Aus der Klinik für Fortpflanzung
des Fachbereichs Veterinärmedizin
der Freien Universität Berlin

Listening, reading, writing – which method leads to the best learning outcome?

Inaugural-Dissertation
zur Erlangung des Grades einer
Doktorin der Veterinärmedizin
an der Freien Universität Berlin

vorgelegt von
Janine Güldenpfennig
Tierärztin aus Berlin

Berlin 2023
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Abbreviations

CAT	Critically appraised topic
CSL	Clinical Skills Laboratory
EAEVE	European Association of Establishments for Veterinary Education
EBVM	Evidence-based veterinary medicine
FU Berlin	Free University Berlin (Freie Universität Berlin)
ICAP	Interactive-Constructive-Active-Passive
KELDAT	Competence center for e-learning, didactics, and education research in veterinary medicine (Kompetenzzentrum für E-Learning, Didaktik und Ausbildungsforschung der Tiermedizin)
LMS	Learning Management System
n	Sample size
p	P-value for null-hypothesis significance testing
PTT	Progress Test Veterinary Medicine (Progress Test Tiermedizin)
R	Programming language for statistical computing and graphics
SAS	Statistical Analysis System, analytics software
TAppV	Regulations for the License to Practice Veterinary Medicine (Verordnung zur Approbation von Tierärztinnen und Tierärzten)
TiHo	University of Veterinary Medicine Hannover Foundation (Stiftung Tierärztliche Hochschule Hannover)
WOAH	World Organisation for Animal Health

1 Introduction

The aim of veterinary education is to provide appropriate competences that enable the future veterinarian to practice the profession (BMG 2006, RCVS 2023). Veterinarians are the only physicians educated to protect the health of animals as well as the one of people (AVMA 2019). Besides, they play critical roles in environmental protection, research, food safety, and public health (AVMA 2019).

According to international associations, veterinary education includes fundamental scientific, interdisciplinary, and methodological knowledge, practical skills, ethical basics, and the professional attitude committed to the well-being of humans, animals, and the environment (BMG 2006, RCVS 2023). Attributes that contribute to being a successful veterinarian encompass a scientific mind and good communication skills, as well (AVMA 2019). Many factors need to be considered when designing veterinary education so that students learn all required veterinary graduate attributes (Carr et al. 2022). Methods that are used by teaching staff to achieve the above competences should motivate and engage students to ensure that they are encouraged to take an active role in the learning process (ENQA et al. 2015). The Regulations for the License to Practice Veterinary Medicine (Verordnung zur Approbation von Tierärztinnen und Tierärzten, TAppV) allows that the usually used forms of classroom education can partly be replaced by appropriate interactive learning programs (BMG 2006).

In general, veterinary education at universities and veterinary schools has been based on lectures to a high extent in the past (Shurtz et al. 2017, McFee et al. 2018). This teaching method is the prototype of frontal teaching and enables providing a lot of information to a large audience by one speaker (Kasch et al. 2015, Lim et al. 2019). Furthermore, it is a quick and inexpensive way to efficiently introduce complex educational material to the listeners (Nawabi et al. 2021, Miller et al. 2013). Nevertheless, it is criticized for being a one-way method of communication (Nawabi et al. 2021). It usually does not involve the audience and, therefore, leads to passive acquiring (Wolff et al. 2015, Saadeh et al. 2021).

These mentioned and other limitations of lectures are the reason why it has been questioned whether this teaching method really leads to sufficient learning outcomes (McFee et al. 2018, Kasch et al. 2015). With different teaching methods available and an increasing number of technical possibilities to design interactive learning scenarios, the issue arises how students learn most effectively (Lim et al. 2019, García-Iglesias et al. 2018). The most important question is: What is the best pedagogical approach for learning, and in what way will students turn into critical thinkers, problem-solvers, and lifelong learners (Poirier 2017, Chi et al. 2018)? Furthermore, is there any difference between veterinary students and their way of learning compared to students of other faculties?

Based on the question of the best applicable teaching method, the presented project on the learning outcome of teaching methods "reading papers", "listening to a presentation", and "writing a summary in group work" was carried out to contribute to answers. The hypothesis was that writing a summary in group work leads to a higher retention of knowledge compared to reading and listening to information.

2 Literature Review

2.1 Veterinary education

Usually, lectures are based on a more or less one-way communication, retention, and repetition of factual information (Poirier 2017). From the recipient's perspective, knowledge can be decided into factual and procedural knowledge: Factual knowledge is understanding of terminology and insight in specific details, for example (Orgill and Nolin 2022). In contrast, procedural knowledge is knowing subject-specific skills and techniques (Orgill and Nolin 2022). It can be claimed that lectures may not be optimal for procedural learning outcomes.

Furthermore, it has been shown that students have a finite attention span during lectures and find it more difficult to pay attention over a long time (Miller et al. 2013, Brandt 2000). Also, their retention rates of additional information material they receive both during and after their courses is limited (Brandt 2000, Varga and Bauer 2017). Thus, especially learning factual knowledge by means of reading, summarizing, testing, and restudying is more difficult than procedural knowledge (Augustin 2014). In particular, if learned just once, new factual knowledge is soon to be forgotten (Varga and Bauer 2017, Augustin 2014). That is why it is recommended that students should test themselves while learning (Augustin 2014).

Lectures do not challenge students (Poirier 2017). They offer no engagement with the teaching staff (Poirier 2017, Chi et al. 2018). Assignments and problem-solving exercises have to be done at home (Sivarajah et al. 2019). Because lectures are not effective for serious learning, students binge and purge for examinations (Poirier 2017).

Teaching methods need to be designed to enhance the efficiency to learn critical thinking and problem-solving competencies (Brandt 2000, Sahoo and Mohammed 2018). At times, when information changes fast and professional knowledge rapidly becomes obsolete, it is essential to develop and maintain professional expertise through active learning teaching methods (Brandt 2000, Alsancak Sirakaya and Ozdemir 2018). In addition, the magnitude of medical science increases continually while contact hours between faculty and students cannot be expanded comparably (Nawabi et al. 2021). On the contrary, in many vet schools teaching of basic knowledge had to be reduced because of the need of teaching new topics such as economy or to make more time available for hands-on training.

That is why it is important to recall information and retest at expanding time intervals (Augustin 2014). Students need to be involved actively (Brandt 2000, Sahoo and Mohammed 2018). This way, learning can be most effective (Augustin 2014, Alsancak Sirakaya and Ozdemir 2018). It also assures optimal long-term retention of factual knowledge (Augustin 2014). Nevertheless, learning how to learn is not a part of the curriculum at university even

though these learning strategies have positive effects on students' performance (Augustin 2014).

2.2 Learning methods and motivation

In order to design good teaching strategies, it is important to examine what learning outcomes passive and active learning methods lead to. In general, the term "passive learning methods" encompasses listening, reading, and watching of information and is equivalent to an instructor-centered classroom setting (Miller et al. 2013, Meng et al. 2019, Plendl et al. 2009). Interactive working on teaching material, speaking, and practical exercises are considered to be student-centered teaching techniques and, therefore, "active learning methods" (Miller et al. 2013, Meng et al. 2019, Plendl et al. 2009). Many authors agree that passive learning only inadequately increases knowledge and long-term memory retention (Mehta and Bhandari 2016, Kooloos et al. 2020).

Short and Martin (2011) divided lectures in presentation lectures that offer at least a minimum of interaction in class and performance lectures that keep students engaged. They could show that students who attended performance lectures performed better on examinations (Short and Martin 2011). Nevertheless, even performance lectures did not always show a high educative value nor were they transformative (Short and Martin 2011). That is why according to Poirier (2017) students should be challenged and exposed to problems. Only, when there is time to reflect and critically appraise information context may be understood (Poirier 2017, Arlt et al. 2012).

As early as 1956, Bloom et al. (1956) stated that although knowledge is an important outcome of education teachers would hardly accept this as the primary goal of instruction. The authors noted that it is more important that students are able to do something with their knowledge and apply it to new situations and problems (Bloom et al. 1956). Miller (1990) developed a similar approach and pointed out that there is more to practicing medicine than knowing. According to him, among other things students have to gain the skill of acquiring information from a variety of sources (Miller 1990). They have to be able to analyze and interpret these data to translate the findings into a rational diagnostic or management plan (Miller 1990).

Such transfer requires competence to understand the new situation and, furthermore, the facility to discern relations between previous experience and the new situation (Bloom et al. 1956). Thus, it represents a combination of knowledge and intellectual skills and may be summed up as ability (Bloom et al. 1956).

That is why Miller (1990) emphasized the importance that students must be able to apply acquired knowledge and take action. He illustrated his concept by using a pyramid that

displayed "knowledge" at the base and "action" at the apex (Miller 1990). A similar pyramid was constructed by Ritzhaupt and Martin (2014). In their framework they put "knowledge" at the base, "skills" in the middle and "abilities" on top (Ritzhaupt and Martin 2014). According to the authors, knowledge referred to factual or procedural information, skills to the manual, verbal, or mental manipulation of things, and abilities to the capacity to perform an activity (Ritzhaupt and Martin 2014). Measurable or observable knowledge, skills, abilities, attitudes, and behaviors, i. e. competencies, are according to Ritzhaupt and Martin (2014) crucial to perform successfully.

It has been shown that one of the strongest predictors for good performance and well-being concerning students' learning experience is motivation (Orsini et al. 2018, Augustyniak et al. 2016). The definition of motivation is both a process that is focused on a goal and an activity that is initiated and continued to achieve the intended goal (Cook and Artino 2016). Ideally, motivation is intrinsic (Orsini et al. 2018, Augustyniak et al. 2016). The meaning of intrinsic motivation is the drive to do something out of interest (Tanaka et al. 2009). In contrast, extrinsic motivation is defined as the drive to do something to achieve a specific outcome such as a good exam grading or avoiding criticism of teachers or parents (Tanaka et al. 2009).

Students who act out of intrinsic motivation engage at university out of curiousness and enjoy their tasks (Orsini et al. 2018, Augustyniak et al. 2016). On the other hand, it has been shown that due to external forces they often show controlled motivation only (Orsini et al. 2018, Alamri et al. 2021). This extrinsic motivation may play a relevant role in some settings (Alamri et al. 2021). It should be important for any teacher and instructor to study the students' type of motivation because motivation cannot only be affected by students' individual characteristics but by educational environment, as well (Alamri et al. 2021, Orsini et al. 2016). That is why motivation can be partly influenced but also partly not (Orsini et al. 2016).

Aside from that, motivation seems to fluctuate along the curriculum (Orsini et al. 2016). Especially, when a lot of information is introduced and students try to excessively take up knowledge then boredom may increase while motivation and classroom engagement lessen (Poirier 2017). Fourth-year dental students, for example, showed highest lack of motivation when transitioning from pre-clinical to clinical courses then extrinsic motivation decreased towards the final year while the intrinsic motivation went up instead (Orsini et al. 2016). The same authors suggested that students' intrinsic motivation might rise with an early patient contact (Orsini et al. 2016). Besides, it seems that motivation cannot be exclusively interpreted as an individual phenomenon but an interdependence between the individual and a setting (Cook and Artino 2016).

Methods that generate higher student engagement have been studied by some authors. Sötje (2013) asked veterinary students which teaching method they preferred. Almost 100 % of the students appreciated structured and comprehensible lectures (Sötje 2013). A similar result has been found in an online survey asking medical students (Wynter et al. 2019). “Attending a lecture in person” was one of the most common selected statements concerning learning resources with high-use response (Wynter et al. 2019).

The learning material used by students has also been subject of research. 80 % of veterinary students asked in a survey valued the availability of accompanying teaching material, more than 90 % supported the use of multimedia teaching material, and 54 % appreciated the inclusion of interactive elements in teaching (Sötje 2013). Regarding preferred sources utilized by veterinary students attending a physiology course, lectures were favored above all, followed by recommended textbooks and random internet search results (Saadeh et al. 2021). A wiki with veterinary content (“Wikivet”) and the online video platform YouTube were also very popular (Saadeh et al. 2021). The medical students chose written notes and textbooks as most frequently utilized resources for learning new material as well as question banks (Wynter et al. 2019). “Watching online teaching videos” were used “sometimes” (Wynter et al. 2019).

2.3 Teaching strategies and learning outcome

To be able to discuss teaching strategies and their learning outcome, the term "learning assessment" needs to be defined. Calenda and Tammaro (2015) referred to it as "result and process of learning", with result meaning the learners' achievement and process of learning meaning the methods by which the results are obtained.

The aim of teaching is to accomplish planned objectives by guiding and developing learners' knowledge process (Calenda and Tammaro 2015). This includes knowledge acquisition on the one hand and attainment of particular levels of ability and competence on the other hand (Calenda and Tammaro 2015). According to both authors, the teaching results are the learners' performances and through these the achieved abilities and competences can be inferred (Calenda and Tammaro 2015).

It can be assumed that for veterinary students good teaching strategies are the same as for other learners – or at least similar. Nevertheless, there are some aspects that differ when comparing veterinary students to students of other faculties: Veterinary students need to learn medicine and basic sciences of a multiple differing animal species (BMG 2006). Also, they need to learn to diagnose in animals that cannot talk (BMG 2006). So unlike their fellows studying human medicine they need to develop considerable observational skills

(Hamood et al. 2014). Last but not least, they need to counsel animal owners (Hamood et al. 2014).

In order to test the acceptance, feasibility, and usefulness of different teaching methods, various studies have been carried out with an attempt to determine the learning outcome of students in general and veterinary students in particular. Park et al. (2012) found that participants of a pathology residency program who learned by writing using a wiki system showed an improvement of 25 % of correct test results compared to results in seven previous years. In a medical school master students using an educational wiki in a group assignment showed a significantly higher quantity and quality of students‘ participation (Khoynaroud et al. 2020). Also, they were more satisfied with the course (Khoynaroud et al. 2020). Instead, students of the non-wiki group showed less participation and engagement (Khoynaroud et al. 2020).

It has been shown that using a wiki to increase engagement does not work in every setting. Kolski et al. (2013) indicated that students asked in a questionnaire – although eager to read wiki articles and to use such a system – were less willing to create content themselves. Cole (2009) tried to promote student engagement by using a wiki in a third-year undergraduate information systems module, but this approach failed because students did not participate voluntarily and decided not to post articles in the wiki. According to an evaluation via questionnaire, these results were not associated with the wiki technology but an unattractive course design (Cole 2009). Besides, only one third of lecturers asked in an online survey were willing to use a wiki system; and at the same time, only 18 % really used them in their courses at the time of the survey (Kolski et al. 2015).

Another approach to foster flexible learner-centered teaching strategies is the “flipped classroom”. In comparison to traditional lectures, this method means that students teach their peers or apply information they learned individually at home or elsewhere (Sivarajah et al. 2019). During course times, the lecturer is present to answer questions, only (Sivarajah et al. 2019). Students in a flipped classroom can focus on application, analysis, synthesis, or evaluation when peers and instructors are there to help them while gaining knowledge and comprehension when being at home (Sivarajah et al. 2019, Matthew et al. 2019). Usually, they can review the teaching materials as long and often as they need at a convenient time (Wolff et al. 2015, Sivarajah et al. 2019).

Dooley et al. (2018) used this method to evaluate the effects on student academic performance, student satisfaction, and engagement with learning materials. Undergraduate Bachelor of Science students and graduate first-year Doctor of Veterinary Medicine students attending the course ‘‘Foundations of Animal Health” were provided with course materials before entering class so that class time could be used for active learning (Dooley et al. 2018).

This “pre-learning” prior to sessions at university can consist of reading a printed journal article, a textbook chapter, or study notes, listening to a podcast, watching a video, or working through a web-assisted learning (Wolff et al. 2015, Matthew et al. 2019). By this way, students are more familiar with the course content so that during the classroom sessions the focus is on applying knowledge to problems (Wolff et al. 2015, Matthew et al. 2019).

It was shown that at a final examination the flipped classroom cohort gained significantly better results than the lecture cohort in a large-group setting (Dooley et al. 2018). But, similar to the use of a wiki the flipped classroom does not necessarily lead to improvement in every setting. Moffett and Mill (2014) also used the flipped classroom concept to teach postgraduate veterinary students. While students seemed to prefer this approach in comparison to traditional lectures, performance did not match the expectation concerning the impact of the flipped classroom on learning (Moffett and Mill 2014).

So, although the flipped classroom concept increases flexibility as well as student satisfaction and enhances effectiveness regarding the use of in-course time, the implementation of this approach also includes challenges and disadvantages (Baillie et al. 2021). The main items to acknowledge are that developing learning materials requires much time and that students need to be motivated to engage with the preparatory work (Baillie et al. 2021).

The definition and communication of learning objectives are useful tools to help lecturers to enable students to properly use the teaching materials at home (Sivarajah et al. 2019). This way, students can prepare optimally for the sessions (Sivarajah et al. 2019). Hence, the instructor is able to spend more time to individually support the students face-to-face (Sivarajah et al. 2019). Students who were part of the flipped classroom cohort were significantly better in answering questions of the final examination than the cohort who attended the traditional didactic lectures in a large-group setting (Dooley et al. 2018). Another study revealed that students participating in a flipped classroom cohort during a radiology medical clerkship showed greater interest in learning, took more pleasure, and valued the task higher than the cohort attending a traditional lecture (O’Connor et al. 2016).

A further alternative to a lecture is the Interactive-Constructive-Active-Passive (ICAP) framework of cognitive engagement in active learning (Chi et al. 2018, Lim et al. 2019). In addition to the aforementioned methods of active and passive learning, in constructive modes students create new knowledge through inferring, comparing, and contrasting (Quesnelle et al. 2021). The constructive mode is also called generative: Students produce something using information provided in their course materials that goes beyond the given information or instruction (Chi et al. 2018).

In interactive modes two or more students enter into a dialog to develop knowledge that was not known to either of the partners before (Quesnelle et al. 2021). This mode is also referred to as collaborating mode: On the one hand, ideas produced by the involved students must go beyond the presented course materials, on the other hand, the contributions of both/all partners must add to each other's share (Chi et al. 2018). In contrast to interactive pedagogies, constructive pedagogies seem to be not as highly generating (Quesnelle et al. 2021).

Lim et al. (2019) conducted a study using the ICAP framework on the learning success of second-semester students majoring in health professions, including medicine, dentistry, veterinary medicine, and nursing. The results of this study matched with the hierarchical relationship of the learning outcomes suggested by Chi et al. (2018): interactive – constructive – active – passive (in descending order). When comparing the total score, the self-study group that was instructed to study written materials and then to develop three questions about the learning material by themselves had the highest performance (Lim et al. 2019). The lecture-group in turn that was asked to listen to a lecture while looking at written materials and then to simply summarize the information in three sentences had the lowest performance (Lim et al. 2019).

2.4 Learning styles

Understanding students' learning styles as well as modifying teaching methods and material accordingly are essential for high quality education (Sivarajah et al. 2019, Stander et al. 2019). However, expecting teachers to accommodate the learning style of each student in their classes is found to be unrealistic, according to Fleming and Mills (1992). Over the years, higher education changed, classes grew and contain now not only more students but also a manifold range of them (Short and Martin 2011). It has been claimed that it is not possible to provide teaching programs that match the diversity of learning approaches of every single student (Fleming and Mills 1992). Therefore, the interactive or collaborative mode that includes a variety of teaching method possibilities offers the opportunity of profound learning and of turning up innovative know-how for most learners (Chi et al. 2018). Interactive mode is followed by constructive or generative mode (Chi et al. 2018).

The cited research and also earlier findings from academic and didactic fields led to specific learning frameworks. As early as 1992, Fleming and Mills (1992) already analyzed the way students perceive any information. They found or defined four categories to describe how students appear to get a greater degree of understanding (Fleming and Mills 1992, Campos et al. 2021, Horton et al. 2012):

- Visual (V), preferring graphic and symbolic ways of representing information
- Read/write (R), preferring information in printed words
- Aural (A), preferring heard information
- Kinesthetic (K), preferring any perceptual mode(s) as sight, touch, taste, smell, and hearing

According to Fleming and Mills (1992), students should be encouraged to reflect upon their modal preferences and to modify their learning methods appropriately. Students who are empowered to know their own learning style may be able to better adjust their learning behavior to the encountered learning programs (Fleming and Mills 1992, Horton et al. 2012). Nevertheless, diverse learning styles demand different ways of teaching and varying teaching materials (Sivarajah et al. 2019). Teaching methods have to be adapted to match different learning methodologies (Sivarajah et al. 2019). That is why lecturers should consider to a large extent the varying learning styles when developing their lessons, as far as it is possible (Fleming and Mills 1992).

The cited projects show that the interest in optimizing teaching has generally increased in the past years – including in veterinary medicine. However, the results are not robust enough, yet, to formulate recommendations for successfully supporting learning in veterinary medicine for the various teaching settings (Chi et al. 2018, Meng et al. 2019, Dooley et al. 2018). Therefore, it is important to further assess different teaching scenarios so that students benefit as much as possible while taking part with interest and motivation. Additionally, it is vital to identify which method leads to effective long-term retention and to determine whether different teaching methods are better suited to imparting either knowledge or skills.

3 Material and methods

3.1 Students

Students of the faculty of Veterinary Medicine at Freie Universität Berlin (FU Berlin) were asked to participate in the present study in winter and summer semester 2015/16. They were in their ninth and tenth semester and attending a two-week clinical rotation at the Clinic for Animal Reproduction. In total, 171 students were enrolled in the study. Presence in the teaching lessons was mandatory, participation in the project was voluntary. All data were assessed anonymously. Because of farm visits or illnesses, 20 students did not take part on one or both of the study days, leading to 151 students who were included in the evaluation.

The project was reviewed and approved by the Ethical Commission of the Charité Hospital associated with FU Berlin (EA 1/087/16).

3.2 Procedure

The course of the study was designed with support of students of previous seminars and staff of the Clinic for Animal Reproduction in November/December 2014. They helped to develop and select the teaching materials, the tests, and the evaluation form.

The study was conducted on the two Wednesdays of two rotation weeks each group spent at the Clinic for Animal Reproduction.

First Wednesday

On the first day, after a brief introduction and obtaining consent for participation from each person, the students were randomly assigned to two equally sized subgroups (± 1 student) by drawing lots. Then the students were asked to perform three different tasks in a predetermined order, defined beforehand:

- *lecture*: attending a 30-minute lecture (including PowerPoint slides) about the first topic that was held by the author,
- *reading*: reading two articles about a second topic within 30 minutes,
- *summary*: summarizing information from two articles on a third topic in a short text in a group of four to five persons within 120 minutes.

Both subgroups were placed in different rooms for the tasks reading and writing. A personal computer with the software Microsoft Word 2013 (Microsoft Corporation, version 15.0.4859.1001) was available for each group to support the writing task. Both

subgroups, however, attended the lecture and worked on the quiz in the same room. The quiz was provided as hardcopy and every student was asked to complete it on site.

Second Wednesday

On the second day, the students were gathered in one room to fill out an evaluation form. Afterwards, they received a short final test that had not been announced beforehand. They were allowed to answer the questions in the same room but without sharing the answers.

3.3 Tasks

The four topics the students were asked to work on were:

- *camelid topic* = “Specific aspects of reproduction of South American camelids”
- *cat topic* = "Mammary hypertrophy in cats"
- *guinea pig topic* = "Pregnancy toxicosis in guinea pigs"
- *ferret topic* = "Hyperadrenocorticism in ferrets"

The selection of these topics was made with the help of the staff of the Clinic for Animal Reproduction, based on some key considerations: The topics had to be clinically relevant in context of animal reproduction but should be largely unknown to the students. They were usually not covered in the veterinary curriculum at FU Berlin until the clinical rotation and were chosen to minimize bias, based on previous knowledge. Furthermore, rather short papers were selected for this task in order to allow the processing of the topics within the given time. Therefore, papers with a median length of 4 pages were picked.

A schedule was developed in a cross-over design showing which subgroup was asked to work on which topic by using which method (see fig. 3.1). All topics should be read, summarized, or heard with the same frequency during the presented study. Additionally, every learning method should be performed equally often, either in the beginning, in the middle, or at the end of the day. The lecture was initially performed at the beginning of all tasks, during the second half of the study it took place in the end.

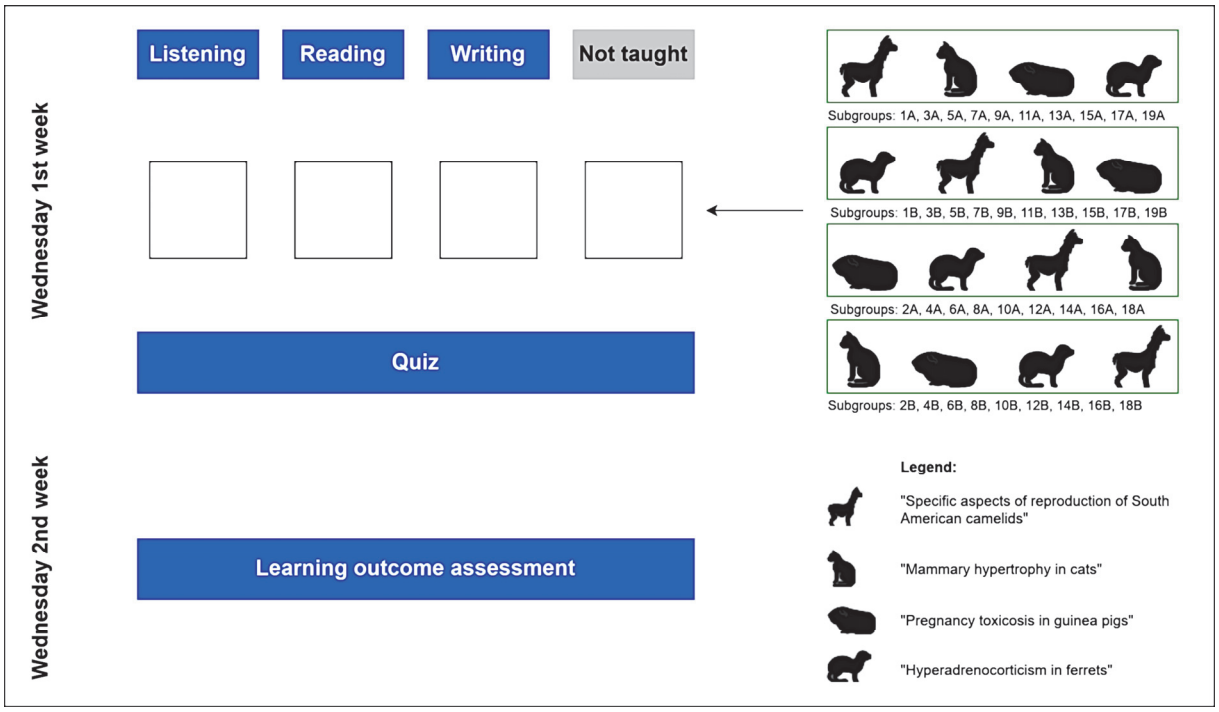

Fig. 3.1. Tasks. Schedule showing the 4 different sort orders (green boxes on the right) in which the subgroups were asked to work on which topic by using which method. All topics were read, summarized, or heard with the same frequency during the study. In each group, one topic was not dealt with at all.

As shown in figure 3.1, one out of four topics remained unaddressed in the respective groups. Nevertheless, this untreated topic was content of both the quiz and the final test to assess any prior knowledge of the students.

3.4 Quiz

At the end of the first Wednesday, all participants were asked to take a short quiz (see appendix 10.1). The content of the quiz was selected with the help of the staff of the Clinic for Animal Reproduction and tested on students from the previous year. The questions were designed to be not too difficult and to not overlap with the questions of the final test. The quiz was meant to give the students a joyful and immediate self-affirmation of their learning success. It was a multiple-choice test with eight questions relating to the four topics. The questions were the same for all students. Three possible answers to each question were given out of which only one was correct. The students were asked to answer the questions to the best of their knowledge, even concerning the topic they had no experimental exposure to. After the quiz was completed, the answers were discussed.

3.5 Evaluation form

On the second Wednesday, the evaluation form (see appendix 10.2) was handed out to the students. It consisted of a total of ten questions. They were the same for all students. The

questions and the method to answer them were selected with the support of the team of the Clinic for Animal Reproduction. They were tested on students from previous semesters.

The evaluation form contained questions including personal information such as age, semester, and gender. Six questions were designed as assertion that could be rated by using a 5-point Likert scale. For statistical analysis the answers "fully agree" and "agree" were summarized in an affirmative statement, "disagree" and "strongly disagree" in a negative statement. As an alternative to a neutral response the students could also reply with "cannot be judged". The other four questions required either "yes" or "no", or a number/specification could be given.

Questions included in the evaluation form related materials commonly used for exam preparation, i. e. textbooks, lecture notes, scripts, journal articles, and internet. It was also possible to indicate alternative sources in a comment. Besides, the students were asked to evaluate which personal learning outcome they expected to gain after applying the different learning methods. Another question referred to the previous knowledge regarding the topics selected for the study, up to what extent the students were already familiar with the topics beforehand.

One question addressed which teaching method the students liked best. In addition to the three possible answers regarding the teaching methods, the quiz as well as the group work as part of the task of writing a summary could also be selected. The questions concerning the quiz or the group work were only asked out of interest, they were not decisive for evaluating which of the teaching methods the students liked best.

3.6 Final test

After collecting the evaluation forms, an unannounced final multiple-choice test was distributed (see appendix 10.3). It included three questions about each of the four topics that were the same for all students. They were developed based on the information given in the teaching material selected for the project. Hence, the students were asked for information they had had contact with one week ago. Four possible answers were provided out of which only one was correct. In addition, the answer "I don't know" could be selected. By also asking questions about the topic without experimental exposure, it was tested whether the students had any prior knowledge.

The questions of the final test were designed with support of members of the Clinic for Animal Reproduction. The aim was that they should not overlap with the questions of the quiz. In such a way, it was avoided that the quiz affected the learning outcome assessment in the fields that were addressed by the final test.

3.7 Analysis

Microsoft Excel 2013 (Microsoft Corporation, version 15.0.4859.1002) software was used for data collection. Descriptive variables were analyzed based on frequencies of responses and frequency distributions. The answer “I don’t know” was taken into account. 95 % confidence intervals were calculated using the Wilson method with continuity correction. This method is recommended if the sample size is rather small or if the values of p are on the extremes (near 0 or 1). Significant differences can be identified by non-overlapping confidence intervals. All calculations were performed using R (R Foundation Vienna, version 3.60).

In addition, student responses were analyzed based on the learning methods performed and the topics covered using the chi-square test, expected frequencies, and standardized residuals for correlations. These analyses were performed using the program SAS® University Edition 3.71 (SAS Institute Inc., Cary, NC, USA), with statistical significance defined as $\alpha = 0.05$. When analyzing cross-tabs such as chi-square test, Cramer's V was used to calculate the strength of association.

The population represented (n) varied depending on the number of students who had answered the respective questions, since answering all questions was not mandatory.

4 Results

In total, 171 students were enrolled in the study. 151 students were eligible for analysis because they took part on both study days. 126 of these students were female (83.44 %), 25 were male (16.56 %). The students were distributed to 19 rotation groups. The size of these groups averaged eight people (ø 7.95, with a variation of three people in the smallest and ten people in the largest group). Median age was 25 years (ranging from 22 to 40 years).

4.1 Quiz

The quiz was not designed to be scientifically evaluated but to give the students a joyful and immediate self-affirmation of their learning success. Students who did not attend the second day of the study, but only the first day, completed the quiz, resulting in 159 participants providing a total of 1,272 responses. 76.5 % of the answers were correct. Most correct answers were given regarding the guinea pig topic (88.4 %) followed by cats (79.2 %) and ferrets (74.2 %). The fewest correct answers were given for questions on camelids (64.2 %).

4.2 Evaluation of the project

The first question asked for the sources the students usually use for exam preparations. They stated to use predominantly textbooks (88.1 %) and scripts (84.6 %) but also their lecture notes (65.1 %, see fig. 4.1).

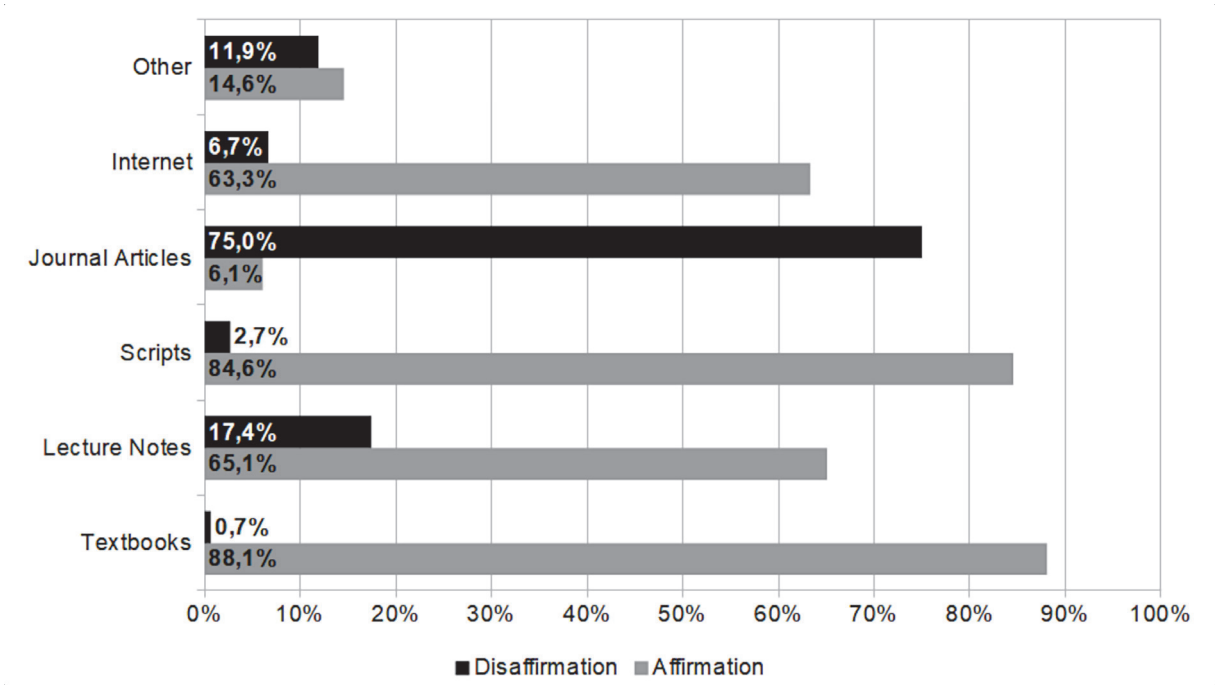

Fig. 4.1. Exam preparation. Answering performance of 151 students who answered questions about the materials they use for exam preparations. Bar graphs show the percentages of affirmation and disaffirmation for each medium. Mediums that could be selected: Textbooks, Lecture Notes, Scripts, Journal Articles, Internet, Other = alternative mediums stated by the students.

When asked to evaluate which learning method they considered to be most effective, about three quarters of the students expected the summary to be the most successful (see fig. 4.2). Almost 50 % of the students selected lecture.

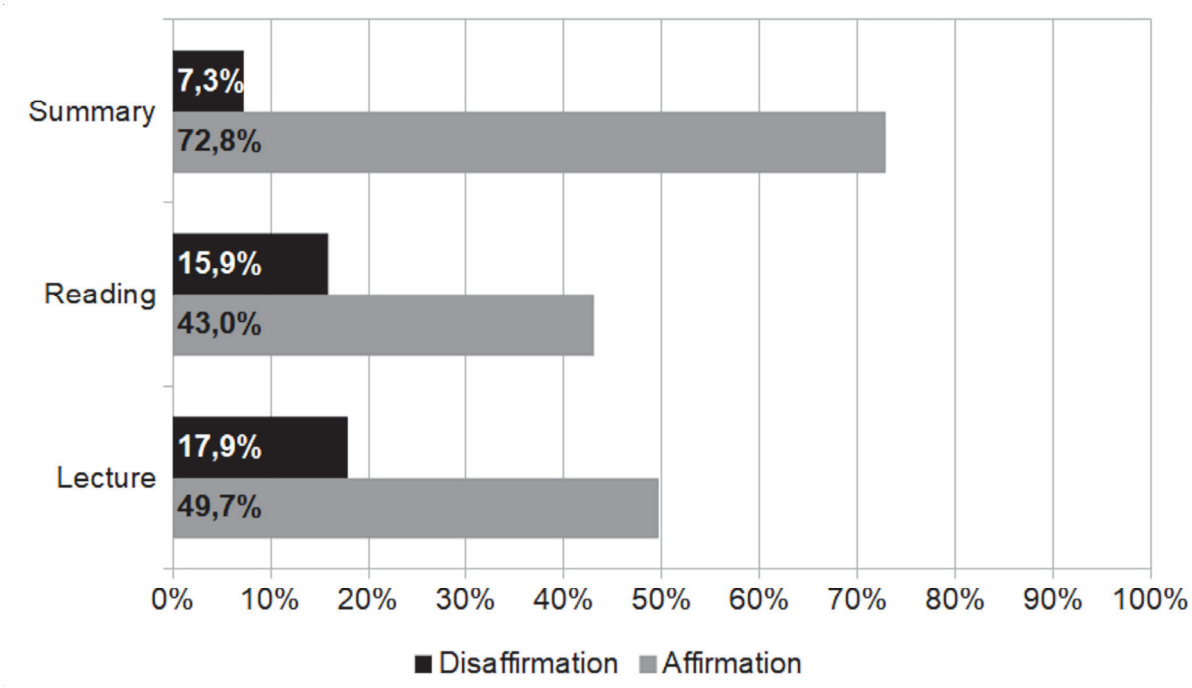

Fig. 4.2. Learning method. Answering performance of 151 students who answered questions about the learning method they expected to be the most successful. Bar graphs show the percentages of affirmation and disaffirmation for each learning method. Reading = Reading papers, Lecture = Attending a presentation by a lecturer, Summary = Writing a summary.

Most students indicated to have had no previous knowledge of the topics. The least knowledge they believed to have about camelids (6.6 %, see fig. 4.3).

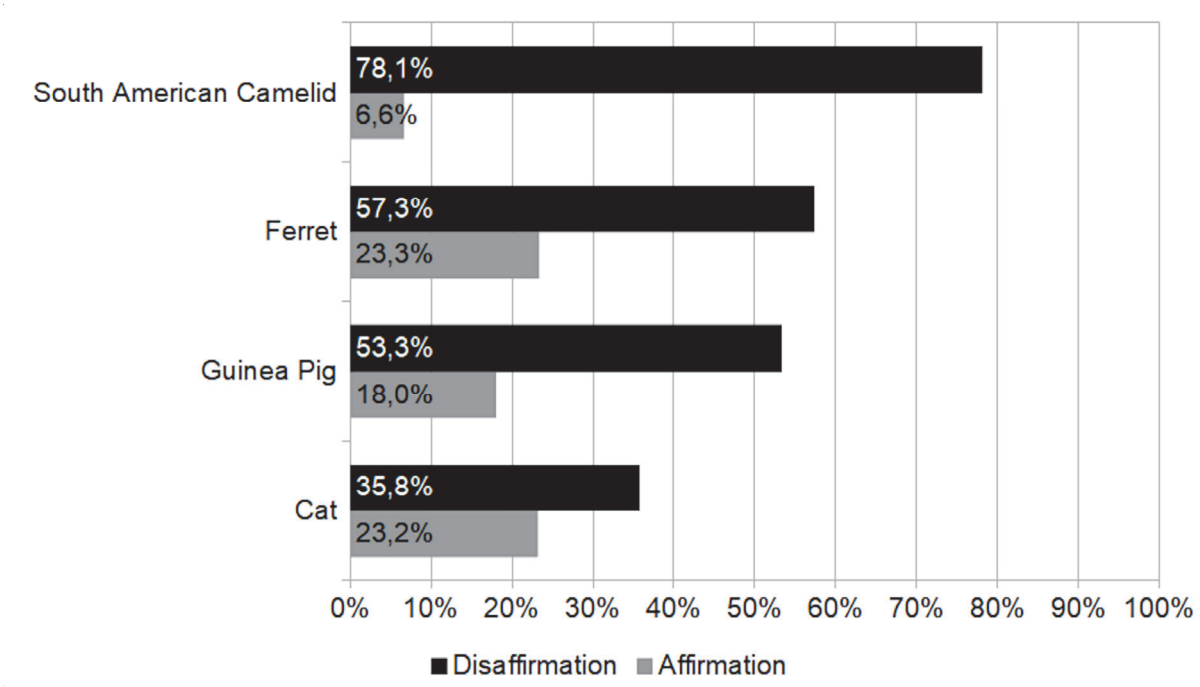

Fig. 4.3. Knowledge of the topics. Answering performance of 151 students who answered questions about the knowledge of the topics before the experimental exposure. Bar graphs show the percentages of affirmation and disaffirmation for each topic. Ferret = Hyperadrenocorticism in ferrets, Cat = Mammary hypertrophy in cats, Guinea pig = Pregnancy toxicosis in guinea pigs, South American camelid = Specific aspects of reproduction of South American camelids.

When asked about the preferred teaching form, lecture was named by most students (42.0 %, see fig. 4.4). Although the question about the quiz and the group work was not part of the final assessment and, therefore, not decisive for the evaluation of the preferred teaching method, it can be stated that nearly two thirds of the students liked the group work that was part of the task of writing the summary.

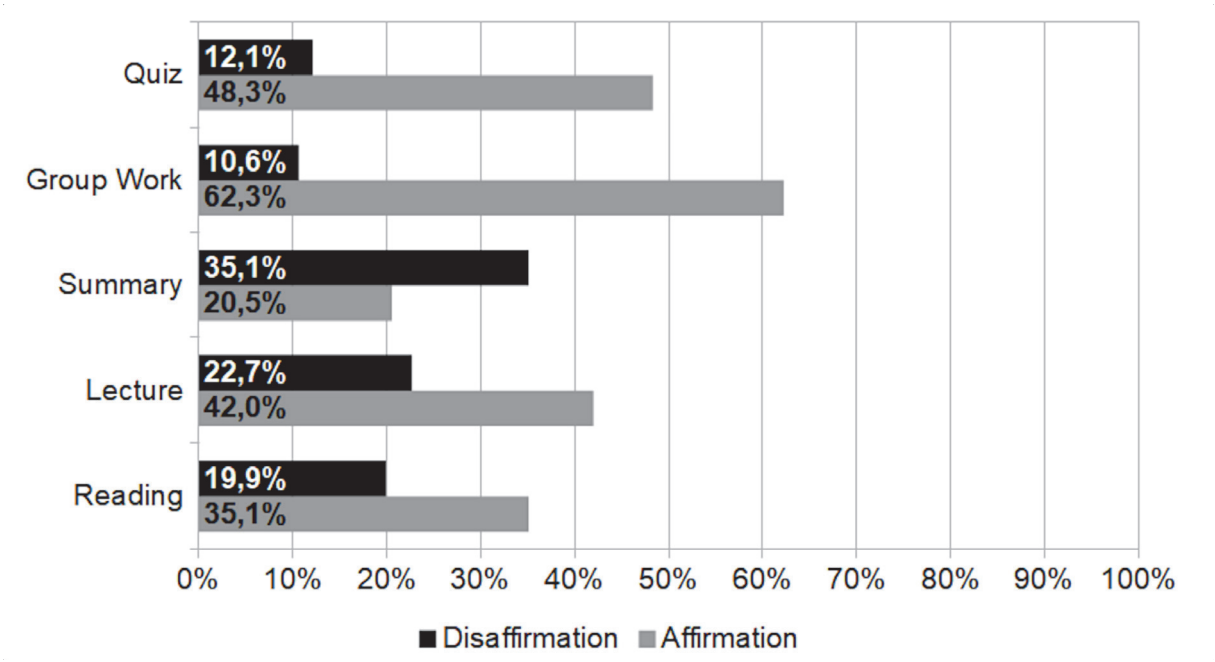

Fig. 4.4. Preferred teaching method. Answering performance of 151 students who answered questions about the preferred teaching method. Bar graphs show the percentages of affirmation and disaffirmation for each method. Reading = Reading papers, Lecture = Attending a presentation by a lecturer, Summary = Writing a summary, Group work = Group work that was part of the teaching method "Writing a summary", Quiz = Quiz at the first day of the study.

4.3 Final test

4.3.1 Effect of topic on learning outcome

Students performed best when answering questions about the cat topic (63.9 % correct answers) and the guinea pig topic (62.8 %). Compared to the ferret topic (43.0 %), both topics received significantly more correct answers (cat vs. ferret: $p < 0.01$, guinea pig vs. ferret: $p < 0.01$). Concerning the questions on the camelid topic, 48.9 % of the answers were correct. In comparison with the cat topic, the proportion of correct answers was slightly significantly ($p = 0.04$) smaller. The proportion of students who answered "I don't know" was similar across all topics, varying from 7.1 % to 11.2 %. In all significant cases mentioned above, Cramer's V showed a weak association (ferret vs. guinea pig: $V = 0.09$, ferret vs. cat: $V = 0.09$, camelid vs. cat: $V = 0.06$).

4.3.2 Answers to the topics without experimental exposure

Each group did not work on one of the topics during this project but was still confronted with questions about it. Looking at the responses to these topics revealed the following (see fig. 4.5): The proportion of correct answers was significantly higher for the guinea pig topic than for the others (guinea pig vs. ferret: $p < 0.01$, guinea pig vs. camelid: $p < 0.01$, guinea pig vs. cat: $p < 0.01$). Cramer's V showed a weak to moderate association in all cases.

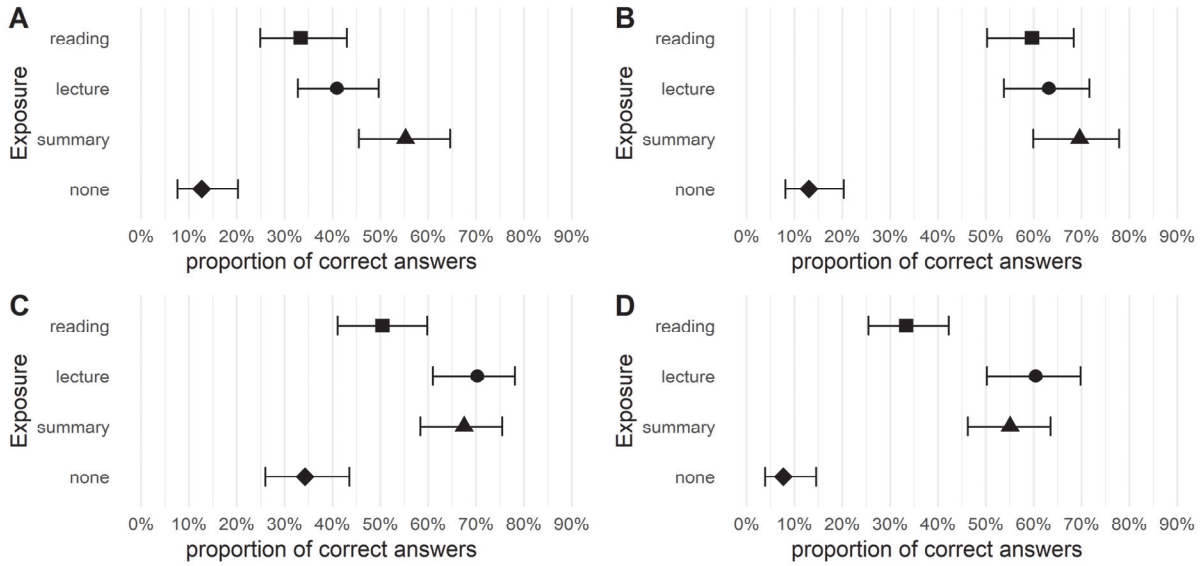

Fig. 4.5. Answers per topic. Proportion of correct answers after exposure to different teaching strategies, presented per topic. All 151 students were equally allocated to different exposures to three of the four topics prior to answering the questions. The test included three multiple choice questions with four possible answers. If students did not feel confident that they could answer the question, they could answer “I don’t know” as a fifth option. Symbols show the proportion of correct answers for each exposure. Error bars are 95 % confidence intervals. Differences between non-overlapping confidence intervals can be considered significant. A = ferret, B = cat, C = guinea pig, D = South American camelid. Reading = Reading papers, Lecture = Attending a presentation by a lecturer, Summary = Writing a summary, None = None of the learning methods applied.

The camelid topic had the fewest correct answers. This was also the topic with most "I don't know" answers (77.1 %). Besides, more answers were wrong than right. Therefore, it can be stated that most of the students were right with their self-assessment that they had little to no knowledge about camelids. In total, the proportion of correct answers for all topics inversely correlated with the number of “I don’t know” answers which indicates that the students were able to correctly assess their knowledge.

4.3.3 Effect of learning method on learning outcome

The learning method with the highest proportion of correct answers was the summary (see fig. 4.6). Overall, the learning methods had no significant effect on the proportion of the answer “I don’t know”.

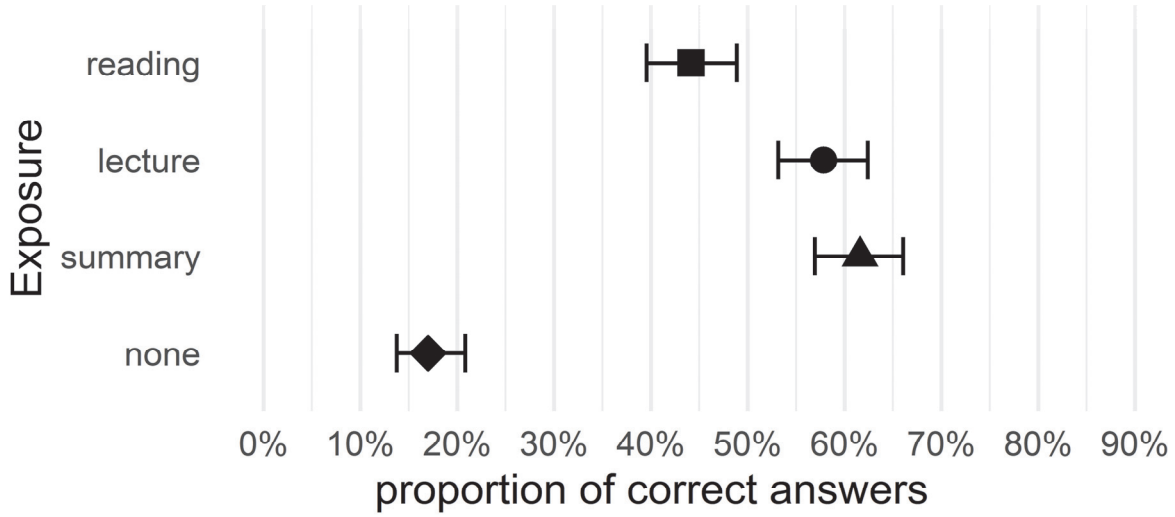

Fig. 4.6. Answers per learning method. Answering performance of 151 students who answered questions about four topics after having used one of three different learning methods or none, respectively. All students were equally allocated to different exposures to the topic and learning method prior to answering the questions. The test included three multiple choice questions with four possible answers. If students did not feel confident that they could answer the question, they could answer “I don’t know” as a fifth option. Symbols show the proportion of correct answers related to the applied learning method. Error bars are 95 % confidence intervals. Differences between non-overlapping confidence intervals can be considered significant. Reading = Reading papers, Lecture = Attending a presentation by a lecturer, Summary = Writing a summary, None = None of the learning methods applied.

Even if reading led to a significantly better learning outcome compared with no exposure ($p < 0.01$), lecture and summary led to better results than reading ($p = 0.02$ and $p < 0.01$, respectively). Cramer’s V showed a weak association in both cases. Lecture and summary resulted in a better learning outcome than no exposure ($p < 0.01$ each). The difference between summary and lecture was not significant ($p = 0.60$).

5 Discussion

Nowadays, teaching methods in veterinary schools are under debate and many attempts are being made to improve learning outcomes of students (Carr et al. 2021, Brown 2018). An important aspect of this debate concerning new or at least modified teaching methods that needs to be taken into consideration is the level of knowledge that lecturers intend the students to gain at university.

In this context, the study was carried out to compare the acceptance and the learning outcome of three different teaching methods: attending a lecture, reading articles, and writing a summary in group work that comprises reading, discussion, and writing of information. To complete each task, a specific time interval of either 30 or 120 minutes was given. Working on the topics on specific days at university provided the same amount of time for all students between learning and the final test. By permuting the order in which the learning methods were administered, it was aimed to minimize possible bias. A constant order might have had an effect on the learning outcomes. Factors such as motivation, concentrativeness, or others may be significant confounders. Therefore, a schedule was developed before the beginning of the project.

5.1 Immediate learning outcome (Quiz)

The quiz was offered to motivate the students to participate in this study and to finalize the project in a fun way on the first day. It was designed not to be too difficult and not to overlap with the questions on the final test. In that regard, it is likely that the quiz did not affect the learning outcome in the fields that were addressed by the final test.

The most correct answers were given concerning the guinea pigs and the cats, vice versa to the results of the final test. In both cases, the camelid topic was the one with the most wrong answers. A possible reason could be that cats and guinea pigs are under the most common companion animals in Germany (IVH and ZZF 2022). Therefore, there may be a broader understanding and the opportunity to adapt general knowledge to the species concerned.

5.2 Evaluation

A 5-point Likert scale was used to evaluate the project by the students. Likert scales are a common tool often used in surveys (Dawes 2008). Using a 5-point scale makes it simple to rate a statement because approval or rejection as well as the degree of agreement or disagreement can easily be recorded (Dawes 2008). However, it can lead to an underrepresentation of extreme positions such as “strongly agree” or “strongly disagree”, respectively (Bishop and Herron 2015). One of the reasons is that most people tend to

choose a more central statement (Bishop and Herron 2015). Some also incline to agree at random, despite their intended opinions (Zhang et al. 2019). On the other hand, there may be respondents who prefer the extreme positions (Park and Wu 2019). Their responses can seriously bias the interpretation because of distortion (Park and Wu 2019).

The evaluation revealed some interesting aspects. Some of the answers matched the results of the final test well but some did not. It could be shown that for exam preparation students still mostly rely on textbooks and lecture notes. This result was in accordance with the outcome of other projects. A survey at University of Veterinary Medicine Hannover Foundation (TiHo) revealed that some preparation methods contained written material such as self-written summaries and flash cards (Ehrich et al. 2020). The majority of the students learned by writing their own summary (Ehrich et al. 2020). Students of human medicine and dentistry at the University of Münster chose printed books and lecture notes for learning before other information sources (Obst and Salewsky 2013).

On the contrary, according to a survey at the University of Oxford, textbooks and lecture notes were the least useful learning resources (Leung et al. 2020). Instead, internet and computer-based technologies had a growing impact on higher education and students' way of learning (Gutmann et al. 2015). In addition, mobile phones play increasingly important roles (Ehrich et al. 2020). A study published in 2019 showed that medical students used them for online textbooks, medical podcasts, medical calculators, online lectures, and taking notes (Latif et al. 2019). This was in accordance with a survey among students, residents, and faculty members in Canadian medical faculties who stated to use their mobile devices for finding drug information, making clinical calculations, and taking notes (Boruff and Storie 2014).

Numerous participants of this study thought that writing the summary may be the most successful task. Their expectations were reflected in the results of the final test. Similar results were seen in another study with 3 groups of medical students who were assigned to self-study, write a summary, or an argumentative essay (Kim et al. 2021). Participants who learned through writing a summary or an essay showed significantly higher performance in transfer of knowledge than those who engaged in self-studying (Kim et al. 2021).

Interestingly, when asked about the previous knowledge of the topics, most of the students mentioned ferrets before cats and the other topics. This seems a little surprising because ferrets are not very common companion animals. For example, in 2017, there were approximately 90,000 ferrets owned in Germany, compared to 9.2 million dogs and even 13.7 million cats in German households (IVH and ZZF 2018). Therefore, ferrets play a minor role in veterinary education, and it was expected that the students had not much previous

knowledge about them. The results of the final test did not support the assumption of the students.

The least preferred teaching form according to the evaluation was the summary. That, too, is surprising as, for example, students asked in a survey at TiHo Hannover mentioned that they would learn for exams by writing their own summaries (Ehrich et al. 2020). But maybe, students appreciate less the added value of writing the summary when, as in the presented project, writing is a part of a study instead of an exam preparation. Nevertheless, what students liked most about writing the summary was the group work.

Moreover, the expectations of the students and the test results did not correspond regarding some other areas, as well. Many students stated that they have had some knowledge of the topics before the beginning of the project, but the final test results did not support their assumption. Vice versa, few students indicated to know little about the topics but received good results. After all, it cannot be ruled out that these outcomes were not only related to a misjudgment of the students but also to the difficulty level of the test questions.

5.3 Final Test

The final test was developed to measure the learning outcome of the different teaching methods after one week. Regarding the hypothesis put forward, it was confirmed that most of the correct answers were given after writing the summary. This was in accordance to the expectations of the students. It can be claimed that writing a summary requires a deep concentration on the given information.

However, due to the fact that part of the method is a collaboration between fellow group members by discussing information, it cannot be finally decided whether writing alone or rather communication between the students led to good results. Yet, only 20.5 % of the students stated that they liked the writing, in turn, 62.3 % liked the group work that was part of this task.

The method with the second best learning outcome was the lecture. Students expected to obtain good results and the test results supported this assumption.

The number of correct answers was lowest after reading which matched well with the students' expectation. Here, it was noticeable that the proportion of correct answers was lower than the wrong ones. More than 90 % of the students felt confident in answering the questions, but the majority of them gave wrong answers. Presumably, the students either overestimated their knowledge after reading or felt compelled to answer, even, when they only remembered little from the articles. In general, it can be assumed that the students have had little experience in reading scientific papers and extracting information before. However,

this is a phenomenon that should be evaluated in future studies as it was not part of this project.

The final test included the possibility to answer "I don't know". This answer was provided because the students were familiar with it from doing the Progress Test Veterinary Medicine (Progress Test Tiermedizin, PTT). This Test, a feedback tool for students of all five German veterinary departments, is frequently used by students of veterinary medicine (Siegling-Vlitakis et al. 2014). In the 1970s, this concept had already been developed for human medicine (Arnold and Willoughby 1990, Vleuten et al. 1996). Since 1999, it is performed among students of human medicine at the Charité-Universitätsmedizin Berlin and 13 other universities in Germany and Austria (Nouns and Georg 2010). By using the Progress-testing, the students are able to monitor their current knowledge continuously throughout their course of studies (Herrmann et al. 2020). Since 2013, this test is also available for students of veterinary medicine (Siegling-Vlitakis et al. 2014).

The Progress Test was launched by KELDAT (Competence center for e-learning, didactics, and education research in veterinary medicine, founded in 2012 to improve teaching in cooperation with all German-speaking universities in Germany, Austria, and Switzerland) and the assessment area of the Charité-Universitätsmedizin Berlin (Siegling-Vlitakis et al. 2014). It is based on so-called day-one skills, competencies defined by the European Association of Establishments for Veterinary Education (EAEVE) (Herrmann et al. 2020, EAEVE and FVE 2021). It encompasses the option to answer "I don’t know" because students can perform this test from the first semester to the last and, therefore, it cannot be expected that all of the students have already gone through all the contents of the questions during their studies (Nouns and Georg 2010, Herrmann et al. 2020). In addition, the response "I don't know" provides the opportunity of self-reflection whether the content of the question is not yet or no longer known (Siegling-Vlitakis et al. 2014, Kirnbauer et al. 2018). There was no intention to encourage guessing, since the students were also asked to answer questions about the topic without experimental exposure in this project. However, guessing was not prohibited.

5.4 Implications of the results for future teaching strategies

According to Miller (1990) and his framework for clinical assessment, it is not only fundamental that students “know” what is needed to carry out a profession (“knowledge”) but also “know how” to use the knowledge that they have gathered at university (“competence”). Students should also be able to apply their knowledge and “show how” they perform when faced with a patient (“performance”) (Thampy et al. 2019, Rhind et al. 2021). The top of

Miller's pyramid shows the most important aspect whether students know what to “do” when functioning independently in a clinical practice (“action”) (Miller 1990, ten Cate et al. 2021).

In 2016, Cruess et al. (2016) amended Miller’s pyramid from 1990 and added a level above the apex of the triangle, as Miller (1990) also called it. For them, it appeared that “being” was a sounder basis for the professional behaviors than “doing”, therefore, they put the level “is” on top of Miller’s pyramid (Cruess et al. 2016). That should demonstrate the attitudes, values, and behaviors that may be expected by one who “thinks, acts, and feels like a physician” (Cruess et al. 2016).

Ritzhaupt and Martin (2014) put up a framework, similar to Miller’s. They assumed that knowledge, skills, and abilities, also known as competencies, are essential to perform effectively (Ritzhaupt and Martin 2014). That is why the base of their pyramid displays "knowledge" as foundation, same as Miller's (Ritzhaupt and Martin 2014, Miller 1990). This is the level the presented project mainly focuses on. However, the center of the pyramid is formed by "skills" and the top by "abilities" (Ritzhaupt and Martin 2014), which may best be trained in clinical settings during the study of veterinary medicine. Nevertheless, the competency layers are not mutually exclusive but can be thought of as overlapping (Ritzhaupt and Martin 2014).

The importance of the core competencies knowledge, skills, and abilities applies to veterinary education. According to World Organisation for Animal Health (WOAH 2012), veterinary education aims to assure that the graduating veterinarian gets a level of education that provides solid overall competencies. Furthermore, the graduate gains the understanding and the ability to perform entry-level veterinary service tasks to promote animal and public health through the required knowledge, skills, attitudes, and aptitudes (WOAH 2012).

But the question arises: How can students acquire these skills and abilities that go beyond mere knowledge? What possibilities are there in university education to teach students more than is feasible through lectures?

One option to complement traditional training and to teach manual skills is the usage of simulators and models provided by Clinical Skills Laboratories (CSL) (Noyes et al. 2022, Balsa et al. 2020). The conveyance of clinical skills for entry-level care without being dependent on hands-on practice and without training on animals is becoming more and more important (Dilly et al. 2017, Rösch et al. 2014).

Overall, the development of veterinary education focuses on goals and objectives such as “first-day competences”, life-long learning, self-directed learning, and evidence-based decision making (EAEVE and FVE 2021, WVA 2017, Hamilton et al. 2020). Based on the question, how students can be provided with said competences some attempts to develop

and assess new strategies for a more successful learning have already been published (Carr et al. 2021, Brown 2018).

A component of evidence-based veterinary medicine (EBVM) is the aptitude such as retrieving, critically appraising, interpreting, and applying results of published scientific studies from literature to practice (Arlt et al. 2012, Brennan et al. 2020). One way to achieve such competences are critically appraised topics (CATs) (Brennan et al. 2020). Arlt et al. (2012) found them to be highly valuable for training veterinary students in EBVM. In this project, students had to work in groups to answer a clinical question (Arlt et al. 2012). This approach included critical reading of information and writing a summary of the work process and the clinical answer (Arlt et al. 2012).

In another survey, students also indicated that they wished for integration of critical appraisal of information into the curriculum (Kasch et al. 2017). Moreover, they supported the statement that the application of current results from science in practice is important (Kasch et al. 2017). After all, the aim of EBVM is to prepare students for daily practice to choose the best therapy for patients (Arlt et al. 2012). And this requires to make rational decisions in line with sound clinical reasoning and scientific evidence (Arlt et al. 2012).

In the past, lectures have been the preferred teaching method at universities and veterinary schools to transfer knowledge. However, many teachers and lecturers agree on the fact that only listening to information is not optimal to increase knowledge or to build up a long-lasting memory (Miller et al. 2013, Fletcher et al. 2015). It can be assumed that lectures are not able to impart skills and abilities in addition to knowledge, since lectures belong to the passive teaching methods. Moreover, it was shown that lectures cannot motivate students sufficiently to engage in learning more actively (Mehta and Bhandari 2016, Dooley et al. 2018).

Thus, the lecturer should show interest in the topic and, furthermore, should demonstrate the relevance of the topic in general and to the students in particular (Poirier 2017). Teaching should be moved away from mere content delivery and, therefore; from teacher-directed methodology to student-centered education (Chi et al. 2018, Brandt 2000). To meet the needs of students, a diversity of teaching approaches is required (Brandt 2000). But so far, students are only meant to memorize and repeat the information (Poirier 2017).

Writing summaries may be used as an additional learning strategy in specific settings. This finding is in accordance with Kim et al. (2021) who found empirical evidence for greater educational benefits when writing is adopted in medical education. This group concluded that writing can enhance both learning and higher-order thinking, each critical for medical students (Kim et al. 2021). These results match the outcome of a comparable study. Sahoo and Mohammed (2018) also showed that introducing writing embedded with collaborative

and reflective practices can increase collaborative learning, critical thinking, and reasoning amid medical students.

5.5 Lessons learned from the pandemic

When the COVID-19 pandemic hit the world in December 2019 it was required instantly to turn away from the usual paths at university and veterinary schools. Immediate innovation was mandatory to ensure that students continued to receive the necessary training, based on the professional registration board competencies and standards (BMG 2006). All of a sudden, it was essential not only to deliver theoretical content but to provide the possibility of practical skills education online, as well.

Introducing writing into the curriculum to give students a more active role as the present study demonstrated was one of the possibilities (Vaz 2022, Rauch et al. 2022, Almansour and Kurt 2022). Even if veterinary education widely changed back to normal, the findings of the presented study may help to develop teaching strategies for similar situations. In general, many teaching innovations that have been developed due to the restrictions related to COVID-19 may lead to better teaching methods in the future.

For example, changed teaching strategies encompassed recorded or live demonstrations of e. g. dissections or laboratory experiments, online tutorials with either breakout rooms (splitting students of live online lectures into smaller, parallel sessions to encourage group discussion), interactive quizzes, or collaborative mind mapping via virtual whiteboard, typed forum discussions, podcasts, or online staged case discussions (Routh et al. 2021, Etando et al. 2021, Koort and Åvall-Jääskeläinen 2021). But, putting all the implementations aside, one aspect that could not be neglected was that students in their practical year were not able to attend their clerkships and trainings (Ferrel and Ryan 2020). Losing the possibility for collaborative experiences became challenging for students to progress forward within veterinary school and to fulfill graduation requirements on-time (Ferrel and Ryan 2020, Etando et al. 2021).

How teaching clinical practical and communication skills changed during the pandemic has been one of recent fields of research. CSL learning stations were digitized, for example, and provided on an online learning platform (Brombacher-Steiert et al. 2021, Grady et al. 2022). Corresponding to “do-it-yourself” principle students could practice practical skills at home by using everyday materials (Brombacher-Steiert et al. 2021). Some universities equipped their students with kits of material to support the skills lab (Grady et al. 2022). This way, basic techniques like suturing and knot-tying could be practiced (Brombacher-Steiert et al. 2021, Grady et al. 2022).

The amount of teaching materials for practical year students were considered adequate and communication with the lecturers worked without difficulties (Brombacher-Steiert et al. 2021). Yet, some students complained about the amount of time it took to receive feedback or comments from their teachers (Mahdy and Sayed 2022). The volume of self-directed reading was at times too great and according to students in need of improvement (Grady et al. 2022). But, to study in their own desired learning environment, helped the students and enhanced their concentration on the course preparations (Yoo et al. 2021). Nevertheless, students stated that it took more time to understand when learning online, compared to in-class sessions (Mahdy and Sayed 2022).

Usually, digital teaching supplements existing face-to-face courses at the CSL to enable students to prepare classroom courses by using digital learning materials (Brombacher-Steiert et al. 2021, Grady et al. 2022). But, since most of the courses are typically practical, this was the main challenge for veterinary education during the pandemic (Mahdy 2020): How to learn practical skills online? Brombacher-Steiert et al. (2021) emphasized that digital teaching could not replace on-site training of practical skills under the guidance of trained staff.

Bernigau et al. (2021) published the joint efforts of a task force veterinary anatomy of the five German veterinary schools to ensure education while national regulations restricted public life. All of them already provided some digital learning material (video demos, e-lectures, etc.) to their students before the pandemic as many other veterinary schools did, as well (Etando et al. 2021, Bernigau et al. 2021). Now, students were able to stream numerous medias from online learning platforms (Etando et al. 2021, Bernigau et al. 2021). They could work on the course material on their own time and place (Schoenfeld-Tacher and Dorman 2021).

To learn anatomy at home, various universities provided a program or e-learning with interactive 3D models explaining anatomical structures (Yoo et al. 2021, Stunden et al. 2021). One of the five veterinary schools in Germany scanned more than 700 new specimens within months so that 3D-scans could be offered to the students (Bernigau et al. 2021). Microscopy classes were already provided digitally before the pandemic and were now made available complemented with digital instructions (Etando et al. 2021, Bernigau et al. 2021). This way, virtual microscopy was used to teach pathology, for example (Etando et al. 2021).

While national regulations restricted public life, practical exercises did not happen basically (Bernigau et al. 2021). At four of the five veterinary schools in Germany examinations were conducted via learning platforms (Bernigau et al. 2021). That is why the topics were not examined in as much practical detail as they usually had been at most locations before the pandemic (Bernigau et al. 2021). Some universities changed their final year examinations to be written completely remote, partly as an open book examination, some other reduced

either the duration of the written examination or the total number of written papers in size (Choi et al. 2020). But, there were also universities that canceled the examinations (Choi et al. 2020).

Overall, the COVID-19 pandemic induced a huge impact on students' lives and career progression (Mahdy 2020, Carney and Thompson 2021). Being away from veterinary schools and clinical rotations showed the need to develop online material that matched the various learning styles of different students (Etando et al. 2021). It was also recognized that new learning and teaching strategies needed to be implemented (Etando et al. 2021, Bernigau et al. 2021). Studies concerning alternative methods, which had already been performed before the pandemic, were of valuable use to show various promising options (Dooley et al. 2018, Noyes et al. 2022, Kasch et al. 2017).

There were also some challenges that occurred while restructuring veterinary education during the pandemic. Because of the immediacy of the situation, universities had to provide content online from one day to the next (Mahdy 2020, Ferrel and Ryan 2020). But on the one hand, some staff and students had deficits concerning computer skills and/or were not familiar with the software (Routh et al. 2021, Schoenfeld-Tacher and Dorman 2021). Thus, extra time was needed for specific training and workshops to improve e-literacy (Routh et al. 2021). On the other hand, the availability of internet and learning devices were partly a problem, especially in low-medium income countries (Mahdy 2020, Schoenfeld-Tacher and Dorman 2021).

One of the biggest adjustments was that in-person classes had to be canceled (Ferrel and Ryan 2020, Carney and Thompson 2021, Etando et al. 2021). Following the advice of their respective government agencies, veterinary schools had to offer some kind of hybrid/blended courses (Routh et al. 2021, Etando et al. 2021, Koort and Åvall-Jääskeläinen 2021). Most of them already used online Learning Management Systems (LMS) before the pandemic so they were able to provide pre-recorded lectures or video demos, for example (Routh et al. 2021, Schoenfeld-Tacher and Dorman 2021, Bernigau et al. 2021). Some veterinary schools complemented these lectures by implementing a flipped classroom approach, audiovisual conferencing, webinars, live-streams, and student polling (Routh et al. 2021, Ferrel and Ryan 2020).

Also, time for online chat at the end of pre-recorded or live sessions was offered (Routh et al. 2021). It gave students the possibility to discuss topics and ask questions (Routh et al. 2021). Some lecturers provided virtual office hours instead (Schoenfeld-Tacher and Dorman 2021). But, the experiences with chats and discussion rooms differed very much. In some cases, neither student-student nor student-teacher interactions were active although chat windows and post-lecture discussion rooms were provided through LMS (Yoo et al. 2021). On the

other hand, some surveys revealed that students appreciated time for discussion and questioning at the end of the sessions, and they even indicated that keeping sessions light-hearted by telling personal anecdotes or jokes was also very welcome (Routh et al. 2021).

Navigating through the challenges the COVID-19 pandemic brought, students were able to prove their adaptability to such a unique situation and showed their persistence (Ferrel and Ryan 2020, Carney and Thompson 2021). It offered the opportunity for innovation and outside-the-box thinking (Ferrel and Ryan 2020). Inevitably, the COVID-19 pandemic changed the way veterinary students will be taught in the future. But, to what extent veterinary education may be revised, detailed studies, which are yet to come, will offer valuable insights.

5.6 Limitations of this study

Albeit the complex study protocol of the presented project including a cross-over design, some potential limitations need to be discussed.

A possible limitation of the project may be related to the study population because only students from FU Berlin were enrolled in this study. It remains open if the enrolment of students of other countries, universities, or semesters would have led to similar results.

Due to the small number of male students in the study, no gender differences were sought. Of the 151 participants there were 126 female and only 25 male students. This gender-ratio is in accordance with distributions described for veterinary medicine students by other authors (Kostelnik and Heuwieser 2009, Radostits 2003). And it also resembles the gender-ratio of veterinarians in Germany. The previously male-dominated profession veterinary medicine has become feminine by now (Lofstedt 2003). In 2008, the number of female veterinarians (n = 17,777) exceeded the number of male veterinarians (n = 17,321) for the first time (BTK 2008).

Another potential source of bias was the varying time provided to work on the different learning methods. Contact time with the topic was 2 hours in case of writing, whereas it was only 30 minutes when students read or listened to a topic. Thus, contact time alone may have increased the learning outcome. However, the nature of writing a summary requires more time because more tasks such as reading, selecting relevant information, and writing have to be carried out. Therefore, a project protocol that had provided only 30 minutes for writing would not have been reasonable. Most subgroups used the two hours to prepare their summary, only few subgroups stated that they would have needed more time. On the other hand, more time for reading or the lecture had not been necessary. Regarding time, the lecture in this project may be considered as the most efficient learning method.

An additional shortcoming of this study may be a limited applicability of the results to larger groups of students in other teaching settings. Therefore, revised strategies may be helpful when teaching larger groups. In this project, the groups consisted of three to ten students. That made it easy to implement the study because it took the lecturer only a short time to instruct the students and to discuss the results.

Furthermore, in the context of this project not all written summaries were systematically evaluated for their overall quality or completeness in relation to the final test. Nevertheless, it can be stated that most summaries comprised all relevant information, which were extracted by the students from the original papers. A throughout revision and discussion of the information with the students, which was not possible in the actual project because of time restrictions, might have improved the results. In a setting with small or larger groups, peer review may be used, meaning that groups of students revise texts from other groups of students. In future projects, acceptance and learning outcomes of such approaches should be evaluated.

6 Conclusion

Writing a summary provides good learning outcomes even if it requires more time than reading or attending a presentation because it implies subtasks such as reading, selecting relevant information, and writing. The group work is a good possibility to motivate students to collaborate and engage themselves intensively with a topic and to discuss the findings. Yet, it needs to be considered that group work might not be feasible with a large group of students. To incorporate small groups, instead, may be challenging because of the increased time commitment (Wolff et al. 2015). Nevertheless, sessions with small groups may enhance interaction because it allows students to participate more willingly (Wolff et al. 2015).

The evaluation results indicating that many students do not like writing may be due to the fact that writing is hardly used as a learning method in veterinary curricula. Nonetheless, it may be worthwhile to implement writing texts into veterinary teaching more frequently to improve these skills, being important for a veterinarian when writing clinical reports, referrals, and veterinary opinions, for example (Park et al. 2012, Kolski et al. 2015, Kasch et al. 2017).

Because it is more time consuming, writing may not be the most efficient way of teaching in each setting. However, there are many occasions in the veterinary curriculum where writing can be considered as a possible teaching method to encourage teamwork and to lead to high quality output, which may be helpful to future generations of students such as wiki texts, as well as a good learning outcome (Park et al. 2012, Khoynaroud et al. 2020). Therefore, offering a mixture of different teaching methods during the veterinary curriculum, which include writing, is recommended.

7 Summary

Listening, reading, writing – which method leads to the best learning outcome?

Traditionally, lecture is the most widely used teaching method in veterinary education. It allows one teacher to provide a lot of information to a large audience with little effort. Therefore, it is a very effective way of teaching. But nowadays, lectures have been questioned as to whether they are motivating and engaging enough for a long-lasting learning outcome. Research has shown that just listening is not sufficient. Lectures are criticized as a one-way communication method. They do not involve the audience and, therefore, lead to passive learning outcome only. That is why it is important to integrate active teaching and learning methods in order to achieve a long-term learning retention.

In recent years, teaching strategies at universities have been revised and adapted to a more active way of learning. Innovative teaching strategies such as case-based learning and hands-on training have been increasingly integrated into undergraduate veterinary teaching. Nevertheless, it can be assumed that lectures still play an important role in many veterinary schools due to the better feasibility. In this context, the aim of the project was to compare acceptance and learning outcome of the teaching methods reading, writing, and listening to a presentation.

The course of study was developed with the help of students from the previous semesters as well as staff of the Clinic for Animal Reproduction. In structured settings, 151 students in their ninth and tenth semester at Freie Universität Berlin (FU Berlin) were asked to work on three different topics in the field of animal reproduction during their two-week rotation at the Clinic for Animal Reproduction. They were meant to read a paper, listen to a presentation by a lecturer, and write a summary in group work on a different one of three topics each. The topics that the students were expected to work on were selected based on the aspect that the students should be largely unfamiliar with them. Usually, these topics become part of the curriculum at FU Berlin from the time of the rotation. A small quiz marked the end of the first day of study.

A week later, the students were asked to complete a test with questions about each of these topics. They were also meant to answer a question on another topic that had not been taught in context of this project. The students were not aware of this final test in advance. In addition, they were given an evaluation form to state their prior knowledge of the topics queried but also their expectations of the outcome of the final test.

With regard to previous knowledge, it was shown that the students' assumption that they already had knowledge about some of the topics in advance was not reflected in the test

results. In terms of learning methods, writing a summary in group work led to the best learning outcome although the results did not differ significantly from the second best teaching method listening to a presentation. This was in correspondence to the expectations of the students. The teaching form students preferred most was the lecture, but almost two-thirds liked writing a summary, as well. The majority of the students also liked the group work as part of the task of writing a summary, which was additionally asked.

In conclusion, presentations by lecturers are still an important and effective teaching method. However, lectures should be supplemented by writing assignments. Training in this skill is particularly important given that writing clinical reports and opinions can be part of a veterinarian's job. Therefore, writing tasks may be suitable to be used in specific settings as a possible way to improve learning outcome in veterinary education.

8 Zusammenfassung

Hören, Lesen, Schreiben – welche Methode führt zum besten Lernergebnis?

Traditionell ist die Vorlesung die am weitesten verbreitete Lehrmethode in der veterinärmedizinischen Ausbildung. Es ermöglicht einer Dozentin oder einem Dozenten, einem großen Publikum mit wenig Aufwand viele Informationen zu vermitteln. Daher ist es eine sehr effektive Art des Unterrichtens. Heutzutage werden Vorlesungen jedoch dahingehend in Frage gestellt, ob sie motivierend und ansprechend genug sind, um einen nachhaltigen Lernerfolg zu erzielen. Die Forschung hat gezeigt, dass es nicht ausreichend ist, nur zuzuhören. Vorlesungen werden zudem als einseitige Kommunikationsmethode kritisiert. Sie beziehen das Publikum nicht mit ein und führen daher nur zu einem passiven Wissenserwerb. Deshalb ist es wichtig, aktive Lehr- und Lernmethoden zu integrieren, um einen langfristigen Lernerfolg zu erzielen.

In den letzten Jahren wurden Lehrstrategien an Universitäten überarbeitet und an eine aktivere Art des Lernens angepasst. Innovative Lehrstrategien wie Fallbasiertes Lernen und Hands-on-Training wurden zunehmend in die veterinärmedizinische Lehre integriert. Dennoch ist davon auszugehen, dass Vorlesungen an vielen veterinärmedizinischen Fakultäten aufgrund der besseren Durchführbarkeit nach wie vor eine wichtige Rolle spielen. In diesem Zusammenhang war es Ziel dieser Arbeit, Akzeptanz und Lernerfolg der Lehrmethoden Lesen, Schreiben und Hören einer Präsentation auszuwerten und zu vergleichen.

Der Studienaufbau wurde mithilfe von Studierenden aus den vorangegangenen Semestern sowie Mitarbeitenden der Tierklinik für Fortpflanzung entwickelt. In strukturierten Settings wurden 151 Studierende des neunten und zehnten Semesters der Freien Universität Berlin (FU Berlin) gebeten, während ihrer zweiwöchigen Rotation an der Tierklinik für Fortpflanzung drei verschiedene Themen im Bereich der Fortpflanzung der Tiere zu bearbeiten. Sie sollten jeweils zu einem von drei Themen ein Paper lesen, sich den Vortrag einer oder eines Dozierenden anhören und in Gruppenarbeit eine Zusammenfassung schreiben. Die Themen, die die Studierenden bearbeiten sollten, wurden unter dem Gesichtspunkt ausgewählt, dass sie den Studierenden weitgehend unbekannt sein sollten. In der Regel sind diese Fächer ab dem Rotationszeitpunkt Bestandteil des Lehrplans an der FU Berlin. Ein kleines Quiz bildete den Abschluss des ersten Studientages.

Eine Woche später wurden die Studierenden gebeten, einen Test mit Fragen zu jedem dieser Themen zu absolvieren. Sie sollten auch eine Frage zu einem anderen Thema beantworten, das nicht im Rahmen dieses Projekts gelehrt wurde. Diese abschließende Prüfung war den Studierenden im Vorfeld nicht bekannt. Zusätzlich erhielten sie einen Evaluationsbogen, in

dem sie ihre Vorkenntnisse zu den bearbeiteten Themen und ihre Erwartungen an den Ausgang des Abschlusstests angeben sollten.

Hinsichtlich der Vorkenntnisse zeigte sich, dass die Annahme der Studierenden, bereits im Vorfeld Wissen über einige der Themen zu besitzen, sich nicht in den Testergebnissen widerspiegelte. In Bezug auf die Lernmethoden erzielte das Schreiben einer Zusammenfassung in Gruppenarbeit die besten Lernresultate, gefolgt vom Anhören einer Präsentation. Dies entsprach den Erwartungen der Studierenden. Die Lehrform, die von den Studierenden bevorzugt wurde, war die Vorlesung, fast zwei Drittel schrieben wiederum gern eine Zusammenfassung. Der Mehrheit der Studierenden gefiel zudem die Gruppenarbeit, wonach im Rahmen der Aufgabe, eine Zusammenfassung zu schreiben, zusätzlich gefragt worden war.

Abschließend kann festgehalten werden, dass Präsentationen von Dozierenden immer noch eine wichtige und effektive Lehrmethode darstellen. Vorlesungen sollten jedoch durch Aufgaben, die das Schreiben von Texten beinhalten, ergänzt werden. Die Ausbildung in dieser Fähigkeit ist besonders wichtig, da das Verfassen klinischer Berichte und Gutachten Teil der Arbeit von Tierärztinnen und Tierärzten sein kann. Daher sind Schreibaufgaben geeignet, um in bestimmten Lehrsituationen der tierärztlichen Ausbildung die Lernergebnisse zu verbessern.

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10 Appendix

10.1 Quiz

Quiz

Die Stuten der Neuweltkameliden …

… sind die meiste Zeit deckbereit.
… sind nur deckbereit, wenn ein Follikel vorhanden ist, der über 7 mm groß ist.
… sind von April bis Oktober deckbereit.

Ein äußeres Anzeichen für eine Brunst bei Stuten der Neuweltkameliden …

… ist das sogenannte Blitzen der Schamlippen wie bei der Stute.
… ist das Hinlegen in sternale Liegeposition.
… gibt es nicht für eine zuverlässige Zyklusbestimmung.

Wenn es beim Frettchen im Östrus nicht zum Deckakt kommt,

... entwickelt sich aufgrund fortwährender Östrogenproduktion eine Dauerbrunst.
… entwickelt sich eine Scheinträchtigkeit mit Gesäugeschwellung.
… entstehen in der Gebärmutterwand nach kurzer Zeit multiple Zysten.

Der Hyperadrenokortizismus bei Frettchen …

… entsteht, wenn man Rüden zu spät kastriert, d. h. wenn sie älter als 5 – 6 Jahre alt sind.
… tritt gehäuft auf, wenn sie unter künstlichen Lichtbedingungen gehalten werden.
… entspricht nicht der Cushing-Erkrankung bei Hund und Katze.

Die mammäre Hypertrophie der Katze

… wird auch als fibroadenomatöse Hyperplasie bezeichnet.
… betrifft insbesondere ältere Katzen, die bereits mehrfach geworfen haben.
… kann auch bei Katern auftreten, verursacht durch hormonelle Imbalance aufgrund einer Prostataerkrankung.

Die mammäre Hypertrophie

… tritt häufiger im Bereich der kranialen Komplexe auf, da die Durchblutung dort größer ist.
… verläuft progressiv und ist in der Regel nicht schmerzhaft.
… besteht aus glatten, abgekapselten, bis zu 10 cm³ großen, nicht flüssigkeitsgefüllten Knoten.

Die Trächtigkeitstoxikose beim Meerschweinchen …

… tritt vor allem bei fetten oder gestressten Tieren auf.
… tritt vor allem bei Einlingsträchtigkeiten auf, weil diese vermehrt zu Geburtsproblemen führen.
… ist meist an einem übelriechenden Vaginalausfluss zu erkennen.

Die Trächtigkeitstoxikose führt pathologisch-anatomisch zu ...

… Nierennekrosen.
… Leberverfettung.
… Ovarialzysten.

Fig. 10.1. Quiz. Quiz taken at the end of the first day, with eight questions relating to the four topics. One answer out of three was correct.

10.2 Evaluation form

Fragebogen zum Lernerfolg-Projekt

Mit dieser Befragung wollen wir untersuchen, wie Sie den Lernerfolg unterschiedlicher Methoden einschätzen, ob und wie intensiv Sie sich persönlich an den Arbeiten beteiligt haben und wie Ihnen das Projekt gefallen hat. Es handelt sich hierbei um eine Umfrage im Rahmen einer Dissertationsarbeit der Tierklinik für Fortpflanzung der FU Berlin (www.tiergyn.de). Alle Informationen werden anonymisiert verwendet und vertraulich behandelt! Bitte geben Sie jeweils an, inwieweit die Aussagen Ihrer Ansicht nach zutreffen.

Vielen Dank für Ihre Mitarbeit!

Janine Güldenpfennig Dr. Sebastian Arlt Prof. Dr. Wolfgang Heuwieser

Persönliche Daten:

Alter:_____ Semester:_____ Geschlecht:_____

1. Welche Medien nutzen Sie üblicherweise zur Prüfungsvorbereitung?
   Bitte geben Sie an, inwieweit die Aussagen Ihrer Ansicht nach zutreffen.

Aussage	trifft voll und ganz zu	trifft zu	trifft mäßig zu	trifft nicht zu	trifft gar nicht zu		kann ich nicht beurteilen
Lehrbücher	□	□	□	□	□		□
Vorlesungsmitschriften	□	□	□	□	□		□
Skripte (der FU Berlin und/oder der anderen tiermedizinischen Hochschulen)	□	□	□	□	□		□
Artikel aus Fachzeitschriften	□	□	□	□	□		□
Internet (Nachschlageseiten wie wikipedia.de, Foren, tiermedizinische Portale wie vetion.de etc.)	□	□	□	□	□		□
Anderes, und zwar:	□	□	□	□	□		□

2. Fragen zum Lernerfolg durch die unterschiedlichen Methoden.
   Bitte geben Sie an, inwieweit die Aussagen Ihrer Ansicht nach zutreffen.

Statement/Frage	trifft voll und ganz zu	trifft zu	trifft mäßig zu	trifft nicht zu	trifft gar nicht zu		kann ich nicht beurteilen
Am meisten zu einem Thema habe ich gelernt durch:							
… den 30-minütigen Kurs, der gehalten wurde.	□	□	□	□	□		□
… das Lesen der vorgegebenen Artikel.	□	□	□	□	□		□
… das gemeinschaftliche Erstellen des Artikels.	□	□	□	□	□		□

3. Bitte schätzen Sie ein, wie intensiv Sie sich an den jeweiligen Gruppenaufgaben beteiligt haben:
   Bitte geben Sie an, inwieweit die Aussagen Ihrer Ansicht nach zutreffen.

Statement/Frage	trifft voll und ganz zu	trifft zu	trifft mäßig zu	trifft nicht zu	trifft gar nicht zu		kann ich nicht beurteilen
Ich habe mich an der Gruppenarbeit beteiligt durch:							
… Selektion relevanter Informationen aus der Literatur.	□	□	□	□	□		□
… Verfassen des Artikels.	□	□	□	□	□		□

- Bitte wenden! -

Fig. 10.2. Evaluation form, page 1. Page 1 of the evaluation form handed out at the second day, consisting of a total of ten questions.

4. Haben Sie bereits vor diesem Projekt veterinärmedizinische Fachartikel gelesen?

   ☐ Nein ☐ Ja, einen ☐ Ja, 2-5 ☐ Ja, 6-10 ☐ Ja, mehr als 10

5. Haben Sie bereits vor diesem Projekt eigenständig Fachartikel mit veterinärmedizinischem Inhalt erstellt (welche mehr als eine halbe DinA4-Seite umfassten)?

   ☐ Nein ☐ Ja, einen ☐ Ja, 2-5 ☐ Ja, 6-10 ☐ Ja, mehr als 10
   ☐ Fall-/Patientenbericht(e) ☐ Artikel für ein Wiki-System
   ☐ Sonstiges: _____

6. Bitte antworten Sie ehrlich: Haben Sie sich intensiv mit den Teilnehmern der anderen Gruppe über die erarbeiteten Themen ausgetauscht?

   ☐ Ja ☐ Nein

7. Haben Sie sich intensiv mit den Teilnehmern der vorhergehenden Rotationsgruppen über die erarbeiteten Themen ausgetauscht?

   ☐ Ja ☐ Nein

8. Waren Ihnen wesentliche Informationen zu dem jeweiligen Thema bereits vor der Rotation an der Tierklinik für Fortpflanzung bekannt?
   Bitte geben Sie an, inwieweit die Aussagen Ihrer Ansicht nach zutreffen.

Thema	trifft voll und ganz zu	trifft zu	trifft mäßig zu	trifft nicht zu	trifft gar nicht zu		kann ich nicht beurteilen
Mammäre Hypertrophie der Katze	□	□	□	□	□		□
Trächtigkeitstoxikose beim Meerschweinchen	□	□	□	□	□		□
Hyperöstrogenismus beim Frettchen	□	□	□	□	□		□
Reproduktion der Neuweltkameliden	□	□	□	□	□		□

9. Haben Ihnen die einzelnen Aufgabenteile in dem Projekt gefallen?
   Bitte geben Sie an, inwieweit die Aussagen Ihrer Ansicht nach zutreffen.

Thema	trifft voll und ganz zu	trifft zu	trifft mäßig zu	trifft nicht zu	trifft gar nicht zu		kann ich nicht beurteilen
Lesen aktueller Paper	□	□	□	□	□		□
Vortrag über aktuelle Paper	□	□	□	□	□		□
Schreiben eines Artikels über aktuelle Paper	□	□	□	□	□		□
Gruppenarbeit	□	□	□	□	□		□
Abschlussquiz (erste Woche)	□	□	□	□	□		□

10. Bitte geben Sie an, inwieweit die folgenden Aussagen Ihrer Ansicht nach zutreffen.

Aussage	trifft voll und ganz zu	trifft zu	trifft mäßig zu	trifft nicht zu	trifft gar nicht zu		kann ich nicht beurteilen
Im Studium sollte mehr aktuelle Literatur eingebunden werden.	□	□	□	□	□		□
Das Lesen von Fachartikeln im Studium ist sinnvoll.	□	□	□	□	□		□
Das Schreiben, Sammeln und online Veröffentlichen von zusammenfassenden Artikeln im Studium ist sinnvoll.	□	□	□	□	□		□

Fig. 10.3. Evaluation form, page 2. Page 2 of the evaluation form handed out at the second day, consisting of a total of ten questions.

10.3 Final test

Thema: Hyperöstrogenismus beim Frettchen

Ich habe dieses Thema im Rahmen der Rotation … (bitte ankreuzen ⊗)			
O gelesen	O im Kurs gehört	O für einen Artikel bearbeitet	O nichts davon

Frage 1: Welche Aussage zum Sexualzyklus des Frettchens ist richtig?
☐ Der Zyklus ist asaisonal polyöstrisch. Der Metöstrus fällt so kurz aus (4 bis 5 Tage), dass es zur Kumulation von Östrogen im Blut der Fähe kommen kann.
☐ Hohe Östrogenkonzentrationen wirken beim Frettchen adrenerg und bewirken eine vermehrte Cortisolausschüttung aus der Nebenniere.
☐ Der Zyklus ist saisonal (long-day breeder). Die meisten Fähen befinden sich in der Fortpflanzungsperiode bis zum Deckakt in einem konstanten Östrus.
☐ Hohe Östrogenkonzentrationen wirken hemmend auf die Nebenniere des Frettchens, wodurch ein Mangel an Cortisol im Blut entsteht.
☐ Ich weiß nicht.

Frage 2: Welche Aussage trifft auf die Kastration beim weiblichen Frettchen zu?
☐ Ein hoher Anteil der Fähen wird nach der Kastration inkontinent. Diese sind dauerhaft auf eine Therapie mit Östrogenderivaten angewiesen.
☐ Nach der Kastration können erhöhte LH- und FSH-Werte einen Hyperadrenokortizismus induzieren.
☐ Aufgrund des fehlenden Progesterons entwickelt sich bei einigen Fähen ein klinisch manifester Diabetes mellitus.
☐ Nach der Kastration können dennoch Ranz-Symptome auftreten, die durch erhöhte FSH-Spiegel ausgelöst werden.
☐ Ich weiß nicht.

Frage 3: Welches ist kein Symptom des Hyperöstrogenismus?
☐ Alopezie
☐ Apathie
☐ Panzytopenie
☐ Polyurie
☐ Ich weiß nicht.

Thema: Fortpflanzung der Neuweltkameliden

Ich habe dieses Thema im Rahmen der Rotation … (bitte ankreuzen ⊗)			
O gelesen	O im Kurs gehört	O für einen Artikel bearbeitet	O nichts davon

Frage 1: Ab welcher Follikelgröße wird bei einem weiblichen Alpaka durch den Deckakt eine Ovulation ausgelöst?
☐ Ab einer Größe von 5 mm.
☐ Ab einer Größe von 7 mm.
☐ Ab einer Größe von 12 mm.
☐ Bei Vorliegen von mindestens drei Follikeln mit einer Größe über 10 mm.
☐ Ich weiß nicht.

Frage 2: Wie lange dauert durchschnittlich die Kopulation bei Neuweltkameliden?
☐ Etwa 20 bis 60 Sekunden.
☐ Etwa 3 bis 8 Minuten.
☐ Etwa 15 bis 20 Minuten.
☐ Etwa 90 bis 120 Minuten.
☐ Ich weiß nicht.

Frage 3: Welche Aussage ist richtig?
☐ In 10 % der Fälle treten Doppelovulationen auf, Zwillingsgeburten sind keine Seltenheit.
☐ Die Ovulation lässt sich bei Stuten auch ohne Deckakt nur aufgrund visueller, akustischer und geruchlicher Reize auslösen.
☐ Mit Erreichen des Körpergewichts eines erwachsenen Tieres im Alter von ca. 2 – 2,5 Jahren kommt es zur ersten Paarung.
☐ In über 70 % der Fälle wird eine Rechtshornträchtigkeit beobachtet.
☐ Ich weiß nicht.

- Bitte wenden! -

Fig. 10.4. Final test, page 1. Page 1 of the unannounced final test, including three questions about each of the four topics. One out of four answers was correct.

Thema: Trächtigkeitstoxikose beim Meerschweinchen

Ich habe dieses Thema im Rahmen der Rotation … (bitte ankreuzen ⊗)
O gelesen O im Kurs gehört O für einen Artikel bearbeitet O nichts davon

Frage 1: Wann tritt die Trächtigkeitstoxikose beim Meerschweinchen im Allgemeinen auf?
☐ In der Mitte der Trächtigkeit, wenn das Größenwachstum der Jungtiere beginnt.
☐ In der Hochträchtigkeit. Vorher ist der Energiebedarf noch nicht hoch, und nach der Geburt ist wieder ausreichend
Platz für den Magen.
☐ Meist erst in der dritten Woche der Laktation, da die Jungtiere dann über die Milch sehr viel Energie entziehen.
☐ Im Zeitraum zwei Wochen vor der Geburt bis zwei Wochen nach der Geburt.
☐ Ich weiß nicht.

Frage 2: Welchen Blutbefund findet man bei Meerschweinchen mit einer Ketose?
☐ Hypoglykämie und Hypoketonämie
☐ Hypoglykämie und Hyperketonämie
☐ Hyperglykämie und Hyperinsulinämie
☐ Hyperglykämie und Hypoinsulinämie
☐ Ich weiß nicht.

Frage 3: Als prophylaktische Maßnahme zur Vermeidung der Trächtigkeitstoxikose wird empfohlen, …
☐ … den Rohfaseranteil im Futtermittel zu senken.
☐ … die Umweltbedingungen konstant zu halten.
☐ … den Anteil an Omega-3-Fettsäuren im Futter deutlich zu reduzieren.
☐ … das trächtige Weibchen aus dem Rudel zu separieren.
☐ Ich weiß nicht.

Thema: Fibroepitheliale Hyperplasie bei der Katze

Ich habe dieses Thema im Rahmen der Rotation … (bitte ankreuzen ⊗)
O gelesen O im Kurs gehört O für einen Artikel bearbeitet O nichts davon

Frage 1: Die typischen klinischen Symptome der fibroepithelialen Hyperplasie sind:
☐ Vergrößerung aller Gesäugekomplexe mit protrahierter Vergrößerung der Lymphknoten, keine Ausmassierbarkeit von
Sekreten, Schmerzhaftigkeit.
☐ Vergrößerung einzelner Gesäugekomplexe mit protrahierter Vergrößerung der Lymphknoten, keine Ausmassierbarkeit
von Sekreten, Schmerzhaftigkeit.
☐ Vergrößerung des Gesäuges, Vergrößerung der Lymphknoten, Ausmassierbarkeit eines wässrigen Sekrets.
☐ Vergrößerung des Gesäuges, keine Vergrößerung der Lymphknoten, keine Ausmassierbarkeit eines Sekrets.
☐ Ich weiß nicht.

Frage 2: Eine mögliche Ursache ist …
☐ … eine vorherige Behandlung mit Progesteronderivaten.
☐ … eine vorherige Behandlung mit Prolaktininhibitoren.
☐ … eine vorherige Behandlung mit Progesteronantagonisten.
☐ … eine vorherige Behandlung mit Östrogenderivaten zur Inkontinenztherapie.
☐ Ich weiß nicht.

Frage 3: Wie kann eine fibroepitheliale Hypertrophie nicht behandelt werden?
☐ Durch eine Kastration
☐ Durch die Gabe von Aglepriston
☐ Durch eine Mastektomie
☐ Durch die Gabe von Medroxyprogesteronacetat.
☐ Ich weiß nicht.

Bitte ehrlich antworten: War bereits vorher bekannt, dass es einen Abschlusstest geben wird?
☐ Ja. ☐ Nein.

Fig. 10.5. Final test, page 2. Page 2 of the unannounced final test, including three questions about each of the four topics. One out of four answers was correct.

11 List of publications

Güldenpfennig J, Bartel A, Arlt S. Listening, reading, writing – which method leads to the best learning outcome? Hören, Lesen, Schreiben – welche Methode führt zum besten Lernergebnis? Tierarztl Prax Ausg K Kleintiere Heimtiere. 2023;51(4): 242-251. doi: 10.1055/a-2136-7599

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13 Conflicts of interest

Within the scope of this work there are no conflicts of interest due to benefits from third parties.

14 Interessenkonflikte

Im Rahmen dieser Arbeit bestehen keine Interessenkonflikte durch Zuwendungen Dritter.

15 Declaration of authorship

I, Janine Güldenpfennig, hereby declare that this submitted thesis “Listening, reading, writing – which method leads to the best learning outcome?” is my own work and that I have not used any sources other than those listed in the bibliography.

Garstedt, September 27, 2023 Janine Güldenpfennig

16 Selbständigkeitserklärung

Hiermit bestätige ich, Janine Güldenpfennig, dass ich die vorliegende Arbeit „Hören, Lesen, Schreiben – welche Methode führt zum besten Lernergebnis?“ selbstständig angefertigt habe. Ich versichere, dass ich ausschließlich die angegebenen Quellen und Hilfen in Anspruch genommen habe.

Garstedt, 27.09.2023 Janine Güldenpfennig

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