HOW THE COVID-19 PANDEMIC IMPACTED A FUTURE GENERATION OF VETERINARIANS

by

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ABSTRACT

Our study will provide insight into the effects of the COVID-19 pandemic on pre-veterinary students and recent veterinarian graduates, specifically from the perspective of established veterinarians. This mixed methods study will explore these veterinarian perspectives via survey data collection and further analysis. This study aims not only to review the effects of COVID-19 on veterinary professionals and pre-veterinary students but also to discuss the implications on the profession's future. How will newly graduated veterinarians practice clinical medicine, and to what degree? How will pre-veterinary students perform in veterinary school? Overall, how did the COVID-19 pandemic impact a future generation of veterinarians? To answer these questions, our study will provide a unique perspective strictly from veterinarians, which has yet to be evaluated.

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I. INTRODUCTION

The traditional education system throughout the COVID-19 pandemic was disrupted by the transition from face-to-face interactions to students exclusively learning online. Institutions of higher education were subject to this transition, impacting how students attending undergraduate or professional programs learned and applied knowledge to real-world scenarios. Veterinary medicine is a field requiring hands-on experience throughout the training process, which ranges from completion of high school, taking collegiate courses, and attending veterinary school. Pre-veterinary students applying to veterinary school must earn hours shadowing a veterinarian in multiple areas of the veterinary field, participate in extracurricular and volunteer activities, submit letters of recommendation, and receive grades noting academic success in pre-requisite courses (American Veterinary Medical Association [AVMA], 2023). Once in veterinary school, students undergo rigorous coursework through didactic methods and gain hands-on experience with animals and their owners.

According to Mahdy (2020), most subjects in veterinary medicine hold practical aspects, and students believe it is challenging to meet the level of competency a veterinarian must possess through online learning only. Many studies have been done on veterinary students' perceptions of the COVID-19 pandemic in relation to academia (Mahdy & Sayed, 2022; Aslim et al., 2023). Other studies have investigated newly developed techniques for virtually providing veterinary medical education (Hunt & Anderson, 2022). Research done by Trivedi et al. (2022) touches on the impact of the pandemic on pre-veterinary opportunities, with 92% of 286 pre-veterinary students reporting losing at least one experience opportunity that Doctor of Veterinary Medicine (DVM) admissions teams look for, such as veterinary, research, and extracurricular experiences. However, research has yet to be done on the impact of COVID-19 on veterinary medical

education from the perspective of seasoned veterinarians. Therefore, our study aims to evaluate how the shift to online learning impacted pre-veterinary students and recent veterinary graduates who underwent educational training during the COVID-19 Pandemic, specifically from the perspective of seasoned veterinarians.

II. REVIEW OF THE LITERATURE

COVID-19: Impact on Education

The COVID-19 pandemic involved nationwide closure of educational institutions and halted in-person interactions. After a global health emergency was declared by the World Health Organization (WHO) on January 30, 2020, it took an average of two weeks after the detection of the first case of COVID-19 within a country for that country to implement national policies for the closure of schools (Nazif-Muñoz et al., 2021). Even though two weeks is a rapid time to implement policies on a national level, early transmission of the virus still led to 95,333 confirmed cases of COVID-19 by the first week of March 2020 (Sun et al., 2020). As a result of climbing case numbers, the transition to digital learning was implemented despite potential negative impacts on the education system (Marinoni et al., 2020).

Roughly 1.6 billion students were impacted by this transition, and a concern for generational impact arose quickly (United Nations Sustainable Development Group [UNSGD], 2020). To prepare for the fall 2020 semester, university campuses rapidly carried out various actions such as testing for the COVID-19 virus amongst students, virus tracing, and new data systems to mitigate online learning (Fox et al., 2020). However, by three weeks into the fall 2020 semester, there was a 56% increase in reports of positive COVID-19 cases for universities holding in-person instruction compared to the three weeks preceding the start of the semester (Leidner et al., 2020). Thus, remote education was adapted by institutions of higher education for an unprecedented amount of time.

Early in the pandemic, schools transitioned to online learning exclusively, where communication from instructor to student is done through online technology (Tzankova et al., 2023). Studies on online education's impact on academic performance yield mixed results

(Spitzer et al., 2023). According to a study done in the Netherlands by Engzell et al. (2020), a comparison of national examination performances before schools began closing and after schools had closed showed a 60% loss in learning across 350,000 students. In contrast, a study by Gore et al. (2020) included 4,800 students and found no significant influence of schools shutting down on students' academic performance, specifically in mathematics.

Later in the pandemic, a blended learning style, which combines standard face-to-face lectures with online learning systems (Venkateswarlu, 2014), was introduced to students in an attempt to negate the transmission of COVID-19 within schools (Murugamani et al., 2021) while also restoring a sense of normalcy. Learning in a blended environment focusing on remote education cannot be specified as poor or excellent (Syska & Pritchard, 2023), yet studies done before the COVID-19 pandemic have suggested there are no significant differences in students applying knowledge gained through either face-to-face instruction or distance education (Lim, 2002). One study suggests that while students prior to the pandemic were familiar with blended learning and could adequately apply it, face-to-face instruction was still the preferred learning method amongst students (Mashifana, 2020).

COVID-19: Impact on Veterinary Medical Education

Accredited veterinary schools within the United States follow a four-year curriculum consisting of three years of didactic lectures followed by one year of hands-on clinical education (AVMA 2023). Throughout the curriculum, students must comprehend biological mechanisms at the molecular and cellular level to understand animal health and diseases, must participate in hands-on education focusing on surgical interventions and physical diagnostic methods, and must learn how to effectively and ethically interact with both clients and patients in a clinical setting (AVMA, 2023). At the start of the COVID-19 pandemic, veterinary schools were forced

to modify the teaching approaches of the core curriculum while still promising the achievement of the curriculum by veterinary students (Micieli et al., 2022).

Clinical work and classroom lectures were considered a safety issue during the pandemic, prompting the introduction of digital technology for both teaching purposes and outpatient care across medical education institutions (Reinholz & French, 2020). Although the introduction of digital technology as a substitute for in-person learning in medical schools provided many different resources for students, the absence of learning bedside mannerisms and performing physical examinations impacted the level of interaction between students and patients and the skills gained from those interactions (Woolliscroft, 2020). The same can be said for veterinary students as a study done at Iowa State University College of Veterinary Medicine revealed that while the transition to online clinical rotations was a positive experience, faculty and students understood that clinical skills such as physical examinations, technical procedures, monitoring of patients, and communicating with clients would be limited (Ward et al., 2022). Many studies have also been done on the implications of the COVID-19 pandemic on specific subjects commonly endured by veterinary students. Two similar studies done by Brassett et al. (2020) and Ross et al. (2021) suggest that students could be affected in the long run by the subject of anatomy switching from in-person experiences, which were equipped with cadavers and teaching protocols involving practical applications, to exclusively learning intricate anatomy via online resources. In contrast, another study focused on the methodology used for the teaching of veterinary cytology and histology subjects at the University of León, which showed that online methodologies adapted for the pandemic led to better academic results for students compared to traditional face-to-face methodologies (Balseiro et al., 2022).

On the subject of clinical skills, many veterinary schools reported to have used video

instruction to provide students with guidance on clinical skills (Parkes & Barrs, 2021). A study done on students attending Lincoln Memorial University College of Veterinary Medicine focused on the academic success of students who practiced surgical skills at home through instructional videos, with results showing that students who practiced surgical skills at home passed surgical assessments at a close rate to students who practiced surgical skills in campus laboratories prior to the COVID-19 pandemic (Hunt & Anderson, 2022).

Studies done on veterinary student perceptions regarding online learning during the COVID-19 pandemic yield mixed outcomes. A survey-based study done on students attending City University of Hong Kong as part of a new Bachelor of Veterinary Medicine degree program showed that student perceptions of the quick implementation of online learning during the COVID-19 pandemic included both challenging and beneficial aspects (Parkes & Barrs, 2021). Further, a study on final-year veterinary students assessed the views held by students on surgical entrustable professional activities (EPAs). Results from 110 surveyed students showed that 50% of respondents were not comfortable performing EPAs, and 95% of respondents said COVID-19 negatively impacted their clinical development (Thompson et al., 2022). A study done on veterinary students attending veterinary schools in Turkey explored the opinions of students on distance education, revealing that students thought of face-to-face education as essential for veterinary school but that distance education can provide supplementary support to students (Aslim et al., 2023).

COVID-19: Impact on the Clinical Practice of Veterinary Medicine

The daily aspects of the clinical practice of veterinary medicine vary between species and specialties, with 46 distinct AVMA-recognized veterinary specialties (AVMA, 2023), but regardless, they tend to focus on interaction between veterinarians, patients, and clients. Before

the COVID-19 pandemic, veterinarians struggled with high rates of occupational stress, burn-out, and suicidal ideations, with the main sources of stress stemming from the number of hours worked, the expectations held by clients, and unexpected or negative patient outcomes (Gardner, 2006). A study investigating suicide among physicians, dentists, veterinarians, and pharmacists in Austria from 1986 through 2020 revealed that male veterinarians had a significantly increased risk of suicidal tendencies than the general population, and female veterinarians also held a similar risk in conjunction with female physicians and pharmacists (Zimmermann et al., 2023).

Throughout the COVID-19 pandemic, veterinary professionals were considered "Frontline essential workers (1b)" for the Advisory Committee on Immunization Practices (ACIP) recommended vaccination phase 1b list (Centers for Disease Control and Prevention [CDC], 2021). So, although many veterinary clinics remained open during the pandemic, the most commonly reported changes implemented were alterations to normal procedures to limit physical contact between clients and coworkers, requiring masks to be worn, and an increase in disinfection (Darby et al., 2023). A total of 226 veterinarians surveyed across the United States reported that an increased workload was the biggest challenge faced during the COVID-19 pandemic (Darby et al., 2023). An increase in stressors, as seen throughout the COVID-19 pandemic, through hours worked, a heavy workload, a high debt-low-income ratio, and compassion fatigue can cause distress in the psychological well-being of veterinarians (Moir & Van den Brink, 2020). Further, a study done during the COVID-19 pandemic showed that out of 2,208 responses, 41% of veterinary professional respondents were experiencing psychological distress, and 17.3% of respondents considered suicide within the past year (Scoresby et al., 2023). Other than increased stress on veterinarians, the COVID-19 pandemic also limited access to veterinary care, according to Munoz et al. (2022) as a study done on access to canine

integrative medical care during the COVID-19 pandemic revealed that widespread human disease, such as a pandemic, adversely affected animal welfare and medical care.

REFERENCES

American Veterinary Medical Association. (2023). COE accreditation policies and procedures: Requirements. *American Veterinary Medical Association*. https://www.avma.org/education/accreditation-policies-and-procedures-avma-council-education-coe/coe-accreditation-policies-and-procedures-requirements

American Veterinary Medical Association. (2023). Veterinary school admission 101. *American Veterinary Medical Association*. https://www.avma.org/resources-tools/careers/veterinary-school-admission-101

American Veterinary Medical Association. (2023). Veterinary Specialties. *American Veterinary Medical Association*. https://www.avma.org/education/veterinary-specialties

Aslim, G., Tekindal, M. A., Yigit, A., Sanal, S., & Mentes, A. (2023). Evaluation of the Attitudes and Opinions of Veterinary School Students on Distance Education During the COVID-19 Pandemic. *Journal of Veterinary Medical Education*. https://doi-org.libproxy.txstate.edu/10.3138/jvme-2021-0150

Balseiro, A., Pérez-Martínez, C., Paz, P. de, & García Iglesias, M. J. (2022). Evaluation of the COVID-19 lockdown-adapted online methodology for the cytology and histology course as part of the degree in veterinary medicine. *Veterinary Sciences*, *9*(2). https://doi-org.libproxy.txstate.edu/https://www.mdpi.com/2306-7381/9/2/51

Brassett, C., Cosker, T., Davies, D. C., Dockery, P., Gillingwater, T. H., Lee, T. C., Milz, S., Parson, S. H., Quondamatteo, F., & Wilkinson, T. (2020). COVID-19 and anatomy: Stimulus and initial response. *Journal of Anatomy*. https://doi-org.libproxy.txstate.edu/10.1111/joa.13274

Burns, G. A., Ruby, K. L., Debowes, R. M., Seaman, S. J., & Brannan, J. K. (2006). Teaching non-technical (professional) competence in a veterinary school curriculum. *Journal of Veterinary Medical Education*, *33*(2), 301–308. https://doiorg.libproxy.txstate.edu/10.3138/jvme.33.2.301

Centers for Disease Control and Prevention. (2021). Interim List of Categories of Essential Workers Mapped to Standardized Industry Codes and Titles. *CDC Web Archive*. https://www.cdc.gov/vaccines/covid-19/categories-essential-workers.html#

Darby, B. J., Watkins, S. T., Haak, P. P., Ravi-Caldwell, N., Bland, K., Bissett, C. J., Kryda, K. T., Murphy, J., Hungerford, L., & Russon, J. (2023). Veterinarians show resilience during COVID-19: challenges faced and successful coping strategies. *Journal of the American Veterinary Medical Association*, *261*(6), 888–897. https://doi-org.libproxy.txstate.edu/10.2460/javma.22.12.0584

Engzell, P., Frey, A., & Verhagen, M. D. (2021). Learning loss due to school closures during the COVID-19 pandemic. *Proceedings of the National Academy of Sciences*, *118*(17). https://doi.org/10.1073/pnas.2022376118

Fox, M. D., Bailey, D. C., Seamonf, M. D., Miranda, M. L. (2020) Response to a COVID-19 Outbreak on a University Campus. *Morbidity and Mortality Weekly Report*, *70*(1), 118–122. http://dx.doi.org/10.15585/mmwr.mm7004a3external icon

Gardner, D. H., & Hini, D. (2006). Work-related stress in the veterinary profession in New Zealand. *New Zealand Veterinary Journal*, *54*(3), 119–124. https://doi-org.libproxy.txstate.edu/10.1080/00480169.2006.36623

Gore, J., Fray, L., Miller, A. et al. (2021). The impact of COVID-19 on student learning in New South Wales primary schools: an empirical study. *Australian Educational Researcher*, 605–637. https://doi.org/10.1007/s13384-021-00436-w

Hunt, J. A., & Anderson, S. L. (2022). Remote assessment of veterinary clinical skills courses during the COVID-19 pandemic. *Journal of Veterinary Medical Education*, *49*(1), 16–24. https://doi-org.libproxy.txstate.edu/https://jvme.utpjournals.press/doi/full/10.3138/jvme-2020-0084

Leidner A. J., Barry V., Bowen V. B., et al. (2020). Opening of Large Institutions of Higher Education and County-Level COVID-19 Incidence — United States. *Morbidity and Mortality Weekly Report*, *70*(1), 14–19. http://dx.doi.org/10.15585/mmwr.mm7001a4

Lim, D. H. (2002). Perceived differences between classroom and distance education: Seeking instructional strategies for learning application. *International Journal of Educational Technology*, *3*(1). www.outreach.uiuc.edu/ijet/v3n1/d-lim/index.html.

Mahdy, M. A. A. (2020). The Impact of COVID-19 Pandemic on the Academic Performance of Veterinary Medical Students. *Frontiers in Veterinary Science*, *7*. https://doi-org.libproxy.txstate.edu/10.3389/fvets.2020.594261

Mahdy, M. A. A., & Sayed, R. K. A. (2022). Evaluation of the online learning of veterinary anatomy education during the Covid-19 pandemic lockdown in Egypt: Students' perceptions. *Anatomical Sciences Education*, *15*(1), 67. https://doi-org.libproxy.txstate.edu/10.1002/ase.2149

Marinoni, G., Van't Land, H., & Jensen, T. (2020). The impact of Covid-19 on higher education around the world: IAU Global Survey Report. *International Association of Universities*.

Mashifana, T. (2020). Students' preferred mode of teaching: Blended vs. traditional face to face instruction. *Institute of Electrical and Electronics Engineers*, 1–5. https://doi-org.libproxy.txstate.edu/10.1109/WEEF-GEDC49885.2020.9293634

Micieli, F., Della Valle, G., Del Prete, C., Ciaramella, P., & Guccione, J. (2022). The use of virtual-problem-based learning during COVID-19 pandemic emergency: veterinary students' perception. *Veterinary Sciences*, *9*(10). https://doi-org.libproxy.txstate.edu/https://www.mdpi.com/2306-7381/9/10/581

Moir, F., & Van den Brink, A. (2020). Current insights in veterinarians' psychological wellbeing. *New Zealand Veterinary Journal*, *68*(1), 3–12. https://doi-org.libproxy.txstate.edu/10.1080/00480169.2019.1669504

Murugamani, C., Samal, A., Mitra, A., Zachariah, N. S., & Kumar, S. P. (2021). Importance Of Online Education During Covid-19 Pandemic. *Turkish Online Journal of Qualitative Inquiry*, *12*(7), 6293–6299.

Nazif-Muñoz, J. I., Peña, S., & Oulhote, Y. (2021). The global viralization of policies to contain the spreading of the COVID-19 pandemic: Analyses of school closures and first reported cases. *PloS One*, *16*(4). https://doi-org.libproxy.txstate.edu/10.1371/journal.pone.0248828

Parkes, R. S. V., & Barrs, V. R. D. (2021). Interaction identified as both a challenge and a benefit in a rapid switch to online teaching during the COVID-19 pandemic. *Journal of Veterinary Medical Education*, *48*(6), 629–635. https://doi-org.libproxy.txstate.edu/https://jvme.utpjournals.press/doi/full/10.3138/jvme-2020-0063

Reinholz, M., & French, L. E. (2020). Medical education and care in dermatology during the SARS-CoV2 pandemia: challenges and chances. *Journal of the European Academy of Dermatology & Venereology, 34*(5), e214–e216. https://doi-org.libproxy.txstate.edu/10.1111/jdv.16391

Ross, C. F., Pescitelli, M. J., Smith, H. F., & Williams, J. M. (2021). Teaching anatomy with dissection in the time of COVID-19 is essential and possible. *Clinical Anatomy, 34*(8), 1135–1136. https://doi-org.libproxy.txstate.edu/10.1002/ca.23640

Scoresby, K., Jurney, C., Fackler, A., Tran, C. V., Nugent, W., & Strand, E. (2023). Relationships between diversity demographics, psychological distress, and suicidal thinking in the veterinary profession: a nationwide cross-sectional study during COVID-19. *Frontiers in Veterinary Science, 10*, 1130826. https://doi-org.libproxy.txstate.edu/10.3389/fvets.2023.1130826

Spitzer, M. W. H., Moeller, K., & Musslick, S. (2023). Assignment strategies modulate students' academic performance in an online learning environment during the first and second COVID-19 related school closures. *PLoS ONE, 17*(5), 1–23. https://doi-org.libproxy.txstate.edu/10.1371/journal.pone.0284868

Sun, F., Jit, M., Munday, J. D., Davies, N., Gimma, A., van Zandvoort, K., Gibbs, H., Hellewell, J., Jarvis, C. I., Clifford, S., Quilty, B. J., Bosse, N. I., Abbott, S., Klepac, P., Flasche, S., Kucharski, A. J., Russell, T. W., Diamond, C., Liu, Y., … Eggo, R. M. (2020). Early dynamics of transmission and control of COVID-19: a mathematical modelling study. *The Lancet Infectious Diseases, 20*(5), 553–558. https://doi-org.libproxy.txstate.edu/10.1016/S1473-3099(20)30144-4

Syska, A., & Pritchard, C. (2023). Blended learning as a site of struggle: A critical realist analysis of students' perceptions of blended learning and its impact on their sense of belonging. *Journal of University Teaching & Learning Practice, 20*(6), 1–28. https://doi-org.libproxy.txstate.edu/10.53761/1.20.6.15

Thompson, J. L., MacKay, J., & Blacklock, K. B. (2022). Veterinary students' views on surgical entrustable professional activities and the impact of COVID-19 on clinical competence development. *Veterinary Record: Journal of the British Veterinary Association*, *191*(9). https://doi-org.libproxy.txstate.edu/https://bvajournals.onlinelibrary.wiley.com/doi/10.1002/vetr.1978

Trivedi, S., Clark, J. C., & Royal, K. D. (2022). The impact of COVID-19 on pre-veterinary opportunities and recommendations for DVM admissions. *Journal of Veterinary Medical Education*, *49*(3), 280–288. https://doi-org.libproxy.txstate.edu/https://jvme.utpjournals.press/doi/full/10.3138/jvme-2020-0145

Tzankova, I., Compare, C., Marzana, D., Guarino, A., Di Napoli, I., Rochira, A., Calandri, E., Barbieri, I., Procentese, F., Gatti, F., Marta, E., Fedi, A., Aresi, G., & Albanesi, C. (2023). Emergency online school learning during COVID-19 lockdown: A qualitative study of adolescents' experiences in Italy. *Current Psychology*, *42*(15), 12743–12755. https://doi-org.libproxy.txstate.edu/10.1007/s12144-021-02674-8

United Nations Sustainable Development Group (UNSDG). (2020). *Policy Brief: Education during COVID-19 and beyond*. https://unsdg.un.org/resources/policy-brief-education-during-covid-19-and-beyond

Venkateswarlu, D. N. (2014). Blended Learning. *International Journal of Multidisciplinary Educational Research*, *3*, 310 – 317.

Ward, J. L., Mulherin, B. L., & Vengrin, C. A. (2022). Virtual VM4 clinical rotations: a COVID-19 pandemic response at Iowa State University College of Veterinary Medicine. *Journal of Veterinary Medical Education*, *49*(2), 141–150. https://doi-org.libproxy.txstate.edu/https://jvme.utpjournals.press/doi/full/10.3138/jvme-2020-0122

Woolliscroft, J. O. (2020). Innovation in Response to the COVID-19 Pandemic Crisis. *Academic Medicine: Journal of the Association of American Medical Colleges*, *95*(8), 1140–1142. https://doi-org.libproxy.txstate.edu/10.1097/ACM.0000000000003402

World Health Organization. (2020). Public health emergency of international concern (PHEIC). *World Health Organization*. https://www.who.int/docs/default-source/coronaviruse/global-research-and-innovation-forum-towards-a-research-roadmap.pdf?sfvrsn=a7fdb05b_1&download=true

Zimmermann, C., Strohmaier, S., Niederkrotenthaler, T., Thau, K., & Schernhammer, E. (2023). Suicide mortality among physicians, dentists, veterinarians, and pharmacists as well as other high-skilled occupations in Austria from 1986 through 2020. *Psychiatry Research*, *323*, 115170. https://doi-org.libproxy.txstate.edu/10.1016/j.psychres.2023.115170

III. METHODOLOGY

Design

This mixed methods study focused on the perspectives held by seasoned veterinarians regarding the impact of the COVID-19 pandemic on recently graduated veterinarians and pre-veterinary students. Veterinarians who graduated from the year 2020 and on were considered recent graduates, and pre-veterinary students from the year 2020 and on were considered relevant for our study. Prior to beginning recruitment, Texas State IRB approval for project #9031 was obtained. Participants were informed of the confidentiality protocol through the initial recruitment email. Veterinarian participants were informed of the research opportunity via a recruitment email (Appendix A) and were invited to participate in a Qualtrics survey. The Qualtrics survey consisted of basic demographic questions, an agreeance and disagreement section, and open-ended questions pertaining to recently graduated veterinarians and pre-veterinary students (Appendix B). Completed survey responses were then analyzed via Qualtrics' analyzation tool.

Population and Sample

Participants consisted of veterinarians who had earned their DVM degree from an accredited U.S. veterinary school. Veterinarians practicing in states with accredited veterinary schools were primarily recruited to increase the chance that a participant has worked with pre-veterinary students, but were still randomly sampled. Veterinarian participants must have practiced clinical medicine before, during, and after the COVID-19 pandemic.

IV. RESULTS

We received 9 responses (n = 9) from veterinarians across the United States within a two-week period. Respondents all earned their DVM degrees from U.S. accredited veterinary schools and currently practiced across the United States with 100% of respondents working in a general practice setting (Table 1). For the main survey, areas of interests regarding new veterinarian graduates included knowledge held, hands-on skills, and communication skills with both clients and veterinarian colleagues. Knowledge held by recently graduated veterinarians was considered efficient according to respondents (Figure 1). Hands-on skills held by recent graduates ranged in efficiency, with surgical skills holding the highest percentage of disagreement among respondents and conducting a physical examination holding the highest percentage of agreeance among respondents (Figure 2). Communication skills were mostly efficient, with the only disagreement centered on recent graduates' interaction with clients (Figure 3). Pre-Veterinary students were evaluated on characteristics held by successful veterinary students such as leadership ability, discipline and dedication to the field of veterinary medicine, and a mature social presence. According to respondents, pre-veterinary students mostly lacked social maturity and did not fully understand the process of earning a DVM degree, but did demonstrate adequate levels of leadership and communication with veterinarians (Figure 4).

Table 1. Demographics of veterinarian respondents

Respondent #	Vet School Attended	Current Practice Location	Current Practice Type i.e. general, emergency, specialty
1	University of Georgia	Atlanta, GA	General
2	Washington State University	Scottsdale, AZ	General
3	Texas A&M University	San Antonio, TX	General
4	Texas A&M University	San Antonio, TX	General
5	Royal Veterinary College	Colorado Springs, CO	General
6	Colorado State University	Colorado Springs, CO	General
7	Cornell University	Colorado Springs, CO	General
8	University of Illinois	Dresden, TN	General
9	Purdue University	Indianapolis, IN	General

Figure 1. Graphs regarding recent veterinarian graduates and knowledge

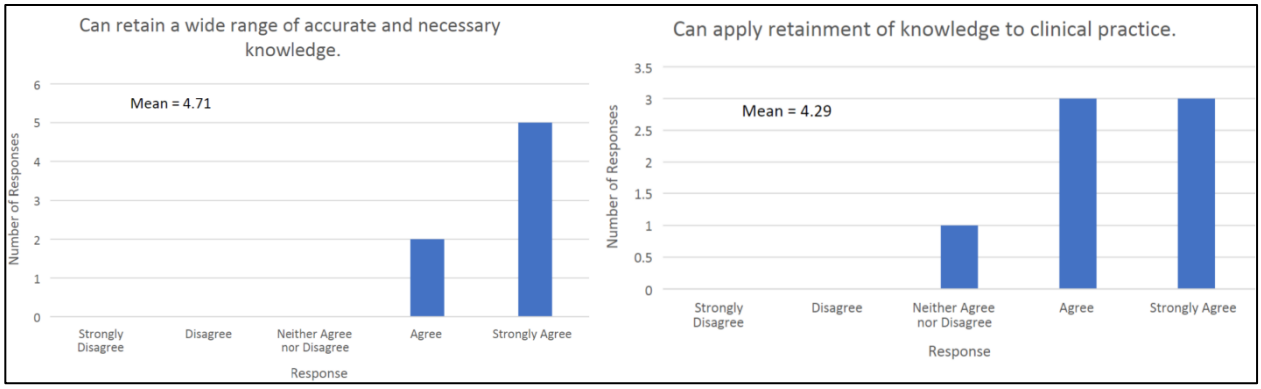


Figure 2. Graphs regarding recent veterinarian graduates and hands-on skills

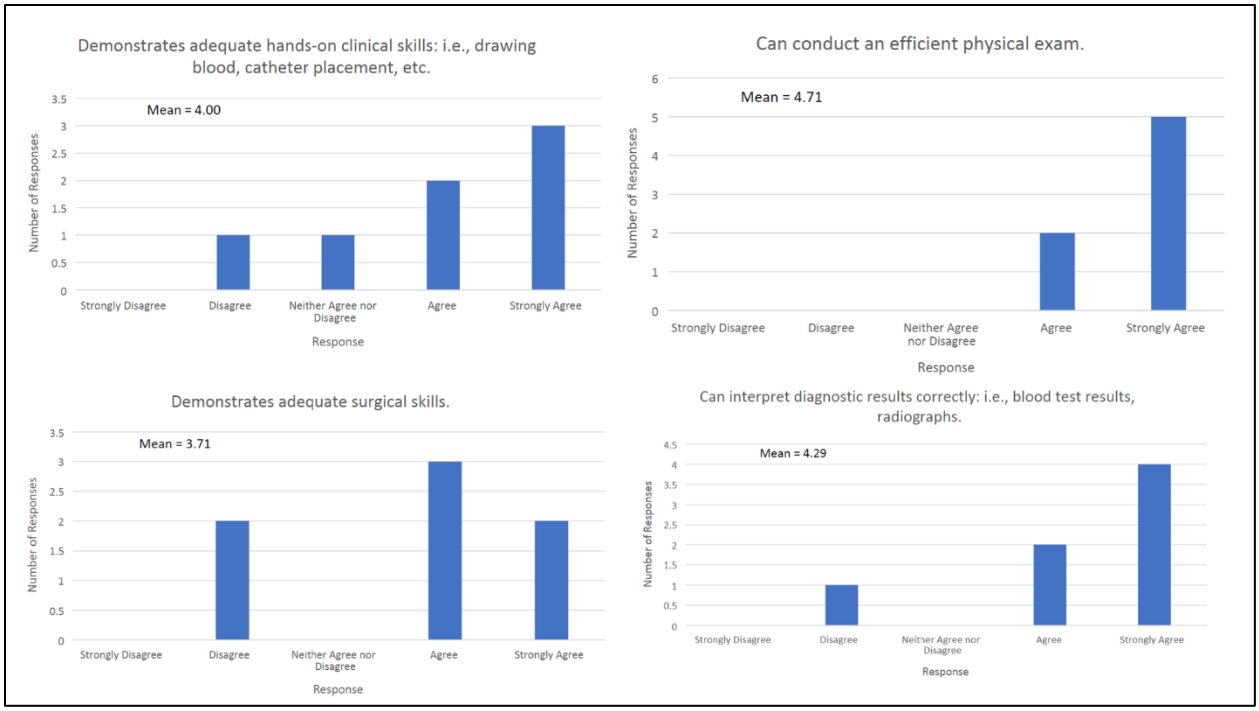


Figure 3. Graphs regarding recent veterinarian graduates and communication

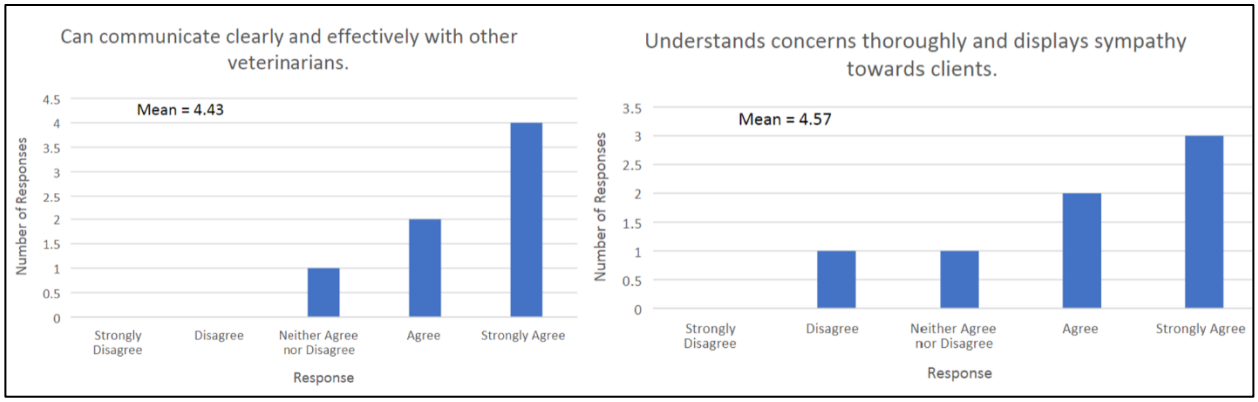
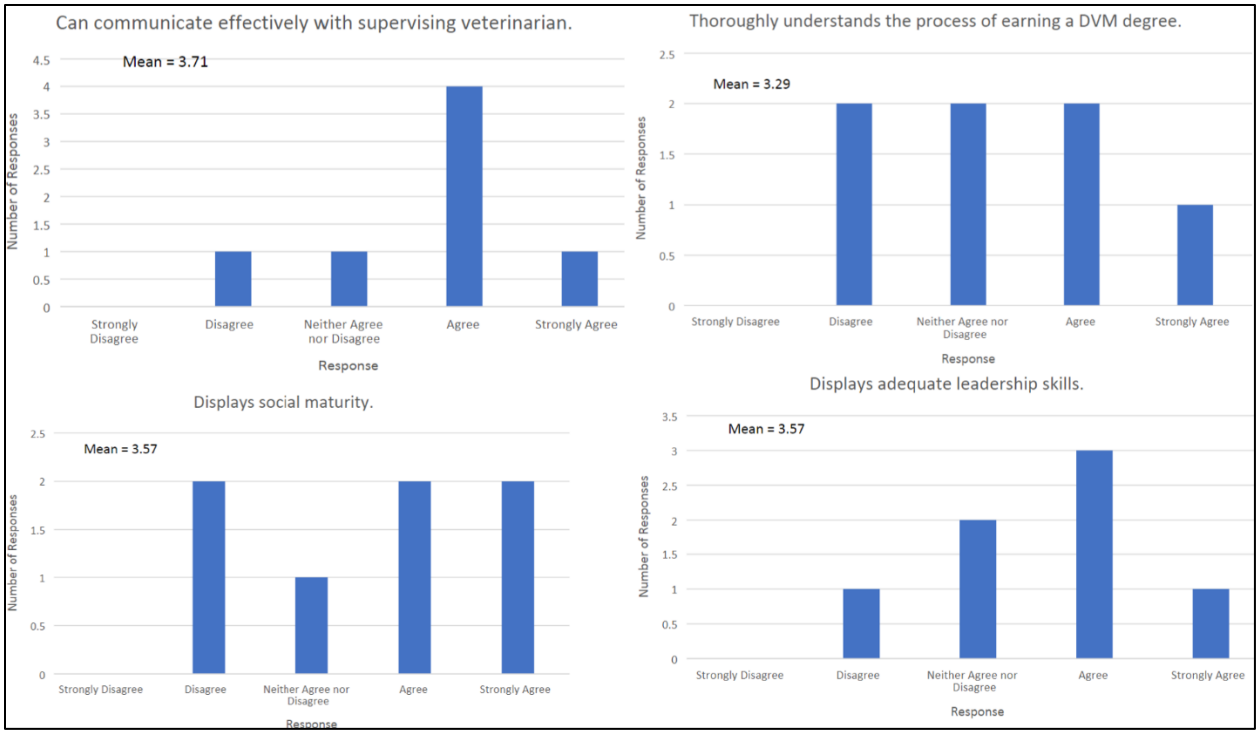


Figure 4. Graphs regarding pre-veterinary student assessments



V. DISCUSSION

The COVID-19 pandemic impacted both new veterinarian graduates and pre-veterinary students at least somewhat, according to the veterinarian respondents of our study. The study of impact focused on specific tasks or characteristics held by recently graduated veterinarians and pre-veterinary students such as hands-on skills or the ability to communicate. Undoubtedly, the COVID-19 pandemic impacted many aspects of everyday life such as employment, education, the economy, and the health of the population, with our study confirming our suspicion of impact on the future generation of veterinarians. Further, our study aimed to investigate the degree of impact the COVID-19 pandemic had on a future generation of veterinarians. However, our study is not without limitations. Most notably, our sample size of respondents was minimal and a larger sample size would hold a greater representation of the seasoned veterinarian population. Our study was also not longitudinal, and future research focusing on the impact of COVID-19 on veterinary professionals years following the pandemic may give a more accurate representation of generational impact. Since 100% of our respondents practiced in a general practice setting, there is a lack in respondent diversity. Outcomes of this study could have been further varied if respondents practiced veterinary medicine in specialty or emergency settings.

Overall, our study and future studies on this topic may reveal new advancements or an increase in efficiency through protocol changes within the field of veterinary medicine. Although the COVID-19 pandemic did impact a future generation of veterinarians based on our study, this does not necessarily signify a primarily negative impact, and may lead to developments in the industry that may have otherwise never been discovered.

APPENDIX A: EMAIL RECRUITMENT

Email Recruitment

To: Individual emails will be sent to randomly selected participants. There will not be a mass email sent to ensure that personal contacts information will not be available to other potential participants.

From: r_sims@txstate.edu

BCC: Will not be used.

Subject: Research Participation Invitation

Our email will read as follows:

Dear XXX,

"*This email message is an approved request for participation in research that has been approved by the Texas State Institutional Review Board (IRB).*"

You have been selected to participate in a 10-minute research survey regarding veterinarian perception on recent veterinarian graduates and current pre-vet undergraduate students. Our research aims to determine the effects of Covid-19 on recent graduate learning outcomes and skills and include the perceptions of seasoned, currently practicing veterinarians.

Your responses will be anonymous. Your personal information will not be shared or published and will remain confidential. Attached you will find our confidentiality statement for your review.

If you would like to decline participation in our research survey, please disregard this email and do not fill out the survey.

If you do consent to participation, please follow the link below to our Qualtrics survey.

https://qualtricsxm6tjxn26kj.az1.qualtrics.com/jfe/preview/previewId/92e89bbf-a978-403f-ba2a-6a4c1c4baf3e/SV_2bG4Az9PyPIJCAe?Q_CHL=preview&Q_SurveyVersionID=current

Thank you for your time and consideration.

Insert Signature

This project 9031 was approved by the Texas State IRB on 07/21/2023 Pertinent questions or concerns about the research, research participants' rights, and/or research-related injuries to participants should be directed to the IRB chair, Dr. Denise Gobert 512-716-2652 – (dgobert@txstate.edu) or to Monica Gonzales, IRB Regulatory Manager 512-245-2334 - (meg201@txstate.edu).

APPENDIX B: QUALTRICS SURVEY

Default Question Block

What veterinary school did you earn your DVM degree from?

What year did you graduate with your DVM degree?

Where is your current practice location?

What type of practice are you currently associated with? Animal Species is not pertinent.

- ○ General Practice
- ○ Emergency Hospital
- ○ Specialty Hospital
- ○ Other

How many years have you been a practicing veterinarian?

- ○ Less than 1 year
- ○ 1-5 years
- ○ 6-10 years
- ○ More than 10 years

Please rank the following skills displayed by recent veterinary graduates you have worked with. Recent Graduates are considered those who have graduated with their DVM degree from the year 2020 and on.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Can communicate clearly and effectively with other veterinarians.	○	○	○	○	○

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Can retain a wide range of accurate and necessary knowledge.	○	○	○	○	○
Can apply retainment of knowledge to clinical practice.	○	○	○	○	○
Demonstrates adequate hands-on clinical skills: i.e., drawing blood, catheter placement, etc.	○	○	○	○	○
Demonstrates adequate surgical skills.	○	○	○	○	○
Understands concerns thoroughly and displays sympathy towards clients.	○	○	○	○	○
Can conduct an efficient physical examination.	○	○	○	○	○
Can interpret diagnostic results correctly: i.e., blood test results, radiographs.	○	○	○	○	○

Please rank the following skills displayed by pre-veterinary students you have worked with from the year 2020 and on.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Shows genuine interest in veterinary medicine.	○	○	○	○	○
Can communicate effectively with supervising veterinarian.	○	○	○	○	○
Can handle a rigorous pre-requisite course load.	○	○	○	○	○

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Thoroughly understands the process of earning a DVM degree.	○	○	○	○	○
Holds a strong intellectual capacity.	○	○	○	○	○
Displays social maturity.	○	○	○	○	○
Seems committed to veterinary medicine.	○	○	○	○	○
Displays adequate leadership skills.	○	○	○	○	○

In your opinion, describe unique and notable challenges, if any, faced by new DVM graduates compared to challenges experienced by graduates who earned their DVM prior to the COVID-19 pandemic.

In your opinion, describe unique and notable challenges, if any, faced by current pre-veterinary students compared to challenges experienced by pre-veterinary students prior to the COVID-19 pandemic.

Do you feel new DVM graduates are adequately prepared for clinical practice compared to those who earned their DVM prior to the COVID-19 pandemic?

Do you feel the number of pre-veterinary students has decreased, increased, or has stayed the same after the COVID-19 pandemic?

Do you feel current pre-veterinary students are adequately prepared for the rigorous course load of veterinary school compared to pre-veterinary students prior to the COVID-19 pandemic?

REFERENCES

American Veterinary Medical Association. (2023). COE accreditation policies and procedures: Requirements. *American Veterinary Medical Association*. https://www.avma.org/education/accreditation-policies-and-procedures-avma-council-education-coe/coe-accreditation-policies-and-procedures-requirements

American Veterinary Medical Association. (2023). Veterinary school admission 101. *American Veterinary Medical Association*. https://www.avma.org/resources-tools/careers/veterinary-school-admission-101

American Veterinary Medical Association. (2023). Veterinary Specialties. *American Veterinary Medical Association*. https://www.avma.org/education/veterinary-specialties

Aslim, G., Tekindal, M. A., Yigit, A., Sanal, S., & Mentes, A. (2023). Evaluation of the Attitudes and Opinions of Veterinary School Students on Distance Education During the COVID-19 Pandemic. *Journal of Veterinary Medical Education*. https://doi-org.libproxy.txstate.edu/10.3138/jvme-2021-0150

Balseiro, A., Pérez-Martínez, C., Paz, P. de, & García Iglesias, M. J. (2022). Evaluation of the COVID-19 lockdown-adapted online methodology for the cytology and histology course as part of the degree in veterinary medicine. *Veterinary Sciences*, *9*(2). https://doi-org.libproxy.txstate.edu/https://www.mdpi.com/2306-7381/9/2/51

Brassett, C., Cosker, T., Davies, D. C., Dockery, P., Gillingwater, T. H., Lee, T. C., Milz, S., Parson, S. H., Quondamatteo, F., & Wilkinson, T. (2020). COVID-19 and anatomy: Stimulus and initial response. *Journal of Anatomy*. https://doi-org.libproxy.txstate.edu/10.1111/joa.13274

Burns, G. A., Ruby, K. L., Debowes, R. M., Seaman, S. J., & Brannan, J. K. (2006). Teaching non-technical (professional) competence in a veterinary school curriculum. *Journal of Veterinary Medical Education*, *33*(2), 301–308. https://doiorg.libproxy.txstate.edu/10.3138/jvme.33.2.301

Centers for Disease Control and Prevention. (2021). Interim List of Categories of Essential Workers Mapped to Standardized Industry Codes and Titles. *CDC Web Archive*. https://www.cdc.gov/vaccines/covid-19/categories-essential-workers.html#

Darby, B. J., Watkins, S. T., Haak, P. P., Ravi-Caldwell, N., Bland, K., Bissett, C. J., Kryda, K. T., Murphy, J., Hungerford, L., & Russon, J. (2023). Veterinarians show resilience during COVID-19: challenges faced and successful coping strategies. *Journal of the American Veterinary Medical Association*, *261*(6), 888–897. https://doi-org.libproxy.txstate.edu/10.2460/javma.22.12.0584

Engzell, P., Frey, A., & Verhagen, M. D. (2021). Learning loss due to school closures during the COVID-19 pandemic. *Proceedings of the National Academy of Sciences*, *118*(17). https://doi.org/10.1073/pnas.2022376118

Fox, M. D., Bailey, D. C., Seamonf, M. D., Miranda, M. L. (2020) Response to a COVID-19 Outbreak on a University Campus. *Morbidity and Mortality Weekly Report*, *70*(1), 118–122. http://dx.doi.org/10.15585/mmwr.mm7004a3external icon

Gardner, D. H., & Hini, D. (2006). Work-related stress in the veterinary profession in New Zealand. *New Zealand Veterinary Journal*, *54*(3), 119–124. https://doi-org.libproxy.txstate.edu/10.1080/00480169.2006.36623

Gore, J., Fray, L., Miller, A. et al. (2021). The impact of COVID-19 on student learning in New South Wales primary schools: an empirical study. *Australian Educational Researcher*, 605–637. https://doi.org/10.1007/s13384-021-00436-w

Hunt, J. A., & Anderson, S. L. (2022). Remote assessment of veterinary clinical skills courses during the COVID-19 pandemic. *Journal of Veterinary Medical Education*, *49*(1), 16–24. https://doi-org.libproxy.txstate.edu/https://jvme.utpjournals.press/doi/full/10.3138/jvme-2020-0084

Leidner A. J., Barry V., Bowen V. B., et al. (2020). Opening of Large Institutions of Higher Education and County-Level COVID-19 Incidence — United States. *Morbidity and Mortality Weekly Report*, *70*(1), 14–19. http://dx.doi.org/10.15585/mmwr.mm7001a4

Lim, D. H. (2002). Perceived differences between classroom and distance education: Seeking instructional strategies for learning application. *International Journal of Educational Technology*, *3*(1). www.outreach.uiuc.edu/ijet/v3n1/d-lim/index.html.

Mahdy, M. A. A. (2020). The Impact of COVID-19 Pandemic on the Academic Performance of Veterinary Medical Students. *Frontiers in Veterinary Science*, *7*. https://doi-org.libproxy.txstate.edu/10.3389/fvets.2020.594261

Mahdy, M. A. A., & Sayed, R. K. A. (2022). Evaluation of the online learning of veterinary anatomy education during the Covid-19 pandemic lockdown in Egypt: Students' perceptions. *Anatomical Sciences Education*, *15*(1), 67. https://doi-org.libproxy.txstate.edu/10.1002/ase.2149

Marinoni, G., Van't Land, H., & Jensen, T. (2020). The impact of Covid-19 on higher education around the world: IAU Global Survey Report. *International Association of Universities*.

Mashifana, T. (2020). Students' preferred mode of teaching: Blended vs. traditional face to face instruction. *Institute of Electrical and Electronics Engineers*, 1–5. https://doi-org.libproxy.txstate.edu/10.1109/WEEF-GEDC49885.2020.9293634

Micieli, F., Della Valle, G., Del Prete, C., Ciaramella, P., & Guccione, J. (2022). The use of virtual-problem-based learning during COVID-19 pandemic emergency: veterinary students' perception. *Veterinary Sciences*, *9*(10). https://doi-org.libproxy.txstate.edu/https://www.mdpi.com/2306-7381/9/10/581

Moir, F., & Van den Brink, A. (2020). Current insights in veterinarians' psychological wellbeing. *New Zealand Veterinary Journal*, *68*(1), 3–12. https://doi-org.libproxy.txstate.edu/10.1080/00480169.2019.1669504

Murugamani, C., Samal, A., Mitra, A., Zachariah, N. S., & Kumar, S. P. (2021). Importance Of Online Education During Covid-19 Pandemic. *Turkish Online Journal of Qualitative Inquiry*, *12*(7), 6293–6299.

Nazif-Muñoz, J. I., Peña, S., & Oulhote, Y. (2021). The global viralization of policies to contain the spreading of the COVID-19 pandemic: Analyses of school closures and first reported cases. *PloS One*, *16*(4). https://doi-org.libproxy.txstate.edu/10.1371/journal.pone.0248828

Parkes, R. S. V., & Barrs, V. R. D. (2021). Interaction identified as both a challenge and a benefit in a rapid switch to online teaching during the COVID-19 pandemic. *Journal of Veterinary Medical Education*, *48*(6), 629–635. https://doi-org.libproxy.txstate.edu/https://jvme.utpjournals.press/doi/full/10.3138/jvme-2020-0063

Reinholz, M., & French, L. E. (2020). Medical education and care in dermatology during the SARS-CoV2 pandemia: challenges and chances. *Journal of the European Academy of Dermatology & Venereology, 34*(5), e214–e216. https://doi-org.libproxy.txstate.edu/10.1111/jdv.16391

Ross, C. F., Pescitelli, M. J., Smith, H. F., & Williams, J. M. (2021). Teaching anatomy with dissection in the time of COVID-19 is essential and possible. *Clinical Anatomy, 34*(8), 1135–1136. https://doi-org.libproxy.txstate.edu/10.1002/ca.23640

Scoresby, K., Jurney, C., Fackler, A., Tran, C. V., Nugent, W., & Strand, E. (2023). Relationships between diversity demographics, psychological distress, and suicidal thinking in the veterinary profession: a nationwide cross-sectional study during COVID-19. *Frontiers in Veterinary Science, 10*, 1130826. https://doi-org.libproxy.txstate.edu/10.3389/fvets.2023.1130826

Spitzer, M. W. H., Moeller, K., & Musslick, S. (2023). Assignment strategies modulate students' academic performance in an online learning environment during the first and second COVID-19 related school closures. *PLoS ONE, 17*(5), 1–23. https://doi-org.libproxy.txstate.edu/10.1371/journal.pone.0284868

Sun, F., Jit, M., Munday, J. D., Davies, N., Gimma, A., van Zandvoort, K., Gibbs, H., Hellewell, J., Jarvis, C. I., Clifford, S., Quilty, B. J., Bosse, N. I., Abbott, S., Klepac, P., Flasche, S., Kucharski, A. J., Russell, T. W., Diamond, C., Liu, Y., … Eggo, R. M. (2020). Early dynamics of transmission and control of COVID-19: a mathematical modelling study. *The Lancet Infectious Diseases, 20*(5), 553–558. https://doi-org.libproxy.txstate.edu/10.1016/S1473-3099(20)30144-4

Syska, A., & Pritchard, C. (2023). Blended learning as a site of struggle: A critical realist analysis of students' perceptions of blended learning and its impact on their sense of belonging. *Journal of University Teaching & Learning Practice, 20*(6), 1–28. https://doi-org.libproxy.txstate.edu/10.53761/1.20.6.15

Thompson, J. L., MacKay, J., & Blacklock, K. B. (2022). Veterinary students' views on surgical entrustable professional activities and the impact of COVID-19 on clinical competence development. *Veterinary Record: Journal of the British Veterinary Association*, *191*(9). https://doi-org.libproxy.txstate.edu/https://bvajournals.onlinelibrary.wiley.com/doi/10.1002/vetr.1978

Trivedi, S., Clark, J. C., & Royal, K. D. (2022). The impact of COVID-19 on pre-veterinary opportunities and recommendations for DVM admissions. *Journal of Veterinary Medical Education*, *49*(3), 280–288. https://doi-org.libproxy.txstate.edu/https://jvme.utpjournals.press/doi/full/10.3138/jvme-2020-0145

Tzankova, I., Compare, C., Marzana, D., Guarino, A., Di Napoli, I., Rochira, A., Calandri, E., Barbieri, I., Procentese, F., Gatti, F., Marta, E., Fedi, A., Aresi, G., & Albanesi, C. (2023). Emergency online school learning during COVID-19 lockdown: A qualitative study of adolescents' experiences in Italy. *Current Psychology*, *42*(15), 12743–12755. https://doi-org.libproxy.txstate.edu/10.1007/s12144-021-02674-8

United Nations Sustainable Development Group (UNSDG). (2020). *Policy Brief: Education during COVID-19 and beyond*. https://unsdg.un.org/resources/policy-brief-education-during-covid-19-and-beyond

Venkateswarlu, D. N. (2014). Blended Learning. *International Journal of Multidisciplinary Educational Research*, *3*, 310 – 317.

Ward, J. L., Mulherin, B. L., & Vengrin, C. A. (2022). Virtual VM4 clinical rotations: a COVID-19 pandemic response at Iowa State University College of Veterinary Medicine. *Journal of Veterinary Medical Education*, *49*(2), 141–150. https://doi-org.libproxy.txstate.edu/https://jvme.utpjournals.press/doi/full/10.3138/jvme-2020-0122

Woolliscroft, J. O. (2020). Innovation in Response to the COVID-19 Pandemic Crisis. *Academic Medicine: Journal of the Association of American Medical Colleges*, *95*(8), 1140–1142. https://doi-org.libproxy.txstate.edu/10.1097/ACM.0000000000003402

World Health Organization. (2020). Public health emergency of international concern (PHEIC). *World Health Organization*. https://www.who.int/docs/default-source/coronaviruse/global-research-and-innovation-forum-towards-a-research-roadmap.pdf?sfvrsn=a7fdb05b_1&download=true

Zimmermann, C., Strohmaier, S., Niederkrotenthaler, T., Thau, K., & Schernhammer, E. (2023). Suicide mortality among physicians, dentists, veterinarians, and pharmacists as well as other high-skilled occupations in Austria from 1986 through 2020. *Psychiatry Research*, *323*, 115170. https://doi-org.libproxy.txstate.edu/10.1016/j.psychres.2023.115170