions and OSCE assessment was relatively short and further research on the effects of deliberate practice and supervision on long-term clinical skill retention is required. Participants in this study were fifth year veterinary students at different stages of their final year of veterinary training. Differences in prior clinical experience could not be controlled for and present an additional limitation.

Findings from this study indicate that the advantages of self-directed deliberate practice in clinical skill training for veterinary medicine students may be underrated. Further research exploring the role of goal setting, debriefing, self-assessment and self-efficacy in self-directed practice sessions could pave the way to optimal implementation in veterinary curricula. Conversely, when opting for instructor-led practice sessions, further exploration of optimal instruction models and instructor to student ratios is necessary for maximizing learning outcomes.

2.7. Conclusion

Our study confirmed the importance of deliberate practice in development of clinical skills and demonstrated that instructor-led practice sessions were not superior to self-directed practice sessions in a clinical skills laboratory at an instructor to student ratio of 1:8. The negative effect of supervision at specific learning stations implies that feedback type and frequency may have affected learning processes and learning outcomes. Additionally, presence of an instructor may have influenced students' motivation and ability to engage with learning materials independently, resulting in reduced learning outcomes at specific learning stations. Students' motivation to practice a task increased their self-perceived and OSCE-measured skill level, indicating that motivational factors play a significant role in clinical skill training. Further research is warranted to determine the circumstances and skills for which self-directed clinical skills practice sessions are as effective as instructor-led practice sessions.

2.8. Notes

[a] First author credentials: veterinarian, 2 years' experience in food animal theriogenology and clinical education, certificate for university teaching (2019).

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2.11. Appendix A

Learning Station 1: Sterile milk sample collection

Learning objectives: The student recalls, understands and is able to carry out all steps in preparing the udder for sterile milk sampling. He/she is able to apply knowledge of a sterile sampling technique in order to obtain clean samples. He/she is able to package and prepare the sample for shipment according to EU regulations (reference).

Equipment: Students are presented with a rubber simulator of the cow udder filled with 1.5 litres of milk. Disposable latex gloves, dry paper towels, a plastic strip cup, disinfecting teat wipes, sterile sample vials, transport tubes, permanent markers and pens, envelopes and sample request forms for lab analysis are provided.

Learning Station 2 – Surgical suture (Buhner) of the vulva in small ruminants

Learning objectives: The student is able to explain the medical indications and alternative treatments for surgical suture of the vulva. He/she is able to close the vaginal opening using vaginal tape. He/she recognizes the importance of, and is able to carry out a correct postoperative examination of the affected area.

Equipment: Students are presented with a silicone model of the external genitalia of a small ruminant (posterior view). Vulva and anus are clearly visible and the model is mounted on a tiled wall using suction cups. Disposable latex gloves, scissors, gauze swabs, needle holder, tweezers, Bühner vaginal tape and various surgical needles of different shapes and sizes are provided.

Learning Station 3 – Thawing and preparing frozen semen for artificial insemination (**AI**) in the cow

Learning objectives: The student is able to identify and name all materials necessary for an artificial insemination in the cow. He/she follows occupational safety regulations while demonstrating the process of thawing frozen semen stored in liquid nitrogen. The student is further able to correctly assemble and load the AI gun in preparation for insemination.

Equipment: This learning station consists of a fenestrated nitrogen tank with three sperm canisters filled with a range of differently sized, empty, unsealed sperm straws with cotton plugs. An empty water beaker, paper towels, a thermometer, scissors, long handled tweezers, thick leather safety gloves, safety goggles, disposable latex gloves and plastic rectal gloves are provided. In addition, two different models of AI guns and plastic sheaths are available for student use.

Learning Station 4 – Assembling the artificial vagina for semen collection in small ruminants

Learning objectives: The student is able to identify and name all necessary materials for assembling the artificial vagina. He/she is able to assemble the artificial vagina correctly. He/she is able to evaluate water temperature, internal pressure and friction and correct errors if necessary.

Equipment: Students are presented with a polyvinyl chloride (**PVC**) outer casing, equipped with a water inlet and an air valve. A latex inner liner, gauze bandages, two wide rubber bands, an empty water beaker, a tulip shaped semen collection vial and a non-drying, non-spermicidal lubricant are also provided.

Learning Station 5 – Surgical suture of the uterus using Cushing suture patterns

Learning objectives: The student is able to name clinical indications and explain the features of a Cushing suture. He/she is able to demonstrate a single-layered Cushing suture pattern using surgical equipment. The student recognizes the importance of an inverting suture and is able to describe the process.

Equipment: This learning station consists of a two-layered silicone suture pad, which is mounted on a tiled wall using suction cups. Students are provided with a variety of surgical needles, a needle holder, anatomic tweezers, surgical scissors (blunt), and suture.

Learning Station 6 – Analysis of sperm vitality

Learning objectives: The student is able to produce an even, single-layered eosin stained semen smear. He/she is able to use a light microscope to set a clear, evaluable image. He/she is able to describe the counting and calculation procedure for determining sperm vitality.

Equipment: This learning station consists of a laboratory table with a binocular light microscope (Zeiss AxioLab). Students are provided with a semen sample (either bull or buck), microscope slides, manual pipettes, universal fit disposable pipette tips and pre-prepared vials of eosin solution.

2.12. Appendix B

OSCE Learning Station 2: Surgical suture (Buhner) of the vulva in sheep

Task: What are indications and alternatives for surgical suture (Buhner) of the vulva in sheep? Demonstrate the Buhner suture using the materials provided.

Step	Points	Max.
The student is able to name at least one indication **(1)** and one alternative **(1)** for the Buhner suture in sheep. **Indications:** ante partum vaginal prolapse, ante partum uterine prolapse, postpartum vaginal prolapse, postpartum uterine prolapse **Alternatives:** Flessa suture, Gerlach suture needle + vaginal tape, bearing retainer, prolapse harness, vaginopexy, cervicopexy		**2**
The student chooses the correct needle.		**1**
The vaginal tape is measured out to be at least five times as long as the vulva.		**1**
The student uses a needle holder to guide the needle.		**1**
The student begins with a subcutaneous insertion of the needle below the ventral commissure of the vulva.		**1**
A subcutaneous bridge of 3 – 5 cm is placed above the dorsal commissure of the vulva **(1)** with the needle inserted in each previously created exit hole **(1).**		**2**
The suture is completed with a subcutaneous stitch on the opposite side of the vulva.		**1**
The student guides the subcutaneous movement of the needle using intravaginal palpation.		**1**
The first insertion site is 1 – 2 cm away from the last exit site.		**1**
The vaginal tape is pulled tight to leave an opening that is wide enough for 2 fingers to pass.		**1**
A gauze swab is placed between the ends of the vaginal tape.		**1**
The vaginal tape is tied with a bow, not knotted!		**1**
The student uses digital palpation of the rectum to rule out perforation.		**1**
Total		**15**

3. PUBLICATION II

Examining the role of structured debriefing in simulator-based clinical skills training for Namibian veterinary students: a pilot study

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4. ADDITIONAL UNPUBLISHED WORK, intended for "Computers in Human Behavior"

Can Provision Of Choice Before A Veterinary Medicine E-Learning Course Influence Learner Autonomy And Learning Outcomes?

S. Schlesinger, S. Schneider, W. Heuwieser

4.1. Abstract

Learner autonomy plays an important role in learner motivation, including in online learning environments. The role of choice in increasing learner autonomy and, in turn, increasing engagement and performance has been controversially discussed. In this study, 143 veterinary students completed an interactive, online course on cattle behavior, cattle handling and workplace safety. Immediately before the online course, Group 1 (*N* = 57) was provided a choice between summary formats. Group 2 (*N* = 86) was not provided a choice. A pre-test survey was used to collect demographic data and information regarding student interest in the covered topics. Learning outcomes were measured using a 15-item multiple-choice test immediately after course completion. Self-reported learner autonomy and learning experience were documented using Likert scales. Participants additionally evaluated the online course in terms of user friendliness, face and content. Results showed that self-reported learner autonomy was positively correlated with learning experience. However, the provision of choice had no significant effect on self-reported learner autonomy or learning outcomes. Potential reasons are discussed.

4.2. Keywords

veterinary education, motivation, provision of choice, blended learning

4.3. Introduction

Blended learning is defined as combining face-to-face instruction with online activities (Graham, 2006) and is considered effective in increasing learning outcomes when compared to traditional instructor-led teaching or purely online education (Means, Toyama, Murphy, & Bakia, 2013; Means, Toyama, Murphy, Bakia, & Jones, 2009). Besides cost effectiveness, advantages include the possibility to improve pedagogy, increase access and flexibility and promote self-directed learning approaches(Graham, 2006; M. Carman, 2005). Learning outcomes in online learning environments are known to be affected by an array of factors such as gender, previous online learning experience, as well as the quality and instructional design of learning content (Lim & Morris, 2009). More importantly, however, it has been shown that learner motivation is a vital component of engagement, effort and performance (Lim & Kim, 2003; Lim & Morris, 2009). Research in the domain of learner motivation has repeatedly demonstrated the importance of learner autonomy in educational settings (Ryan & Deci, 2000). Increased learner autonomy is said to increase intrinsic motivation, which has positive effects on learning experience and increases learning outcomes (Kusurkar, Croiset, et al., 2011; Núñez & León, 2015; Reeve et al., 2003; Schneider et al., 2018). One method of increasing learner autonomy, particularly in online learning environments, is the provision of choice (Assor, Kaplan, & Roth, 2002; Kusurkar, Croiset, et al., 2011; Niemiec & Ryan, 2009; Patall, Cooper, & Robinson, 2008; Patall, Cooper, & Wynn, 2010; Schneider et al., 2018).

In this study, a novel online teaching platform on cattle behaviour, cattle handling and workplace safety was introduced to third-year veterinary students at the beginning of their clinical training. The interactive online teaching materials could be accessed by each student from a personal laptop or smartphone. The aim of this study was to explore whether provision of choice before the online course could influence self-reported learner autonomy, learning experience and learning outcomes. Specifically, we set out to test the following hypotheses:

1. Provision of choice before an online course enhances self-reported learner autonomy throughout the learning experience.
2. Increased learner autonomy results in increased learning outcomes and a better learning experience.

The e-learning platform was additionally evaluated in terms of user friendliness and content.

4.4. Materials and Methods

4.4.1 Participants

A total of 143 students participated in this study (Table 1). All participants were undergraduate veterinary students in their 3rd year of education at the Faculty of Veterinary Medicine, Freie University of Berlin. The study was conducted in the Clinic for Animal Reproduction. All data was handled anonymously. The study protocol was approved by the Ethics Commission, Charité University Clinic, Berlin (EA2/162/18). Informed consent was obtained from all participants.

4.4.2. Pre-test survey

A pre-test survey was developed using Questback EFS Survey software (Questback GmbH, Cologne, Germany). It was used to collect demographic data (age, gender) and gather information concerning participants' previous experiences with cattle and other animals as well as their interest in being well prepared for a task and working with cattle in the university environment or in practice after graduation. The pre-test survey consisted of three multiple-choice questions and nine 10-point Likert scales ranging from 'strongly disagree' to 'strongly agree'.

4.4.3. E-learning course

The online course was developed using a cloud-based authoring and hosting software (2018 Gomo Learning, Brighton, United Kingdom). Learning content consisted of an interactive, online course entitled "Introduction to cattle behaviour" with the primary focus on workplace safety in cattle handling. The course was accessible from any mobile or stationary device with an internet connection and was designed to take approximately ten minutes to complete. The amount of time spent by each student working on the online course was documented as "time on task" (seconds). Course materials were categorised by topic under the titles 'Infos & Learning Objectives', 'Herd Behaviour', and 'Fight or flight?' and generated specifically for this study, in accordance with current standards in literature (Fukasawa, Kawahata, Higashiyama, & Komatsu, 2017; Grandin & Shivley, 2015; Hemsworth, 2007; Kammel, Burgi, & Lewis, 2019; Kosako, Fukasawa, Kohari, Oikawa, & Tsukada, 2008; Lima, Negrao, de Paz, & Grandin, 2018; Sorge, Cherry, & Bender, 2014; Uetake, Morita, Hoshiba, & Tanaka, 2002). A summary of the key take-home messages was provided at the end of the course.

4.4.4. Learning outcome test

Learning outcomes were documented as the percentage of correctly answered questions in a 15-item test. The test was developed using a cloud based authoring and hosting software (2018 Gomo Learning, Brighton, United Kingdom) and consisted of nine retention questions (i.e. requiring learners to repeat information obtained in the course) and six application questions (i.e. requiring learners to apply concepts and theories obtained in the course). Question formats varied between single-choice questions with three distractors (n = 10), multiple-choice questions with 2 – 4 distractors (n = 2), true-or-false questions (n = 2) and matching questions (n = 1). The test was designed to take approximately 12 minutes to complete.

4.4.5. Post-test survey

A post-test survey was developed using Questback EFS Survey software (Questback GmbH, Cologne, Germany). Two multiple-choice questions were used to gather information concerning user friendliness. Subsequently, 10 statements with corresponding 10-point Likert scales were used to gather information concerning participants' learning experience. This section included statements such as "The online course increased my understanding of cattle behaviour" and "After having completed the online course, I now feel safer in approaching and handling cattle." Learners used a second set of four statements with corresponding 10-point Likert scales to self-report learner autonomy within the learning environment (Houlfort, Koestner, Joussemet, Nantel-Vivier, & Lekes, 2002). Finally, users were prompted to estimate how much time they spent on the course (time estimate) and how well they would expect to perform on a multiple-choice test on the course contents (judgement of learning; **JOL**). Mean learning experience and mean learner autonomy were calculated from agreement ratings.

4.4.6. Study design

The introductory seminar to the class 'Clinical Examinations in Reproduction' took place in the lecture hall of the Clinic for Animal Reproduction, Freie University Berlin. Students (n = 143) were assigned to one of two groups, according to the first letter of their surname. Group 1 (n = 57) completed the introductory seminar on the 12th of December 2018. After a short introduction, all students were asked to complete the pre-test survey. Students were then asked to complete the online course on their own and at their own pace. At the beginning of the course, participants were required to choose one of two formats (i.e., video or table format) in which to receive the summary at the end of the course. The post-test survey was integrated into the final page of the online course. After completion of the online course and post-test survey, the learning outcome test was unlocked for student use. Students were prompted to complete the test immediately after course completion and without guidance from fellow students.

Group 2 (n = 86) completed the introductory seminar on the 14th of December 2018. After an identical introduction, students were asked to complete the pre-test survey, followed by the online course. However, in this instance, students were not given the choice between summary formats, with the system displaying the summary in video format automatically. Students proceeded to complete the same post-test survey and learning outcome test.

An instructor was present in both groups to answer any questions concerning technical manipulation. Access to the online course was granted for one week after the introductory seminar and the test could be repeated unlimitedly. Only results from the first test completion were considered in statistical analysis.

4.4.7. Statistical analyses

Data from the surveys and gomo Authoring software were transferred into Microsoft Excel (Office 2016, Microsoft Deutschland Ltd., Munich, Germany) spreadsheets. Statistical analyses were performed using SPSS for Windows (Version 25.0, SPSS Inc. IBM, Ehningen, Germany). Pearson correlations were computed to assess the relationships between time on task and learning outcome, self-reported learner autonomy and learning experience and self-reported learner autonomy and learning outcome.

To evaluate the effect of choice on learning outcome and self-reported learner autonomy and, two general linear models were constructed using SPSS. All affecting parameters were analyzed separately in a univariate model with the parameter in question set as a fixed factor (categorical parameters) or a covariate (continuous parameters). Only parameters resulting in univariate models with $p \leq 0.20$ were included in the final linear model. Regardless of the significance level, the intervention was forced to remain in the model.

In analysis 1, the outcome variable was learning outcome (percentage of correctly answered questions in multiple-choice test). The model included the explanatory variables time on task (seconds), provision of choice (yes or no) and own livestock (number of species). The model additionally tested for interaction effects between provision of choice and time on task. In analysis 2, the outcome variable was self-reported learner autonomy and included the explanatory variables provision of choice (yes or no), mean learning experience (0 – 10), age group (over or under 25) and own livestock (number of species). Interaction effects between provision of choice and mean learning experience were included in the model. Odds ratios and 95% CI were reported for all analyses and significance was set at $p < 0.05$.

4.5. Results

A total of 143 veterinary medicine students participated in this study. Demographic data is depicted in Table 1. While 86% of participants grew up with pets, only 46.1% of students reported previous experience with large animals. Only 8 participants (5.6%) reported having a background in cattle husbandry. When asked in which field their previous medical experience was most concentrated, only 4.7% of participants chose bovine medicine. 87.5% of participants reported having most medical experience in small animal medicine or equine medicine. Although the large majority of participants did not plan a career involving cattle, 57.8% of participants reported that they enjoyed working with cattle (≥ 7 on Likert scale). Interest in bovine medicine and cattle behavior was high overall with 45.5% and 49.2% of participants strongly agreeing with the respective statements (≥ 7 on Likert scale). However, before the online course, only 22.7% of participants reported that they felt safe handling cattle (≥ 7 on Likert scale). Responses to Likert-scale statements are depicted in Figure 1.

The online course was completed by 135 participants with time on task ranging from 70 to 1434 seconds (Mean = 692.7, *SD* = 282.5). Of these, 121 participants completed the multiple-choice test. Learning outcomes ranged from 33.3% to 95.2% (Mean = 74.2%, *SD* = 10.9). Only results from participants who completed both the online course and multiple-choice test were included in statistical analysis. After completion of the course and multiple-choice test, 51 participants completed the post-test survey at the end of the seminar. Results of the Pearson correlations indicated that there was no association between time on task and learning outcome ($r = 0.043$, $p = 0.639$) and no association between self-reported learner autonomy and learning outcomes ($r = -0.168$, $p = 0.238$). Self-reported learner autonomy and mean learning experience showed a weak positive correlation ($r = 0.505$, $p < 0.01$).

Analysis 1 revealed that provision of choice had no significant effect on learning outcomes ($p = 0.901$). There was no interaction effect between provision of choice and time on task. Analysis 2 revealed that self-reported learner autonomy was significantly affected by mean learner experience ($p = 0.006$) but not by provision of choice ($p = 0.439$).

Overall, the online course was rated positively by students, with 40.7% of participants giving it the highest available grade ($N = 59$). Nearly half of the participants (44.2%) felt that the online course had increased their understanding of the included topics and 22.1% of students strongly agreed (≥ 7 on Likert scale) with the statement ‘I now feel safer in approaching and handling cattle than before the course’. Judgements of learning ranged from 13% to 100% with 65.4 % of students expecting to answer at least 80% of questions correctly.

Table 2. *Demographic data*

Parameter	**Classification**		***n***	**%**	**Cumulative Percent**
Age Group	19 – 25		90	72.0	72.0
	25 – 41		35	28.0	100.0
		Total	125	100.0	
Gender	male		11	8.7	8.7
	female		115	91.3	100.0
		Total	126	100.0	
Population of home town	<50 000		62	48.4	48.4
	50 000 – 100 000		12	9.4	57.8
	100 000 – 500000		11	8.6	66.4
	>500 000		43	33.6	100.0
		Total	128	100.0	

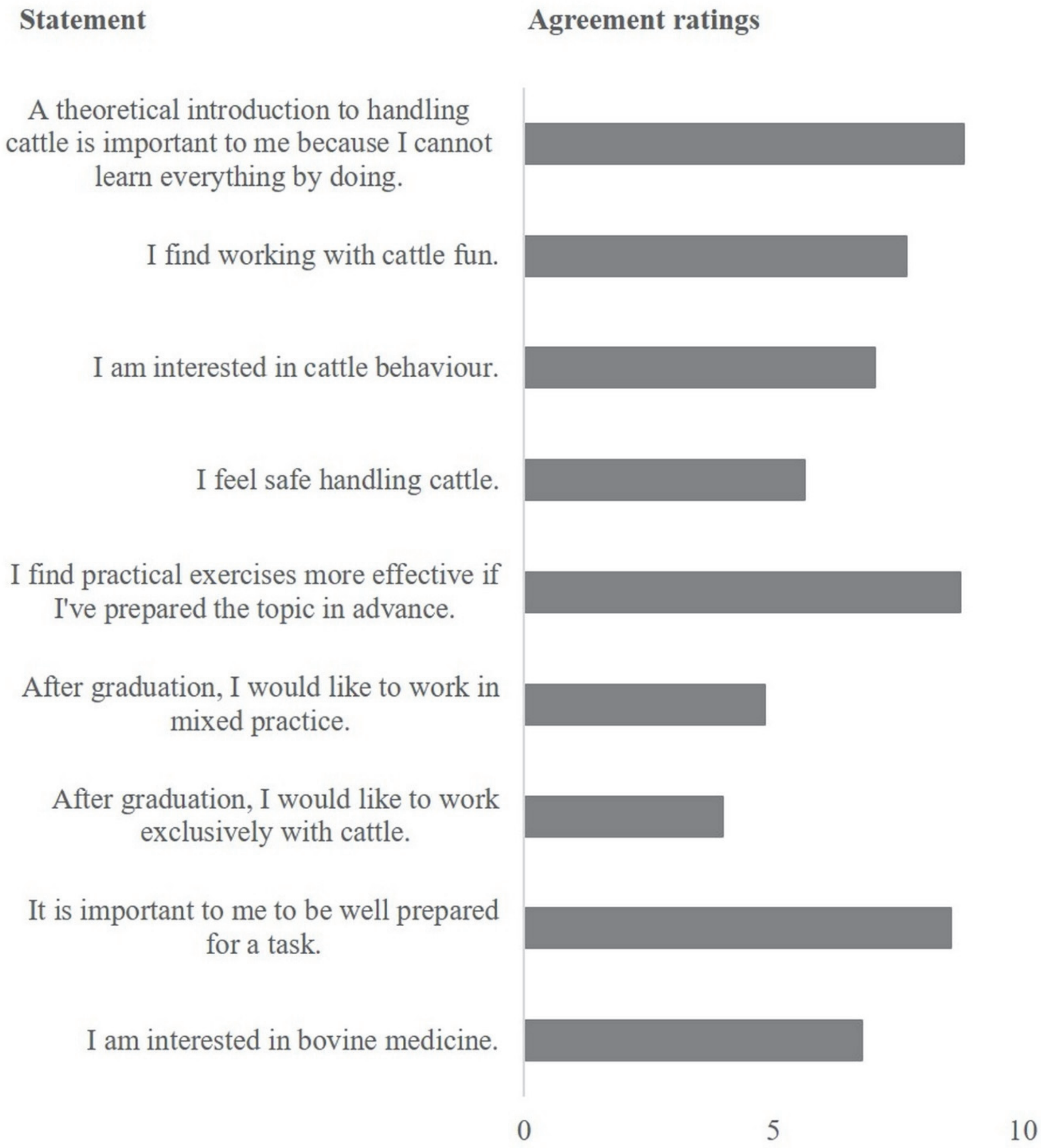

Figure 3. Agreement ratings from the pre-test survey (0 = I completely disagree, 10 = I completely agree) (*N* = 128)

4.6. Discussion

The present study explored the effects of provision of choice on learner autonomy, learning outcomes and learning experience. Research shows that learners, who are intrinsically motivated, learn more effectively (Lim & Kim, 2003; Lim & Morris, 2009). According to self-determination theory, intrinsic motivation (i.e. a person engaging with a task for the pure and unsolicited joy of doing so) is facilitated when three innate human needs are satisfied: the need for competence, the need for relatedness and the need for autonomy (Ryan & Deci, 2000). Learner autonomy is defined as the multidimensional capacity a learner has to take charge of their own learning (Zhong, 2018) and consists of the three core components internal locus, volition and choice (Reeve et al., 2003). Providing learners with choices should therefore lead to an increased experience of autonomy in the learner (Assor et al., 2002; Kusurkar, Croiset, et al., 2011; Niemiec & Ryan, 2009; Patall et al., 2010; Schneider et al., 2018) and has been associated with increased motivation, effort, task performance and perceived competence (Assor et al., 2002; Niemiec & Ryan, 2009; Patall et al., 2008) in clinical and non-clinical teaching scenarios (Orsini, Evans, & Jerez, 2015). However, evidence on the effects of choice has not been uniformly positive (Flowerday & Shell, 2015; Patall et al., 2010).

In our study, we were unable to confirm the hypothesis that self-reported learner autonomy is higher in learners who are provided a choice before the online course. This is in line with findings from several studies, which reported that provision of choice is beneficial only on some levels (Flowerday & Schraw, 2003; Katz & Assor, 2006) or not at all (d'Ailly, 2004; Reeve et al., 2003). The act of providing choices can, in itself, be influenced by several factors (Katz & Assor, 2006). For example, option choices (i.e. simply choosing between two options) can influence perceived choice but do not facilitate intrinsic motivation. Action choices (i.e. choices that influence the problem-solving approach, the learner's conduct and how their time is allocated) influence both volition and internal locus and thus facilitate intrinsic motivation (Reeve et al., 2003) and are more effective in increasing student engagement (Stefanou, Perencevich, DiCintio, & Turner, 2004). The choice provided in our study can be classified as an option choice, which may explain the fact that no significant effect on self-reported learner autonomy could be detected.

Further factors affecting the effectiveness of choices in learning environments include number of choices and number of options per choice. If a learner is presented with few options or choices, the perception of having made choices may not be sufficiently distinct. An excessive number of choices, on the other hand, may lead to learners feeling overwhelmed and, as a result, demotivated (Patall et al., 2008). Variations in skill level, experience and preference between individual learners present an added difficulty in providing the optimum number of choices and options per choice in learning environments (Evans & Boucher, 2015).

It is conceivable, however, that provision of only one choice with only two options was not sufficient to influence self-reported learner autonomy in our study.

Research also suggests that learner autonomy as a whole is influenced to different degrees by its individual components. It appears that an increase in internal locus and volition is more effective in increasing intrinsic motivation and autonomy than an increase in choice (Reeve et al., 2003). As a result, the act of choosing is not necessarily determinant when separated from other aspects of autonomy support and self-realization such as interest, values, volition and goals (Flowerday, 2004). The simple choice provided in our study design did not permit expression of individual interest, values or goals and may thus have inhibited the motivation-enhancing effect. Although Patall et al. (2010) described choice as a critical element in student perception of autonomy-support overall, they agree that different autonomy-supportive practices support different motivational and learning-related outcomes (Patall et al., 2010). Hence, additional autonomy supportive practices may have been necessary to produce significant effects in our study.

Besides increased intrinsic motivation (Kusurkar, Ten Cate, et al., 2011; White, 2007; Woltering, Herrler, Spitzer, & Spreckelsen, 2009), autonomy supportive teaching approaches are said to enhance “deep” learning (Cake, 2006) and positively affect academic achievement (Black & Deci, 2000; Núñez & León, 2015) and student attitudes toward learning (Stefanou et al., 2004). In our study, self-reported learner autonomy was positively correlated with learning experience but provision of choice had no significant effect on learning outcomes ($P = 0.439$). This is in line with findings from a series of studies by Flowerday et al., in which provision of choice as an autonomy supportive teaching approach was associated with positive effects on affective engagement and student attitudes (Flowerday & Schraw, 2003; Flowerday, Schraw, & Stevens, 2004; Flowerday & Shell, 2015). However, this did not seem to translate into increased cognitive engagement and did not result in higher performance.

The pre-test survey in our study showed that student interest in learning about cattle behavior and bovine medicine was high overall. Similarly, being well prepared for a task was important to participants. There is general consensus that interest contributes to motivation (Lim & Kim, 2003) and that students, who are more interested in a given topic, show increased active engagement and attentional focus (Schraw & Lehman, 2001). The levels of intrinsic motivation among participants in this study are therefore likely to have been relatively high overall. This is in line with findings from previous research, which suggests that veterinary students are known to be particularly intrinsically motivated (T. Parkinson & M St George, 2003). This homogeneity among participants may have contributed to the lack of detectable effects of provision of choice on learner autonomy and learning outcomes. Although there is little evidence to support this, researchers believe that choice as an autonomy supportive method may particularly benefit low-achieving or low-motivation students (Flowerday &

Schraw, 2000; Patall et al., 2010). Assuming that the participants in this study were predominantly highly motivated, provision of choice may not have been an adequate method to enhance motivation.

Besides the fact that the online course and multiple-choice test were relatively short, the limited number of choices presents a clear limitation in this study. The study design did not cater to action choices, or choices related to student interests, goals and values; an aspect that should be considered and explored further in future research. Due to the fact that this study was conducted in an everyday educational setting, we could not fully control inter-student interactions and external influences, which can be regarded as a further limitation. However, choices are expected to be particularly beneficial and have larger effects in settings, in which it makes sense to have choices and seems realistic (Patall et al., 2008) so the real-life teaching scenario in the lecture hall, as opposed to a testing center, certainly has its advantages. Control groups that are explicitly denied a choice or are aware of alternatives that they are not allowed to choose may experience a notable decrement in motivation when compared to groups, who are provided a choice (Patall et al., 2008). The fact that the control group in our study was unaware of the choices the other group was presented with, can therefore be seen as a strength of the study but may, at least in part, explain the lack of significant differences between groups. The online course was rated exceptionally positively by participants, which suggests that similar e-learning materials may prove to be a useful tool in engaging learners and stimulating interest in new topics.

4.7. Conclusion

This study was unable to confirm the hypotheses that provision of choice before an online course on cattle behavior and work place safety leads to increased self-reported learner autonomy and increased learning outcomes. While previous research shows that the optimum number, type and timing of choices may well result in increased perception of learner autonomy, results from this study suggest that autonomy supportive teaching approaches should not be limited to the provision of choice alone. Further research is warranted, in particular, to explore the role of choices related to learner interests, volition, values and goals. In online teaching scenarios in the veterinary field, autonomy supportive teaching methods related to enhancing internal locus and volition should also be explored further.

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5. DISCUSSION

The benefits of simulation-based education in veterinary clinical skills training are well documented (Dilly et al., 2017; Hart et al., 2005; Scalese & Issenberg, 2005). The steady surge in popularity associated with this teaching method in veterinary education institutions around the world is therefore unsurprising. However, results from dozens of studies on the subject clearly demonstrate that simply having teaching simulators at one's disposal, however well designed they may be, does not necessarily guarantee effective clinical skills training. Optimal implementation of simulation-based veterinary clinical skills training requires careful consideration of an array of factors that influence learning processes and, in turn, learning achievements in students on the receiving end (Issenberg & Scalese, 2007; McGaghie et al., 2010). The objective of this thesis was to explore some of these factors under day-to-day educational conditions.

It has been shown that practice is indispensable in the development of motor skills (Ericsson, 2008) and that this can be extended to clinical skills in the medical professions (Dale et al., 2008; Duvivier et al., 2011; McGaghie et al., 2006; Moulaert, Verwijnen, Rikers, & Scherpbier, 2004). Allocating time for learners to practice at available teaching simulators can therefore be regarded as one of the very first steps in implementing simulation-based clinical skills training in veterinary curricula (Baillie et al., 2015). Results from our first study confirmed this notion and demonstrated that learners, who were given the opportunity to practice at a given learning station, performed significantly better on the subsequent assessment than learners who were not. With the importance of practice thus becoming clear, the question arises as to how these practice sessions should be designed to maximize learning achievements.

Feedback from an instructor constitutes one of the top influential factors in simulation-based education (Issenberg & Scalese, 2007; McGaghie et al., 2010; Scalese & Issenberg, 2005; Wulf et al., 2010) and yet, the advantages of self-directed learning without any instructor involvement have been highlighted in a range of studies. Learners benefit from being able to tailor a learning experience to their needs and preferences (Chiviacowsky & Wulf, 2002; Post et al., 2011) and feel more relaxed and confident to make mistakes without an authoritative figure in the room (Baillie et al., 2009; Bates et al., 2016). Our first study investigated the effect of instructor supervision during practice sessions on learning achievements and did not reveal a significant superiority of instructor-led practice sessions to self-directed practice sessions. This is in line with findings from the domain of medical education research where no significant differences in knowledge and technical performance were found between students who took part in practice sessions with and without an instructor present (Brydges et al., 2012; LeFlore et al., 2007). It appears plausible that the ratio of instructors to students has an effect on the intensity and quality of the guidance provided. There is general agreement that teaching of psychomotor skills is most effective in small group settings (Snider et al., 2012) with an instructor: student ratio of 1: 4 appearing to produce optimal results (Dubrowski & MacRae, 2006). We can argue therefore that in our study, the instructor: student ratio (1: 8) may have been insufficient for effective supervision.

Interestingly, in our study, we were able to show that supervision had a negative effect on OSCE scores at specific learning stations. This underlines the potential benefits of self-directed learning formats in veterinary clinical skills training. In an unsupervised environment, learners are forced to overcome difficulties and solve problems on their own rather than relying on an instructor for help. This may encourage deeper engagement with the learning content, arguably leading to a more profound learning experience and better learning achievements. Post-practice questionnaires revealed that students who were supervised during practice sessions were more likely to strongly agree with the statement ‘An instructor should always be present during practice sessions’ than students who were not supervised. This implies that unsupervised students developed a stronger feeling of independence and confidence to complete tasks on their own.

Essentially, both the positive effects of adequately executed feedback from an instructor and the positive effects of students taking charge of their own learning have been researched extensively and are accepted as genuine in the field of simulation-based education. This prompted our interest in investigating the effectiveness of a practice model that combines the two approaches and amplifies their respective positive effects. Hence, in our second study, a third practice model where students received an introduction to the exercise, then engaged in self-directed practice and were “debriefed” by an instructor at the end of the practice session was compared to the initial models (instructor-led and self-directed practice). Since the importance of reflecting on the experiences with which one is faced during a simulation scenario is well known (Husebø & O'Regan, 2015), “debriefing” learners in order to facilitate the reflective process has gained general acceptance in simulation-based education (Dufrene & Young, 2014; Fanning & Gaba, 2007; Levett-Jones & Lapkin, 2012).

Results from our study demonstrated an interesting heterogeneity between the effects of different practice models on learning achievements at different learning stations. While instructor involvement had no effect on student performance at learning station 1 (assembling the artificial vagina), the instructor-led approach produced the best results at learning station 3 (exteriorization of the uterus). At this station, more so than at the others, student ratings of overall learning effect decreased significantly with decreasing degrees of instructor involvement. At learning station 2 (Bühner stitch), self-directed practice with post-event debriefing resulted in slightly higher learning achievements than instructor-led practice and significantly higher learning achievements than self-directed practice without debriefing. This reflects the assumptions made in our hypothesis and is in line with findings from a range of studies, suggesting that some form of feedback or debriefing is beneficial to learners and results in better learning achievements (Fanning & Gaba, 2007; Issenberg et al., 2005; McGaghie et al., 2010). These findings indicate that learner demand for instructor involvement cannot be generalized across learning stations and that the optimal practice model at one learning station may differ from the optimal approach at the next. Further research is warranted to identify characteristics of individual learning stations, which make them more or less suitable for self-directed practice.

Overall, student evaluations of the learning stations and practice experiences in the first and second study were very positive. Learner motivation plays a key role in learning processes (Parkinson & St George, 2003) with research indicating that intrinsically motivated learners are more likely to exhibit “deep” learning, reflection and increased performance (Brissette & Howes, 2010; Kusurkar et al., 2012; Kusurkar, Ten Cate, et al., 2011). According to self-determination theory, intrinsic motivation (i.e. a person engaging with a task for the pure and unsolicited joy of doing so) is facilitated when three innate human needs are satisfied: the need for competence, the need for relatedness and the need for autonomy (Ryan & Deci, 2000). Hence, the role of autonomy support in educational settings has been researched extensively and is associated with increased academic achievement (Black & Deci, 2000; Núñez & León, 2015) and positive student attitudes toward learning (Stefanou et al., 2004). Providing learners with choices is one aspect of autonomy supportive teaching and has been shown to positively affect motivation, effort, task performance and perceived competence (Assor et al., 2002; Niemiec & Ryan, 2009; Patall et al., 2008) in clinical and non-clinical teaching scenarios (Orsini et al., 2015). In our third study, we were unable to confirm the hypothesis that, in an online environment, self-reported learner autonomy is higher in learners who are provided a choice.

Researchers believe that the type of choice (action choice or option choice), the number of choices and the number of options per choice all play a role in the effect provision of choice has on learners (Katz & Assor, 2006). Action choices influence the learner’s conduct and how their time is allocated and are likely to be more effective in increasing student engagement than option choices (Stefanou et al., 2004). Very few options or choices may not be sufficient to alter the learner’s perception of choice (Patall et al., 2008). In our study, students were given what can be considered an option choice with only two options, which may explain the fact that no significant effects were detected. Student interest, volition, values and goals represent other important components of learner autonomy (Flowerday et al., 2004; Reeve et al., 2003). The simple act of choosing, when seperated from these components, as was the case in our study, is not necessarily effective in increasing intrinsic motivation (Flowerday et al., 2004).

In the first study conducted as part of this thesis, we were able to see a relationship between students' motivation to practice at specific learning stations and their self-perceived clinical skill improvement at that learning station. We also noticed that the two learning stations with the highest motivation ratings were those at which self-directed practice was the most effective. Similarly, in the second study, the students' self-elected "favorite learning station" was the one at which learning achievements were highest overall. Certain levels of intrinsic motivation can thus be considered a prerequisite in effective clinical skills training, particularly when opting for self-directed learning approaches. Therefore, further insight on how clinical educators can facilitate intrinsic motivation could help pave the way to maximum learning achievements in simulation-based veterinary medical education.

6. SUMMARY

The use of simulation-based clinical skills training has become increasingly popular in veterinary education in recent years, its benefits spanning from increased learning achievements to cost effectiveness and animal welfare aspects. Factors involved in motor skill learning and clinical skill development have received substantial research attention with practice and feedback consistently finding their way to the top of the list. Apace with these findings is the growing number of investigations into the benefits associated with self-directed learning (**SDL**). The importance of reflection, motivation, autonomy and self-efficacy in simulation scenarios, particularly when opting for self-directed learning, is also becoming increasingly clear. Hence, the overall objective of this study was to explore the roles of practice, supervision, learner motivation and debriefing in clinical skills training for veterinary medicine students.

In the first study, we compared the effects of supervised and unsupervised deliberate practice on clinical skill development in veterinary medicine students. One hundred and fifty veterinary students took part in instructor-led practice (supervised) or self-directed practice (unsupervised) at a selection of four learning stations in a veterinary skills laboratory. Each learning station consisted of a teaching simulator, materials required to complete the task and a standard operating procedure (**SOP**) detailing how to execute the task. Students used Likert-type scales to self-evaluate their clinical skills before and after practice sessions as well as evaluating their motivation to practice a given task. An objective structured clinical examination (**OSCE**) was used to compare participants' clinical skill performance between learning stations. We were able to show that practice had a significant positive effect on OSCE scores at 3 out of 6 available learning stations. Motivation ratings varied between learning stations and were positively correlated with increase in self-perceived clinical skill. At an instructor to student ratio of approximately 1:8, supervision had no effect on OSCE scores at 4 out of 6 learning stations. At the remaining two learning stations, self-directed practice resulted in better learning outcomes than instructor-led practice.

In the second study, we set out to examine the effect of structured post-event debriefing sessions in simulation-based veterinary clinical skills training. Nineteen Namibian veterinary students took part in instructor-led practice, self-directed practice with structured post-event debriefing and self-directed practice without debriefing (control) at three different learning stations in a veterinary clinical skills laboratory. Learning achievements were subsequently assessed using an OSCE. We were able to show that the choice of practice model had no significant effect on learning achievements overall. However, at individual learning stations, different practice models showed significant differences regarding effect on learning

achievements. Students generally preferred practice sessions with some form of instructor involvement but the importance of instructor guidance was rated differently at each individual learning station.

Applying self-direction to a learning situation requires learners to exhibit some degree of autonomy, motivation, confidence and self-efficacy. The roles of and relationships between learner motivation and learner autonomy represent key aspects in learning theory. In a third, tangential study, we explored the role of choice in increasing learner autonomy and, in turn, increasing engagement and performance. One hundred and forty-three veterinary students completed an interactive, online course on cattle behavior, cattle handling and workplace safety. Immediately before the online course, Group 1 ($N = 57$) was provided a choice between summary formats. Group 2 ($N = 86$) was not provided a choice. Learning outcomes were measured using a 15-item multiple-choice test immediately after course completion. Self-reported learner autonomy and learning experience were documented using Likert-type scales. Results showed that self-reported learner autonomy was positively correlated with learning experience. However, the provision of choice had no significant effect on self-reported learner autonomy or learning achievements.

7. ZUSAMMENFASSUNG

UNTERSUCHUNGEN ZUR BEDEUTUNG VON ÜBUNG, SUPERVISION UND NACHBESPRECHUNG IM SIMULATIONS-BASIERTEN TRAINING VON KLINISCHEN FERTIGKEITEN BEI STUDIERENDEN DER VETERINÄRMEDIZIN

Die veterinärmedizinische Ausbildung hat im Laufe der letzten Jahrzehnte einen markanten Anstieg in der Anwendung von simulationsbasierten Lehrmethoden erlebt. Kosteneffizienz, Tierschutzaspekte und klare Lernerfolgsvorteile im Vergleich zu anderen Lehrmethoden treiben die Beliebtheit von verschiedensten Modellen und Lernsimulatoren stetig in die Höhe. Das Erlernen motorischer Fähigkeiten und die Entwicklung klinischer Fertigkeiten wird von einer Vielzahl an Faktoren beeinflusst. Sowohl die intensive Übung am Modell als auch das qualifizierte Feedback einer Lehrkraft werden zu den einflussreichsten Faktoren gezählt. Zugleich weisen Ergebnisse von diversen Studien auf die Vorteile des selbstgesteuerten Lernens (*self-directed learning*, **SDL**) hin. Auch die Bedeutung der Reflexion, Motivation, Autonomie und Selbstwirksamkeit wird im Zusammenhang mit Simulationsszenarien, insbesondere bei selbstgesteuerten Lernansätzen, zunehmend deutlich. Demzufolge war das Ziel dieser Arbeit, wesentliche Einflussfaktoren auf die Entwicklung klinischer Fertigkeiten von veterinärmedizinischen Studierenden zu erforschen. Die Bedeutung von und das Verhältnis zwischen Übung, Supervision, Motivation und strukturierter Nachbesprechung („debriefing“) als Methode der Reflexionsförderung standen hierbei ganz besonders im Fokus.

Im Rahmen der ersten Studie nahmen 150 Studierende der Veterinärmedizin an selbstgesteuerten oder durch eine Lehrkraft gesteuerten Übungseinheiten in einem veterinärmedizinischen Nutztier Skills Lab teil. In jeder Übungseinheit standen 4 Lernstationen, bestehend aus Simulator, Standardarbeitsanweisung (*standard operating procedure*, **SOP**) und notwendigen Zusatzmaterialien, bereit. An jeder Lernstation wurde die selbsteingeschätzte klinische Fertigkeit der Studierenden vor und nach der Übung und die Motivation der Studierenden, an der Station zu üben, anhand von Likert-Skalen erfasst. Zur Bewertung der klinischen Fertigkeiten nach der Übungseinheit wurde das Prüfungsformat *Objective Structured Clinical Examination* (**OSCE**) gewählt. An 3 von 6 aufgenommenen Lernstationen schnitten Studierende signifikant besser ab, wenn sie vorher die Möglichkeit hatten, an der Lernstation zu üben. Es ergab sich neben einer starken Varianz der Motivationseinschätzungen zwischen einzelnen Lernstationen auch eine signifikant positive Korrelation zwischen Motivationseinschätzungen und selbsteingeschätztem Zuwachs an Fertigkeit. Bei dem in dieser Studie angewandten Verhältnis von einer Lehrkraft zu ca. 8 Studierenden, konnte an 4 Lernstationen kein signifikanter Unterschied zwischen OSCE

Ergebnissen nach selbstgesteuerter und Lehrkraft-gesteuerter Übung festgestellt werden. An den verbleibenden 2 Lernstationen schnitten Studierende nach selbstgesteuerter Übung besser ab als nach der Übung in Anwesenheit einer Lehrkraft.

Im Rahmen der zweiten Studie wurde der Einfluss von einer strukturierten Nachbesprechung direkt im Anschluss an eine Übungseinheit (*post-event debriefing*) eruiert. Neunzehn namibianische Studierende der Veterinärmedizin nahmen in Kleingruppen an einer dreiteiligen Übungseinheit teil: an der ersten Lernstation wurde in Anwesenheit einer Lehrkraft geübt, an der zweiten Lernstation fand selbstgesteuertes Lernen mit anschließender strukturierter Nachbesprechung statt, die dritte Lernstation galt mit selbstgesteuerter Übung ohne Nachbesprechung als Kontrollgruppe. Der Lernerfolg wurde mithilfe einer OSCE Prüfung überprüft. Insgesamt konnte kein signifikanter Effekt des Übungsformates auf den Lernerfolg festgestellt werden. Die individuelle Betrachtung der Lernstationen ergab allerdings, dass verschiedene Übungsformate an einzelnen Stationen signifikante Unterschiede der OSCE Ergebnisse nach sich zogen. Obwohl Studierende Übungsformate mit einem gewissen Grad an Lehrkraftbeteiligung generell bevorzugen zu scheinen, ist auch dies abhängig von der Lernstation selbst.

Im Zusammenhang mit Selbststeuerung in Lernsituationen wird die Bedeutung von Motivation und Autonomie und deren Wechselwirkung regelmäßig diskutiert. Wahlmöglichkeiten haben das Potential, das Autonomiegefühl und dadurch die Motivation von Lernenden zu beeinflussen und zu besseren Lernerfolgen zu führen. Im Rahmen der dritten Studie nahmen 143 Studierende der Veterinärmedizin an einem interaktiven Onlinekurs zum Thema „Umgang mit dem Rind“ teil, wobei nur der Hälfte der Teilnehmenden eine Wahl zwischen verschiedenen Zusammenfassungsformaten geboten wurde. Studierende machten Angaben zu ihrem Autonomiegefühl und dem Lernerlebnis und bearbeiteten einen Multiple-Choice-Test zur Erfassung des Lernerfolges. Es konnte eine positive Korrelation zwischen dem selbsteingeschätzten Autonomiegefühl und der Einschätzung des Lernerlebnisses festgestellt werden. Das Anbieten einer Wahlmöglichkeit hatte jedoch keinen signifikanten Einfluss auf das Autonomiegefühl oder die Testergebnisse der Studierenden.

8. REFERENCES FOR INTRODUCTION AND DISCUSSION

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9. PUBLICATIONS

Research articles:

Schlesinger, S., Heuwieser, W., & Schüller, L.-K. (2020):
Comparison of Self-Directed and Instructor-Led Practice Sessions for Teaching Clinical Skills in Food Animal Reproductive Medicine. *J Vet Med Educ,* doi:10.3138/jvme.2019-0040

Schlesinger, S., Heuwieser, W., & Fischer-Tenhagen, C. (2020):
Examining the Role Of Structured Debriefing in Simulator-Based Clinical Skills Training for Namibian Veterinary Students: a Pilot Study. *J Vet Med Educ (in print)*

Oral presentations:

Schlesinger, S. (2019):
Comparison of Self-Directed and Instructor-Led Practice Sessions for Teaching Clinical Skills in Veterinary Medicine. In: 12th DRS PhD-Symposium "Biomedical Sciences" 27.09.2019, Freie Universität Berlin

Poster presentations:

Schlesinger, S. (2018):
Validating teaching simulators and teaching formats in manual skill training for veterinary medicine students. In: VetEd International symposium of the Veterinary Schools Council, 5th/6th.07.2018, Utrecht University

Schlesinger,S. (2019):
Comparing teaching approaches in simulator-based manual skill training for veterinary medicine students. In: 7. Leipziger Doktorandenforum, 14.02.2019, Veterinärmedizinische Fakultät, Universität Leipzig

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11. DECLARATION OF INDEPENDENCE

Hiermit erkläre ich, dass ich, Samira Schlesinger, alle Studien selbständig durchgeführt und die vorliegende Arbeit selbständig angefertigt habe. Ich versichere, dass ich ausschließlich die angegebenen Quellen und Hilfen in Anspruch genommen habe.

Tabelle 1. Eigener Anteil[1] an den Forschungsprojekten der vorliegenden Dissertation

	Studie 1[a]	Studie 2[b]	Studie 3[c]
Studienplanung	+++	+++	+++
Datenerhebung	+++	+++	+++
Datenanalyse	+++	+++	+++
Verfassen des Manuskripts	+++	+++	+++
Editieren des Manuskripts	++	++	++

[1]Legende: +++: >70%
++: 50-70%
+: <50%

[a] Comparison of self-directed and instructor-led practice sessions for teaching clinical skills in food animal reproductive medicine

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