2

The challenge of remote practical teaching and e-learning assessment in Veterinary Medicine

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Introduction

Online teaching or e-learning has experienced a progressive increase in recent years (Pei & Wu, 2019). However, the current crisis situation caused by the Covid-19 pandemic, has forced most of educational institutions to rapidly adapt and include non-face-to-face teaching-learning methodologies, even in degrees with high practical content. This quick adaptation has supposed a real challenge for those institutions who traditionally followed a face-to-face teaching format, especially in Health Sciences educational programs (Ferrara *et al.,* 2020).

According to Dong *et al.* (2020), e-learning is defined as every educational activity that is carried out via Internet or with information technology. This ubiquitous modality of learning has shown some advantages over traditional off-line teaching, such as the absence of time and spatial limitations (Pei & Wu, 2019) and even linguistic barriers (Dong *et al.*, 2020). However, it also presents some limitations, as it could lead to a decreased interaction between the teacher and the students, and also a reduced collaboration between students (Pei & Wu, 2019; Petrarca *et al.*, 2018). Furthermore, students are required to self-encourage and be as independent as possible with their work (Petrarca *et al.*, 2018).

On the other hand, virtual teaching represents an important challenge for subjects with clinical contents (Petrarca *et al.*, 2018; Sawras *et al.*, 2020), such as laboratory skills or as it happens in Veterinary Medicine which is characterized by high contents of hands-on participation of the students which leads to an active learning of the subject based on direct experience (Monahan & Yew, 2002). In this regard, it is necessary to analyze how the implementation of a non-presential teaching-learning methodology affects the academic results of veterinary students compared to those who have carried out the on-site practical activities at a laboratory and visiting livestock farms. One of the possible metho-

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dologies frequently used to integrate theoretical and clinical learning in medical and veterinary subjects is the case-based learning (CBS) (Sawras *et al.,* 2020). This methodology has been successfully adapted to on-line learning in subjects of the Degree in Veterinary Medicine in previous studies (Allenspach, Bell & Whittlestone, 2008; Monahan & Yew, 2002; Sawras *et al.,* 2020). However, in order to better understand the real effectiveness of on-line CBS, studies comparing the knowledge acquired by this adapted methodology with the off-line CBS modality should be performed.

Assessment of the skills and knowledge acquired by the students is also important in order to evaluate the efficiency of a teaching program. Although some studies have shown higher academic performance in students who attend on-line courses (Wassef & Elkhamisy, 2020), a more careful analysis of virtual evaluation systems should be performed, especially when evaluating clinical skills (Gledhill *et al.*, 2017; Torres-Madroñero, Torres-Madroñero & Ruiz Botero, 2020).

Therefore, the objectives of this study[1] are: 1) to compare the learning outcomes and academic performance of the students who attended face-to-face and virtual activities, both through CBS; and 2) to compare the student assessments of acquired knowledge between those who take a traditional (on-site) exam or a virtual (non face-to-face) exam. This study was performed in a context of a clinical subject in the Degree in Veterinary Medicine, using the subject of Parasitic Diseases as a model.

Methodology

Study subjects

In the context of social distancing and self-containment measures imposed during the first wave of the Covid-19 pandemic in Murcia, Spain, the on-site practical activities were suspended for veterinary students from March 16th to the end of July 2020. From the total of 91 students who were enrolled for practical training of Parasitic Diseases from February to May 2020, 51 attended face-to-face clinical lessons prior to the confinement (FC group), while the remaining 40 students that had scheduled their practical training after March were only able to participate in virtual lessons (VC group).

Ninety students took the theoretical examination of Parasitic Diseases during the 2020/2021 academic course. The Covid-19 pandemic in Murcia also caused the suspension of the June and July face-to-face examinations, so they had to be performed on-line. From the total of 90 students, 48 took a traditional mode (TE group) in February 2020, while other 42 students took a virtual exam (VE group) in June or July 2020, for the first half of the subject contents. All the students were virtually assessed for the second half of the subject contents in June or July 2020.

1 This work is a development of the abstract published in the CIVINEDU Conference 2020 Book of Proceedings.

Practical lessons and qualifications

Practical activities consisted of:

- Presentation and discussion of a seminar in front of the teacher and the rest of the group´s classmates, which was carried out in the classroom (FC group) or by videoconference (VC group).
- Diagnosis and solving clinical cases of parasitic diseases from different animal species that was performed using diagnostic techniques in the laboratory (FC group) or by solving previously designed virtual cases based on images, videos and internet resources (VC group).

Seminars were assessed by the teacher *in situ* during the class. The criteria for evaluating the students were based on the coherence of the answers, attitude, writing and oral clarity, and synthesis capability. After two weeks of practical activities, both student groups had to demonstrate the acquired skills and knowledge by means of a written test, with similar structure and contents for both groups, consisting of five short questions concerning the parasitic diseases that were the subject of the practical activities.

Seminar and written exam qualifications could range between 0 and 10 points. In order to pass both the seminar and the written exam, a minimum score of 5 points was required. The final grades obtained by the students of both groups were calculated by weighting the scores achieved in the seminar (40% of the final grade) and the written exam (60%), with a maximum of 5 points. A minimum score of 2.5 points at the final grade was also required to pass the practical training of Parasitic Diseases.

Theoretical evaluation

At the end of each semester, students had to prove their acquired knowledge in the basis of pathogenesis, epidemiology, clinical presentation and control of Parasitic Diseases. The contents of these lessons were divided into two partial exams, each of which the student could obtain a maximum of 5 points and both to be passed independently (more than 2.5 points).

Design of the traditional face-to-face test included:

- 30 multiple choice questions, with four possible answers of which only one is correct.
- Four short essay questions. Accurate and correct responses, writing clarity and synthesis and analysis capability were the evaluated criteria.

Virtual exam consisted of 50 multiple choice questions, with four possible answers of which only one is correct. It was carried out through the Sakai-based examination tool available in the University of Murcia's On-line Teaching Platform (Sakai, 2020).

Final qualification

After having separately passed both the practical and theoretical parts of the subject, final qualifications were calculated by summation of the practical final grade and the average value of both theoretical partial examinations, with a maximum of 10 points. To pass the course, a minimum score of 5 points was needed.

Data analysis

Statistical significance between the average scores (seminar, written exam and final grade) obtained by both FC and VC groups was studied by Student's T test. Median, 25th and 75th percentiles of the different scores were represented by box-plots. Statistical analysis was performed by SPSS software (Statistical Package for Social Sciences, Version 22.0, IBM Corp., Armonk, NY, USA). Significant statistical differences were considered when p value < 0.05.

Results

Practical lessons

All students, both from in the FC and VC groups, passed the practical part of the subject. The mean scores obtained by FC and VC groups in the seminar, written exam and final grade are shown in Table 1.

Table 1. Mean scores for seminar, written exam, practical final grade, first partial examination and final qualification of the subject

		N	Mean score
Seminar	FC group	48	7,50
	VC group	37	8,94
Written exam	FC group	50	7,69
	VC group	39	8,79
Practical final grade	FC group	48	3,82
	VC group	37	4,42
First partial examination	TE group	48	6,44
	VE group	42	7,07
Final qualification	TE group	48	8,05
	VE group	42	7,12

N = Number of students who took the evaluation; FC group = group of students attending to face-to-face practical lessons; VC group = group of students attending to virtual practical lessons; TE group = group of students taking traditional first partial examination; VE group = group of students taking virtual first partial examination.

However, the VC group got better results, with average scores significantly higher in the seminar, the written exam and the final grades ($p < 0.001$) (Table 2). Comparison of median, 25th and 75th percentiles of the different scores obtained by FC and VC groups are graphically represented in Figure 1.

Table 2. Results of Student's T test for seminar, written exam and final grades depending of the practical training modality (face-to-face for FC group and virtual for VC group), and for first partial examination and final qualification of the subject according to the modality of first partial exam (traditional for TE group and virtual for VE group)

		Levene's test for equality of variances		**Student's T test for equality of means**				
		F	Sig	t	df	Sig. (2-tailed)	Mean difference	Std. Error difference
Seminar	Equal variances assumed	10,12	,002	-6,31	83	,000*	-1,44220	,22855
	Equal variances not assumed			-6,63	81,61	,000*	-1,44220	,21749
Written exam	Equal variances assumed	17,54	,000	-4,37	87	,000*	-1,09418	,25011
	Equal variances not assumed			-4,69	77,79	,000*	-1,09418	,23321
Practical final grade	Equal variances assumed	9,39	,003	-5,72	83	,000*	-,59868	,10464
	Equal variances not assumed			-6,11	77,63	,000*	-,59868	,09804
First partial examination	Equal variances assumed	4,92	,029	-1,81	88	,074	-,63149	,34881
	Equal variances not assumed			-1,76	68,42	,083	-,63149	,35863
Final qualification	Equal variances assumed	,449	,505	3,73	88	,000*	,92202	,24751
	Equal variances not assumed			3,70	83,62	,000*	,92202	,24909

* = Statistically significant.

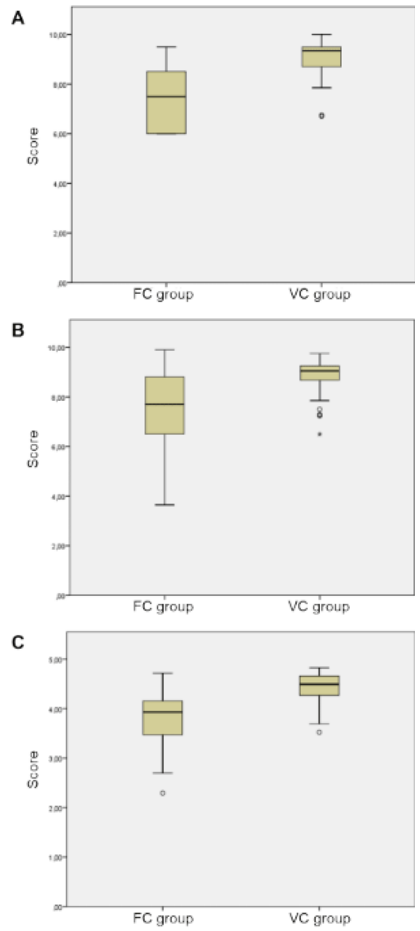

Figure 1. Box plots representing seminar (1A), written evaluation (1B) and final (1C) grades achieved by both students who attended to face-to-face practical lessons (FC group) and virtual practical lessons (VC group)

Theoretical examination and final qualification

The majority of students (87.8%) from both TE and VE groups passed the first partial examination. Only 11 students failed the exam. Mean grades obtained by TE and VE groups in the first partial exam and the final qualification are represented in Table 1. Although VE group seemed to have a better performance (7.07) than TE group (6.44) in the first partial exam, there was no significant difference between the average scores obtained by both groups ($p > 0.05$) (Table 2).

Focusing in the final qualification, only 3 students did not pass the course. Therefore, 96.7% of students had a successful achievement in the subject of Parasitic Diseases. Mean scores of TE group (8.05) were higher than those achieved by VE group (7.12), with statistically significant differences between both groups ($p < 0.001$) (Table 2).

Median, 25th and 75th percentiles of first partial exam and subject final grades were graphically compared between TE group and VE group (Figure 2).

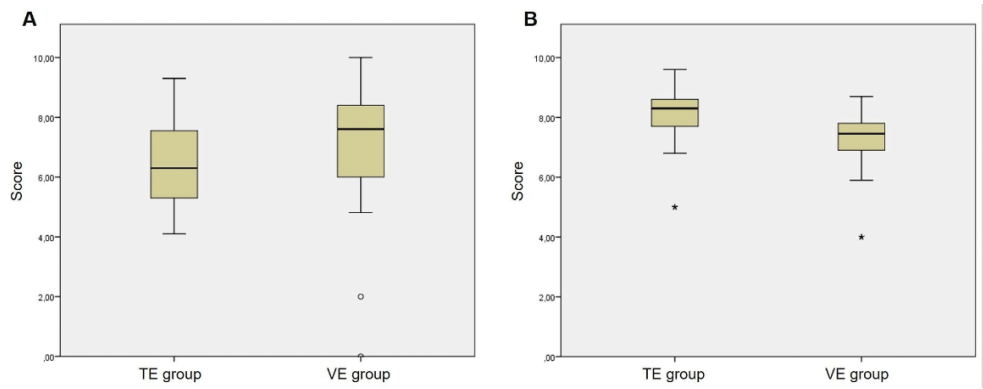

Figure 2. Box plots depicting median, 25th and 75th percentiles of first partial examination scores (A) and final qualification of the subject (B) obtained by students who took the first partial examination in a traditional (TE group) or virtual (VE group) modality

Discussion

In the present study, the results obtained seem to indicate that the students participating in virtual classes have been able to optimize the time and resources available on self-learning oriented activities (Marcus, Taylor & Ellis, 2004), and performed better on demonstrating their practical knowledge of the key information related to the parasitic diseases of animals (etiology, diagnosis, lesions, clinical signs, treatment and preventive measures), and therefore, getting higher score in the final practical evaluation. In addition, due to the sudden need of virtual classes, teachers may have made special efforts during virtual clinical cases providing more videos, precise images and internet links referring to parasitic diseases to the VC group (Allenspach *et al.*, 2008). So, although the absence of interaction between teacher and students has been found as a possible limitation for online learning (Pei & Wu, 2019), in the present study, there was a similar interaction between the teacher and both FC and VC groups.

On the other hand, in the light of the results achieved, CBS has been correctly adapted to e-learning for Parasitic Diseases subject. According to Sawras *et al.* (2020), online CBS shows several advantages. For example, it facilitates the standardization on course content, which could be also available on student's demand. Furthermore, immediate results could be obtained and discussed with the teacher and other classmates by video-conference, and also avoiding the laboratory expenses. In contrast, Marcus *et al.* (2004) detected variable learning outcomes of online CBS caused by the fact that some students only acquired limited knowledge of the subject, and a deep understanding of the causes and mechanism of disease is necessary to be acquired in order to succeed in Veterinary Sciences. We have to take into account that hands-on training in the laboratory with real samples and visiting farms is an essential part of clinical training for veterinary students (Sawras *et al.*, 2020), but possibly due to the difficulty to perform time-consuming technical skills to diagnose parasitic diseases by means of a microscope, the FC group got lower grades in the written exam, while during the virtual exam the teacher made available a picture with the parasite or lesion to identify to the students, so they did not have any limitation regarding the use of the microscope.

Students who took a traditional first partial exam achieved a better final qualification than those who took a virtual exam. This finding could be caused by the lack of experience in virtual evaluation systems that had undergraduate students that took part in the study, who were used to face-to-face written exams. Nowadays, this assessment method is the most frequently used by Universities and other educational institutions to standardize the students outcomes (Torres-Madroñero *et al*., 2020). An alternative hypothesis is that students who take the first partial examination in February are those who normally attend to every theoretical lesson and/or dedicate a daily effort to study the contents of the subject. Anyway, results of the present study could agree with those showed in a wide systematic review and meta-analysis performed by Pei & Wu in 2019. Although none of the studies collected on this review showed worse outcomes when using e-learning than offline teaching, they did not find that e-learning had a better effectiveness than the face-to-face evaluation system.

Importantly, the advantage of carrying out face-to-face activities is that students acquire practical skills in the laboratory or in the clinical activity that cannot be acquired through virtual learning, although they are not always reflected in the final grades. E-learning could also be affected by computer-related or technical, or even accessibility problems (Dong *et al.*, 2020). Further improvements on practical on-line teaching would be to design and use new tools that could mimic the activities carried out in the diagnostic laboratory, such as the virtual microscope Leica SCN400 Image Viewer (Leica Microsystems) and other e-learning tools, and to incorporate more specific E-Learning Platforms focused in Veterinary Sciences (Gledhill *et al.*, 2017); and, more importantly, to use evaluation systems designed to reflect more accurately the skills acquired by the students (Torres-Madroñero *et al.*, 2020).

Conclusion

This study provides an example of the successful qualifications obtained by students who attended to virtual practical activities, comparing to those who assist to laboratory practices. On the other hand, it shows a better performance of students who took a traditional exam than those who had a virtual assessment of their acquired knowledge. Some implementations should be incorporated on the virtual model, in order to equal the learning achievements which are usually obtained by face-to-face practical lessons and traditional evaluation of the subject.

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