International Journal of Veterinary Science and Medicine 6 (2018) 131–140

HOSTED BY

Contents lists available at ScienceDirect

International Journal of Veterinary Science and Medicine

journal homepage: www.elsevier.com/locate/ijvsm

Review Article

Teaching animal welfare in veterinary schools in Latin America

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ARTICLE INFO

Keywords:
Animal welfare
Study plans
Study programs
Teaching
Veterinary medicine

ABSTRACT

There is a high demand for a veterinary education in animal welfare (AW) with different approaches from the academic, society and trade points of view. Latin American (LA) countries members of the World Organization for Animal Health (OIE) are under the urge and should be obligated to teach AW. The aims of this article are to analyze the current drives of change on the importance of teaching animal welfare in LA, the competences recommended from international education organizations for the region, and to provide the contents on the curriculum in AW that a future veterinarian should achieve in the LA scenario, in other words to examine why teaching AW, what should be taught and how. Despite significant advances in introducing AW into veterinary training programs, much remains to be done regarding the future of this field in teaching veterinary science in Spain and LA countries, and in including this science as an independent course in programs at distinct levels to integrate the scientific, ethical and legal aspects of AW. This paper presents a proposal that was constructed with a view towards integrating diverse curricular approaches based on criteria, contents and concepts provided by the researchers and professors who collaborated in the book entitled: Bienestar Animal: Una Visión Global en Iberoamerica [Animal Welfare: A Global Vision in Ibero-America]. To ensure veterinary students will be better equipped to graduate with OIE day 1 competencies in AW, teaching approaches are needed that support project-based learning and gamification, critical thinking, reflection and collaborative learning.

1. Introduction

Animal welfare (AW) is a subject of increasing interest to society, thus the veterinary medical profession has an opportunity —and a duty— to provide leadership and expertise [1]. Both the public and the international institutions that regulate the veterinary profession have high expectations that veterinarians will understand and take the lead in issues of AW [2]. An increasing number of Latin-American scientists have been doing a high level of research. In the last decades, an increasing number of Latin-American scientists, mainly from veterinary faculties – have been doing a high level of research, resulting in numerous papers on AW rising five times in the Journal Citation Research database of the ISI Web of Science [3]. But the question is: Are they trained to teach AW? [3].

To answer this question, the curriculum of veterinarian training programs must be taken into consideration. In Latin American countries two different veterinary programs are available, one is “doctor in Veterinary zootechnics” (VZ) and the other is Veterinary Medicine (VM). While VZ is the official denomination for those who undergo a dual training program in veterinary medicine and animal husbandry in universities of Bolivia, Colombia, Ecuador, El Salvador and Mexico. VM prepares medical professionals in Argentina, Chile, Paraguay and

Peer review under responsibility of Faculty of Veterinary Medicine, Cairo University.
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https://doi.org/10.1016/j.ijvsm.2018.07.003
Received 28 April 2018; Received in revised form 17 July 2018; Accepted 18 July 2018
Available online 30 July 2018

Uruguay, who protect the health and well-being of both animals and people, and their curricula is full of medicine topics. They diagnose and control animal diseases and treat sick and injured animals; whereas VZ, although they also have subjects focused on medicine and animal health, among other competences, their curricula also focus on how to improve the development of environmentally friendly production technologies, how to increase the production of confined farm animals and improve product quality, focused on food safety. To meet these obligations, VZ/VM need to be trained to confront the challenges involved in maintaining animal health and productivity, ensuring their good welfare. For these reasons, students of veterinary medicine need to acquire knowledge in several key fields: physiology, pathology, clinical diagnostics, epidemiology, bioethics, and applied ethology of farm animals, companion animals and wildlife, as only this will enable them to integrally learn and assimilate the concept of AW. Without doubt, including aspects of AW in the veterinary curricula will complement their professional training of future VZ/VM, and since there is a growing awareness of AW among the public at large, as a driving force for change —seen in many countries as pacific demonstrations— it is important that we adapt our teaching systems to fulfill the professional competence that a VZ/VM requires by the society, in other words, a responsible, committed professional with good communicating skills, well-versed in communication and information technologies, that can become an outstanding leader or member of teams devoted to promoting and ensuring AW [4]. In this paper we analyze the current drives of change on the importance of teaching animal welfare in Latin America, the competences recommended from international education organizations for the region, and discuss how students of veterinary science may acquire AW sound skills by using project-based learning and gamification. Hence, this paper presents a proposal for the contents of such an approach and identifies the main topics that should be included in AW courses and training for the future vets. It is urgent that we endow AW courses with a much clearer profile in VZ/MV training to ensure that graduates in 2030 will have the scientific, ethical and legal competencies that this field will demand [5].

2. Why teaching animal welfare at Latin America vet schools?

The welfare of an animal is defined in terms of its physical, psychological and social conditions, which means that they must not only be healthy but also feel well. For these reasons, veterinary programs include numerous courses on the art and science of maintaining animals in good condition by implementing appropriate husbandry practices, ensuring good hygiene, using preventive medicine and guaranteeing prompt treatment of lesions or diseases [6].

Animal welfare is an important topic in the field of animal production. Productivity and AW are not incompatible goals; indeed, the opposite is true. Producers and scientists have been working for years to develop systems that maximize production levels while simultaneously enhancing AW and reducing costs [7–9]. Fraser and Broom [10], argue that general improvements in AW enhance production, but measuring such advances requires that VZ study plans incorporate contents that help students understand animals' needs and make them broadly familiar with their behavior [11].

Concern for the welfare of farm animals among consumers and the general public has been intensified, especially as society has increasingly become aware of how animals are raised and slaughtered, and demand healthier products coming from sustainable production systems that do limit the use of antibiotics to their animals. This underscores as well, worries about the stress that animals suffer in production units, transportation and, more acutely, before slaughter [12–13]. Animals must be raised under acceptable standards of welfare from stable to table, ensuring humane handling during slaughtering procedures too [14]. This perspective has led to intensified legal and regulatory demands related to AW. According to Molento [15], in recent years AW has acquired importance worldwide, commencing in European countries before spreading –though more subtly– to the United States, and has had significant repercussions on international trade. As a result of these developments, clear tendencies have emerged in some nations that now demand minimum levels of AW in businesses importing products from animal origin. Briefly, if the country of origin fails to ratify legislation and regulations regarding AW and, above all, does not certify its agricultural products under AW protocols at their abattoirs or processing plants, then they will not be allowed to export them, since poor AW now constitutes a non-trade barrier to international markets. Today, all stakeholders must be prepared to comply with these new norms [9].

Another aspect that justifies including courses on AW in veterinary medicine study plans is that society requires veterinarians to be certified in AW, a professional who audits or assess AW standards, with the goal of addressing official opinions. Currently, board certification in American College of Animal Welfare (ACAW) is a new specialization recognized by the American Veterinary Medical Association (AVMA) and should be spread to Latin America. Veterinarians educated to an advanced level in all aspects of animal welfare science and ethics are uniquely positioned to step forward to provide the public, general veterinary practitioners, and other stakeholders with accurate information, advice, and advanced expertise concerning AW questions and challenges [16]. The Organizing Committee of the ACAW recognizes that AW interest and knowledge cuts across many disciplines of veterinary medicine. Thus, expertise was solicited from the breadth of the profession as the American College of Animal Welfare was formed. This breadth in training and educational requirements, as well as a focus on best practices used to develop the new animal welfare certification examination, will help ensure veterinarians who become ACAW diplomates have the expertise to understand the full scope of animal welfare issues (http://www.acaw.org/) [16].

In Mexico, board certification in Applied Ethology and Animal Welfare is provided by the National Council of Veterinary Education and Certification (CONCERVET). In Europe veterinarians specialize by passing the examination to become a Diplomate of the European College of Animal Welfare and Behavior Medicine (ECAWBM). ECAWBM strives to provide animal owners and their veterinarians with European Veterinary Specialists; veterinarians specialized in animal welfare and/or behavioral medicine [17]. In addition, the need for undergraduate teaching of Animal Welfare and Ethics (AWE) in Australian and New Zealand veterinary courses reflects increasing community concerns and expectations about AWE; global pressures regarding food security and sustainability; the demands of veterinary accreditation; and fears that, unless students encounter AWE as part of their formal education, as veterinarians they will be relatively unaware of the discipline of animal welfare science [18].

Since 2013, the welfare of both the humans and the animals involved are carefully considered in a positive solution, the One Welfare concept. Through a 'One Health, One Welfare' lens, the increased empathy, compassion, and stewardship of early career veterinary professionals will lead to improved animal and human welfare, and thus improved community health [19].

Veterinary medicine/zootechnics students should understand the principles that govern AW and honor the commitment to promote it in all animals that come under their care. This is the true spirit of veterinary medicine, but only the beginning of an adequate system of veterinary education. Moreover, the professional code of practice oath establishes that it is our ethical and moral responsibility to look towards the animaĺs welfare, thus, the veterinarian is expected to be the animal welfare professional per excellence.

3. What to teach in animal welfare

Intensive housing systems allow confined animals to either cope positively with their environment —show good welfare— or prevent them from adapting and impair their welfare. Environmental stimuli

Table 1
Basic topics and contents of an animal welfare course. Animal welfare: neurophysiological and behavioral responses.

1. Animal welfare: neurophysiological and behavioral responses	
Topics	Contents
1. Man-animal interaction	– Domestication of animals – Types of human-animal interaction (visual, auditory, physical, reward, invasive) – Factors affecting human-animal relations: prior experience and animal husbandry systems – Assessing human-animal interaction: fear, approaching and reactivity – Impact of human-animal relations on AW and productivity – Global warming and livestock production
2. General adaptation syndrome (GAS)	– Stages of GAS; Fight and flight response: autonomic responses to acute stress; – Energetic metabolism; –Sleep-vigilance cycle; – Thermoregulation; –Acid-base balance
3. Neurophysiological mechanisms in response to stress	– Modulating responses in the face of stressful stimuli – Changes in metabolism in response to stress – Gas exchange and acid-base balance in response to stress – Changes in water and electrolytic balance
4. Stress, allostasis, allostatic load, habituation and animal adaptation	– Concepts: stress, allostasis, allostatic load, habituation and adaptation – Patho-physiology of animal stress; – Psycho-neuro-immune-endocrine system; – Allostatic load and overload: signs and biomarkers
5. Neurobiology of behaviour	– What is neurobiology? –Biological systems of the animal organism; –Genetic bases of behaviour; – Limbic system: hippocampus, cerebral amygdala, thalamus, cingulate and hypothalamus; – Innate responses; – Learned responses; – Cognition; – Memory; –Habituation; –Motivation
6. Emotional states in animals	– Aggression; – Anxiety; – Pain: use of grimace scales – Frustration; – Fear; – Anhedonia
7. Sensory perception by animals	– Smell; – Taste; – Touch; – Vision; – Cognition; – Audition
8. Applied ethology	– What is behaviour? – Tinbergen four questions: causal, ontogenetic, phylogenic, adaptative; – Designing an ethogram
9. Behavioural repertoir	– Social behaviour: Sexual, maternal, ludic and agonistic behaviour – Maintenance behaviour: trophic and eliminative behaviours
10. Abnormal behaviour	- Vices; – Redirected behaviours; – Anomalous or stereotyped behaviour patterns; – Inactivity; – Excitability
11. AW and the housing accommodation	– Physical environment: recommendations on space allowance, floor, shade and shelter, light and noise; equipment including feeders and waterers (drinkers) – Social environment: animal density, commingled animals from different sources or ages, crowding effects – Climatic environment: recommendations on weather temperature, humidity, ventilation, and environmental noxious gases
12. Measuring animal behaviour	– States and events – Measures of behaviour: latency, frequency, duration, intensity, sequence – Sampling techniques: *ad libitum*, focal, scan sampling, behavioural – Recording methods: continuous recording, time lapse interval, one-zero
13. Environmental enrichment	– What is animal enrichment? – Social enrichment: conspecifics (mate or group), contra-specifics (human or non-human), without visual and auditory contact – Occupational enrichment: psychological (control of the environment) and physical activity (exercise) – Physical enrichment: habitat, accessories, permanent (logs), movable (toys, substrates), external (vegetation, hanging objects) – Sensorial enrichment: visual (mirrors and images), auditory (vocalizations and music), olfactory, tactile, taste – Alimentary enrichment
14. Scientific assessment of AW	– Ethological bases for the scientific assessment of AW – The concept of biological needs – Main concepts on AW: AW definition by OIE – Biological functioning of the organism – 'Natural' behavior of animals – Emotions of animals – AW assessment: – The Brambell Report: The Five Freedoms; – Indicators or biomarkers of AW (invasive and non-invasive): Case studies; – Protocols for the practical assessment of AW (Welfare Quality®, AWIN) – Risk evaluation applied to AW
15. Euthanasia in pets and in experimentation	– Euthanasia: Euthanasia techniques, euthanasia agents, euthanasia in pets, euthanasia in experimental animals – Choosing an appropriate endpoint in experiments using animals for research, teaching and testing – Confirming death: Signs of return to consciousness in animals under anaesthesia and in stunned animals prior to killing processes – Humane destruction of livestock: Emergency euthanasia in large animals. – Disposing of cadavers
16. National and regional legislation related to AW	– Federal Law of Animal Hygiene – Law for the Protection of Animals in Mexico City – NOM-033-SAG/ZOO-2014. Methods for killing domestic and wild animals – NOM-051-ZOO-1995. Humane treatment when moving animals – NOM-045-ZOO-1995. Zoo-sanitary characteristics for operations at establishments where animals are confined; *e.g.* fairs, auctions, exhibitions, markets, and similar events – NOM-062-ZOO-1999. Technical specifications for the production, care and use of laboratory animals. – Official Norms that regulate AW in Latin American countries

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Table 1 (*continued*)

1. Animal welfare: neurophysiological and behavioral responses	
Topics	Contents
17. AW and productivity	– Productivity *vs.* welfare – Welfare of laying hens and poultry; – Welfare of farm hogs; – Welfare of small ruminants: sheep and goats
18. Enrichment, AW and production through ethology	– Orphaned animals; –Mother-young distress; –Design of housing facilities; –Man-animal relation; –Use of social facilitation for handling animals; –Feeding; –Changes in social structure
19. The sick animal and its wellbeing	– Relation between welfare and disease; –Behavior of the sick animal; –Disease and trophic behavior; – Disease and sleeping behavior; –Behavior as a tool for diagnosing disease

Sources. Adapted from: De Boo and Knight [33,53]; Price and Orihuela [54]; Orihuela [55]; Webster [6,56,57]; Fraser [58]; Mota-Rojas et al. [9,14,22,24]; Galindo and Manteca, [59]. Once these general concepts of AW had been covered, we propose continuing with the content shown in Table 2.

vary widely, so before attempting to define what the adequate environment for a particular animal might be, we must first evaluate key components of the site, including climate, food, water, topography and conspecific social relations [20]. In this view, an environment is only deemed appropriate when it allows animals to satisfy their needs appropriately. The aspects of productive systems that exert the greatest influence on AW and therefore, need to be analyzed and taught in detail are: housing facilities, personnel training, feeding, handling, hygiene, transportation and slaughtering procedures [21].

Animal welfare assessments are applied at distinct levels and conducting audits is important because long-term experience demonstrates that they improve AW [9,22–25]. This field has now developed protocols for appraising and monitoring AW quality on farms and at abattoirs using assessment tools that enable us to establish and apply measuring criteria that ensure the elaboration of reliable audits of AW. The 'Welfare Quality®' project in Europe, for example, objectively assesses AW on farms and in slaughterhouses by, first, identifying the causes of deficient welfare and then orienting producers on how to make improvements. After lengthy discussions with consumers, scientists, and stakeholders, the 'Welfare Quality®' project defined four principles of AW: good feeding, good housing, good health and appropriate behavior [26]. These principles have 12 complementary criteria in an effort to convince producers –not just consumers– of the benefits of enhancing AW by implementing recommendations based on the assessments conducted on their farms [27].

Training students in the professional competencies that will allow them to elaborate scientific assessments of AW is not an easy task. It requires knowledge of several disciplines and various approaches. In addition, it is important to develop protocols that will allow specialists to assess AW more objectively by deepening our understanding of animals' cognitive and neurophysiological mechanisms related to pain, depression and pleasure, among other emotions, together with habituation mechanisms that are still inadequately understood.

3.1. Global animal welfare competences

The World Organization for Animal Health (OIE) developed the Guidelines for a Model Core Veterinary Curriculum to serve as a companion to its recommendations regarding the competencies of graduating veterinarians ('Day 1 graduates') to assure the quality of public and private components of National Veterinary Services ('Day 1 Competencies'). The Day 1 Competencies were published in May 2012 (http://www.oie.int/en/support-to-oie-members/veterinary-education/). It has been proposed that these guidelines —with code standards for the welfare of production animals— serve as a tool for Veterinary Education Establishments in OIE member countries to use when developing curricula to educate veterinary students to the expected level of competency [28]. These 10 principles for AW in agricultural production systems are reviewed in detail in [29]. They reflect the multidisciplinary nature of AW and the practical implications of many aspects involved in raising production animals, namely, nutrition, genetics, housing facilities, health, behavior and handling.

According to OIE recommendations, the minimum competencies expected of recently-graduated veterinarians in relation to AW to guarantee high-quality national veterinary services include the ability:

- to explain AW and the related responsibilities of proprietors, handlers, veterinarians and others involved with the care of animals;
- to identify the main problems of AW and participate in implementing corrective measures;
- to know where reliable, up-to-date information on local, national and international AW rules and norms is found, in order to prescribe methods of care for:
- Companion animals
- Food animals
- Wild animals
- Transportation
- Slaughtered animals for human consumption
- Animals for research or educational prophylactic purposes.

For more ample information on this key topic, consult the document: "Recommendations of the OIE on the minimum competencies expected of recently-graduated veterinarians to guarantee high-quality National Veterinary Services" (2012), http://www.oie.int. Paris, France [30].

3.2. Animal welfare competences for students in the region

Gallo and Cajiao [5], suggest that the new VZ graduated by 2030 will have to confront problems that will emerge through the required competencies that the Panel on AW at the 2013 congress: "Professional Profile of the VZ in Latin America: Vision 2030", outlined in the following actions:

- All institutions training veterinarians/zootechnists should include one compulsory course on AW in their study plans, and the topic of AW must be cross-referenced in various other courses. They should also offer ongoing education in this field at the undergraduate and graduate levels.
- Extend training and knowledge (or instruction) on AW topics to other medical and agronomic sciences that involve practices with animals, as well as to careers in education, law and communication, so that future professionals will be educated in and aware of care and respect for animals and so promote them in their communities and with the general public.
- Ensure that the topics covered in AW courses include broad information on the guidelines of the World Veterinary Association (WVA), the OIE, FAO, and the Pan-American Council of Veterinary Sciences (*Consejo Panamericano de Ciencias Veterinarias*, COPEVET).
- Guarantee an adequate offer of AW courses. This obliges all

Table 2
Basic topics and contents of an animal welfare course. Bioethics, ethology and welfare in domestic animals.

1. Bioethics, Ethology and Welfare in Domestic Animals	
Topics	Contents
1. Bioethics and Animal Welfare	– Zooethics – Ethical theories framework: – Teleological: Utilitarianism and Emotivism; – Deontological: Absolutionism, Contractualism Virtue Ethics and Ethics of Care and their practical application – Ethical conflicts or dilemmas in veterinary science – Animal welfare dilemmas – The 3R's: Reduce, replace and refinement practices – Application of bioethics to a concrete case: "animals used for experimental purposes" (teaching and research)
2. Behavior and welfare in dogs	– Social behaviour and communication – Ontogeny of behaviour – Importance of the socialization period – Current issues on welfare in canine species – The stray dog: Abandonment and maltreatment – Confinement at dog shelters – Behavioural problems – Training and work dogs – Breed selection – Evaluating stress and improving welfare – The use of pharmacological and biological therapies – Behavior modification programs – Environmental enrichment programs – Measures of early intervention
3. Behavior and welfare in cats	– Social and territorial organization (social relations, affective relations, hierarchies, territory) – Communication – Ontogeny of behavior – Learning; -Intelligence – Behavioral problems of cats (house soiling, aggressiveness, scratching, other stress-related problems) – Environmental enrichment programs
4. Welfare of dairy cows	– Transition period – Lameness: -Scoring systems for diagnosing lameness – Early detection of sick animals or those at risk of becoming sick: – Behavior changes – Use of blood biomarkers; –Use of other technologies – Assessing AW in dairy production units: Use of Welfare Quality® protocol
5. Behavior and welfare of pigs	– Maternal behavior; -Weaning behavior; -Thermoregulatory behavior: eliminative behavior; -Trophic behavior; – Welfare issues in husbandry procedures: early weaning, castration, teeth clipping, tail docking – Abnormal behavior and stereotypies: tail biting, vacuum chewing, navel suckling, dog sitting, bar biting – Space allowance for feeder pigs – Assessing AW in swine production units: Use of Welfare Quality® protocol for pigs
6. Welfare of neonate piglets	– Relation between uterine dynamics and umbilical cord morphology – Etiology of meconium staining and meconium-aspiration syndrome – Determining the physiometabolic profile of neonates – Vitality scale and latency to first contact with the maternal teat
7. Welfare of sows	– The use of stalls in pregnant sows – The use of crates in lactating sows
8. Behavior and welfare of the water buffalo	– Mother-young bond – Handling offspring – Thermoregulation behavior – Trophic behavior – Welfare in extensive systems – Welfare in intensive systems – Assessing AW in production units
9. Equids behavior and welfare	– Confinement – Low roughage diets – Development of the mother-young bond – Weaning and breaking the mother-young bond – Play in the development of colts – Problems in the mother-young bond – Temperament and character of the foal – Assessment of animal welfare using AWIN protocols for working horses and donkeys
10. Welfare in animals in circuses, zoos, dolphinariums, sports and traditional or cultural events	– Fighting bulls: – Physiological and biochemical responses, – Muscular lesions, pain and hypovolemic shock – Circus animals – Zoos – Dolphinariums – Equitation: rodeo (*charrería*) and racehorses – Dogfights and cockfights

(*continued on next page*)

Table 2 (*continued*)

1. Bioethics, Ethology and Welfare in Domestic Animals	
Topics	Contents
11. AW in situations of disasters and emergencies	– Disaster contingencies and AW: –Preparation phase, –Alert phase – Impact phase, – Phase of emergency, aid or assistance, – Reconstruction phase – Evaluating damage and analysis of needs related to AW – Freedoms and AW criteria during disasters
12. Painful practices in farm animals	– Surgical castration (orchiectomy): Consequences of extirpating the testicles of production animals, reducing pain in castrated pigs; – Castration in bovines – Tail docking (in pigs and ruminants) – Teeth-clipping in piglets – Beak trimming – Dehorning (options for reducing pain during dehorning)
13. Ethology applied to animals at auction	– Animalś basic needs – Sensory organs – Ante mortem ethological measurements – Ante mortem AW problems – Effects of lairage facilities design at the abattoir and stockman handling on animals on AW
14. Animal welfare in livestock at markets	– Transport: – Loading and unloading – Holding in livestock markets (lairage) – Inadequate handling: – Lesions, – Diseases – Recommendations
15. Animal welfare during transport, lairage and slaughtering at abattoirs	– Shipping: – Transport; – Unloading; – Herding methods – Stunning methods: Signs of return to sensibility during stunning – Typification of carcasses

Sources: Keeling and Jensen [60]; Jensen [61]; De la Cruz et al. [62]; Dalmau and Velarde [25]; Gallo [63]; Galindo and Manteca [59]; García-Herrera et al. [64]; Henao et al. [65]; Huertas-Canén [66]; Mora-Medina et al. [46,67]; Mota-Rojas et al. [9,14,22,24]; Orihuela [55]; Mejia-Isaza et al. [68]; Corrales-Hernández et al. [69]; Rosado et al. [70]; Sepulveda and Bustamante [71]; Strappini [72]; Tadich et al. [35].

institutions teaching future veterinarians to have a critical mass of trained professionals who is certified in the precepts of AW, especially in relation to agricultural and livestock production systems.

- Regional professional organizations should collaborate to: 1) establish professional certifications that include AW as an area of veterinary specialization; 2) offer undergraduate and graduate courses on related topics; and 3) implement accreditation systems for specialization in AW. Animal welfare should also be included in the internal and external evaluation systems of all study programs.
- Universities and research institutions should establish committees for the care and use of animals (in bioethics, research and teaching), and promote and maintain the development and implementation of alternatives to the use of animals in teaching and experimentation.
- Educational institutions should maintain a firm commitment to training future VZ in key technical, philosophical and economic areas, including competence in communication.
- VZ schools/faculties should generate extension projects to raise consciousness of AW in the general public from early ages. This should be linked to imbuing all VZ students with a profound sense of social responsibility.
- Regions should collaborate in constructing strong, unified communities that have the ability to negotiate 'in block' based on common policies, shared interests and common goals.
- Finally, VZ educational institutions should agree upon and diffuse a standard glossary and terminology for animal health and AW [5].

Nowadays, teaching appropriate animal practices, preventive medicine and disease treatment is not enough. Future vets require a sound knowledge of animal behavior and mental states of animals. However, themes like ethics and the mental and emotional state of animals, the social context, and the importance and types of human-animal relationships are virtually absent from the study programs in the region.

3.3. One welfare approach

As mentioned before, the professional profile of ZV has been also defined by COPEVET; therefore, veterinary science spans a broad and varied spectrum of study areas, due to the extension and importance of its occupational field. These areas include:

1. Caring for animal life under both health and illness conditions.
2. Improving and controlling animal production, with a view to achieving maximum efficacy and economic profitability.
3. Preserving and improving certain species.
4. Controlling the hygienic-sanitary conditions of products of animal origin.
5. Sanitary prevention of diseases that affect both animals and humans.
6. Resolving clinical and surgical problems that affect animals.
7. Preserving and improving natural environments by implementing sustainable procedures [31].

In this scope, veterinary science not only contributes to enhance the conditions of animal's life, but substantially improves the health and welfare of human populations, while also enables and fosters economic development in countries by propitiating and strengthening agricultural activities. Thus, the "One Welfare" approach is an essential component of veterinary education as it covers animal and human health, food security, sustainability, and farming production improvement [32] in accordance with the Panamerican Association of Veterinary Sciences (PANVET) recommendations.

3.4. Contents of animal welfare courses offered in Latin America

In the past, numerous professors of veterinary medicine did not have a clear idea as to what the ideal content for study plans on AW should be. The syllabus "Concepts in Animal Welfare" launched in 2003 by the former World Society for Protection of Animals (WSPA, today WPA) and the University of Bristol veterinary School, responded to this educational need [33,34]. Currently, most Latin American countries face limitations in terms of teaching AW, among them a shortage of specialized professors [35]. When today's veterinary teachers were students, AW topics were hardly ever included in their curricula. Back

then, courses on nutrition, genetics and related topics seldom dealt with AW; in other courses, good livestock production practices were confused with animal welfare. Nowadays, in contrast, it is necessary to design courses that satisfy the requirements of todaýs students, and to develop research in this field as well [36]. Since AW is an emerging discipline, this shortage of qualified professors will have to be resolved gradually; one approach has been the employment of graduate students, who studied AW or applied ethology abroad, and are being contracted by regional universities. Another strategy has been extracurricular training, through continuing education courses.

According to Fraser [8], any instruction in AW should include the following three cornerstones: animal behavior, ethics and legislation (policy). These basic concepts are necessary to provide students with initial AW science education. Welfare science predominantly concerns the quantification of the influence of human actions on animals [37], and its repercussions on physiological, behavior and health issues. Traditionally AW concepts and assessment are taught in this subject. Animal Welfare Ethics involve examining the morality of human actions towards animalś use and husbandry [38,39]; therefore general ethical frameworks and approaches, as well as common ethical dilemmas seen in practice should be discussed in classroom. Whereas Animal Welfare Legislation takes into account how humans should treat animals as a result of science and ethics, in this course, public policies, current national and international laws and regulations, as well as animal welfare minimum standards should be taught [37]. To address the problems of animal welfare in developing countries, it would be inappropriate to adopt the international standards that are implemented in the developed countries [40], therefore it is advisable to teach the matters about responsibilities and duties towards animals in accordance to the country's animal welfare laws and regulations, based on a sound scientific basis and overlaying this information with social, ethical, cultural, economic and environmental considerations.

In Spain, despite significant advances in introducing AW into veterinary education, including the creation of research groups at several universities, much remains to be done regarding the future of this course in veterinary teaching. Fernández-Lazaro et al. [41] presented an analysis of the university course offered at different faculties of veterinary science for the 2015–2016 academic year, based on two sources: the Registry of Universities, Centres and Titles of Spain (*Registro de Universidades, Centros y Títulos*, RUCT, Ministry of Education, Culture and Sports), and the country's link to the universia.net network [41].

Turning to Latin America with regard to courses focusing on AW [35], of 33 universities surveyed in 14 nations, 21 offered such courses, 15 of them are compulsory. Taylor et al. [42] surveyed 100 of the almost 400 veterinary schools in Latin America and found that 98% included AW in their study plans although, once again, most were optional. While it is highly likely that the schools that did not respond to the survey simply had nothing to report in this regard, it is clear that progress has been made in including AW courses in veterinary medicine programs. We can assume that this trend will continue, since the OIE [30] has included AW among the competencies that all veterinarians must embrace before they graduate [43]. Currently, Mexico has more than 50 veterinary schools with different academic strengths and teaching strategies [44] all under the recommendation from OIE to teach AW. Results from Alonso-Spilsbury et al. [44] show that one fourth of the institutions had introduced compulsory instruction in AW into their programs although 20% offer no instruction at all in this subject; there is no consensus on which semester should AW courses be taught, a range from one to six was found.

In Chile, AW courses have been introduced in the curricula of several schools of veterinary medicine [35]. In 2002 *Universidad Mayor*, a private university introduced a compulsory course in Ethology and Animal Welfare in its curricula, being the first veterinary school in Chile to have this type of course. Later in 2006, *Universidad Austral de Chile* offered one optional course, Basic Animal Welfare for undergraduate students, which was taught in the second year. In 2008, a second optional course, Applied Animal Welfare, was included, which still is taught in the fifth year of the curriculum [35]. Finally in 2016 the course Ethology and AW was incorporated as a mandatory independent course, and Advanced Animal Welfare is offered as optional course for postgraduate students. All these courses address animal behaviour, AW science and legislation.

There is no consensus also on the topics that should be covered in AW courses or the depth into which they should be examined. It is of interest that the inclusion of the core subjects, animal welfare, ethics and legislation are taught under different names among Mexican vet schools and universities [44]. Animal Welfare subject was found as Behavior and Animal Welfare; Behavior, Animal Husbandry and Animal Welfare; Environment, Behavior, Husbandry and Animal Welfare; Welfare, Protection, Ethology and Animal Stress; Stress and Animal Adaptation, and as Mechanisms of Animal Adaptation, as a single compulsory course in each case. For the Ethic course, which is now included in most of the veterinary schools, because it is relevant and is an expected day one competency for veterinary graduates [30], the following names were found: Bioethics, Bioethics Seminar, Professional Ethics, Ethics and Professional Practice, Ethics from the Professional Practice of a Veterinary Medicine and Zootechnics; Ethics, Society and Profession, General Ethics, Ethics and Social Responsibility, Ethics, Social Responsibility and Transparency; Identity and Values, Mankind and Behaviour, and as Globalization and Human Rights. Whereas legislation is taught under the following names in the Mexican veterinary science curricula: Legislation for the Veterinary Medicine, Animal Production Legislation, Agricultural and Animal Production Legislation, Legislation for the Veterinary Practice, Agriculture Legislation and Wildlife; Animal Hygiene Legislation, Legislation and Producer Organizations, Legal Framework for the Veterinary Medicine; Deontology, and Hygiene Norms and Regulation.

Indeed, there is a marked diversity of teaching contents among different schools of veterinary sciences; an issue that surveys by Tadich et al. [35] and Taylor et al. [42] have highlighted for Latin America. Findings may be attributable in part to more emphasis on Ethics and ethology matters by the specific interests of teaching faculty at some schools, while others focus more on their preferences for welfare of companion animals, wildlife, animals in captivity or production animals. According to the results of the discussion at the aforementioned Panel on AW at the "Professional Profile of the Veterinary Doctor in Latin America: Vision to 2030 Congress" [5], future veterinarians should have the ability to:

- articulate/integrate their ethical, philosophical, moral and sociocultural training with their technical-professional formation,
- find effective ethical, humane, medical and technical solutions to work integrally and harmoniously on issues of public health and production,
- promote AW in the professional practice using all available tools,
- avoid implementing procedures that put animals' needs at risk and/or entail inflicting pain,
- improve food production and safety without affecting AW,
- be familiar with legislation and communicate and generate changes that promote AW,
- use technical/scientific argumentation to rationalize the use of animals in experimentation, research and teaching,
- recognize scientifically the needs and applied ethology of animals,
- identify problems that affect AW and propose solutions, and
- be active in managing risks and dealing with disasters.

In this last item, it is worth mentioning that since 2011 some Mexican veterinary colleges have had workshops on veterinary emergencieś response with trained veterinary students on animal rescuing by the World Society for the Protection of Animals (WSPA), so currently they are Veterinary Emergency Response Units in Guadalajara

and Veracruz and others such as the *Facultad de Estudios Superiores-Cuautitlán-UNAM* (*FES-C*, State of Mexico), where protocols for risk management have been developed in the livestock facilities of the institution and which are developed by the students as a case study [45].

In addition to the above, it is worth mentioning that the latter institution has also organized inter-institutional extra-curricular courses, such as the so-called cycle of lectures on animal welfare and meat quality, to address specific issues of animal welfare, in which academics and students from other universities and schools of VZ, such as *Universidad Autónoma Metropolitana* (*UAM*, Mexico City), Faculty of Veterinary Medicine-UNAM, Autonomous University of Querétaro, among others, are also involved. UNAM was also one of the pioneer institutions to have a committee for the care and use of animals for experimentation, where they regulate practices where animals are used for researching and teaching. Additional information about animal experimentation or euthanasia in research animals can be found in Mora-Medina et al. [46].

The preceding paragraphs lead to the conclusion that while teaching strategies differ from one country to another, or between institutions in the same country, there is a broad consensus on the contents that should be explored, including ethics and a scientific perspective on AW, animal behavior and needs, legislation, how animals are used and strategies for assessing AW [36]. Though each nation will integrate these concepts in accordance with its own political, religious and social structures, we have proposed the contents of an initial module or course on AW and listed them in Table 1. This course could be followed by an examination of the topics described in Table 2, regardless of the cross-sectional contents that may be desirable to include in the curricular map. The contents have been taken from different sources in an attempt to design a comprehensive study program for Latin America. The contents in Tables 1 and 2 are a consensus of relevant topics of the animal welfare subject for Latin America and come from the proposals of more than 30 authors who contribute with their ideas and propose their contents; many of them wrote book chapters in the animal welfare book, a global vision in Ibero-America. We, the authors of this article only take care of ordering and organizing the information in tables to have a clear and ordered proposal about what are the basic topics and contents of an animal welfare course. Therefore, under the tables the references can be found in order to give credit to the authors and facilitate finding more details about the topics.

4. How to teach animal welfare

4.1. New approaches to train students in animal welfare

Current teaching practices are more based on ‘guiding’ and ‘orienting’ students, ‘coordinating’ them, and ‘cooperating’ with them to open new perspectives and discover possibilities [47]. For students to become effective future professionals it is important that they develop such autonomy. Thus, university teaching in the 21st century must imbue learning processes with this profile of practicality and utility [48]. In this sense, integrating formal teaching with practical experience and supervised self-learning is as essential for AW study programs as are basic courses on pathology and surgery; although, the autonomy of each university must determine the best way to offer their programs. Traditional classroom-based teaching methodologies have been largely replaced by other new approaches such as project-based learning and gamification.

Project-based learning approach leads students to examine topics and problems in practical sessions, working in teams to develop the ability to search for, acquire and process knowledge. This active methodology fosters students’ capacities and competencies through a kind of self-directed education that enhances learning by developing metacognitive abilities [49]. In this approach, learning is produced as students’ progress in different projects, continually correct errors, and striving to improve their abilities in the activities required by project design. Cooperative work among students is another essential learning strategy, because it offers greater realism by presenting problems based on real-world situations [50].

Project-based learning enhances students’ critical and self-critical faculties, both individually and at the group level [4]. This approach is currently being used in several universities. In Spain, the Faculty of Veterinary Science at the *Universidad de Córdoba* (Córdoba) seeks to ensure that the quality of education and the abilities that students acquire satisfy the high demands of European countries and labor markets. In Mexico, the *UAM* offers a module-based system that encourages students to design research projects with different species, requiring application of theory acquired in the classroom into practice in the field (a farm, stable, ranch, dog shelter, etc.). Competence in implementing and monitoring an animal welfare assessment protocol requires evidence that knowledge and skills has been learnt and applied, therefore, students need to apply a validated protocol in the field. This represents a large number of credits in the modular system used at *UAM*, as a teaching-learning approach; this method provides a kind of training that greatly differs from what they would receive in a traditional course-based system. In Colombia, the students of the *UNIAGRARIA* University (Bogotá) should apply the concepts learned in practical workshops in ways that demand relating that knowledge with analyses of animals’ real conditions in their respective contexts in the framework of human-animal-environment relations, always in compliance with national and international guidelines on the topics involved (OIE, WVA, FAO, etc.). This approach promotes greater competitiveness in local, regional and global contexts.

4.1.1. Gamification

Another approach that can be applied as AW teaching methodology is gamification. Gamification –learning through gaming– is used to encourage students to apply mechanisms, concepts and dynamics in teaching-learning contexts as a way to enhance in-class motivation. The role-playing approach in which learners represent different personages is not widely used in veterinary programs, though it has been shown to support the acquisition of the competencies and abilities that the profession demands. In Spain, at the University of León, Alonso and Lomillo [51] used role-playing to help students enhance their competence in the field of animal bioethics. They reported that this teaching methodology propitiates a better identification with and understanding of bioethical dilemmas that can arise in professional practice in clinical medicine with small and large animals, in the food industry and in research, meanwhile students evaluated the experience very positively. Similarly, at the *UAM* in Mexico City, veterinary students learning ethics are required to write a five pages essay and give a 12 min Power Point presentation to the class, on a chosen dilemma in animal husbandry techniques. They have to be able to construct reasoned arguments to support their actions and positions based on the ethical theories acquired in the classroom. In addition, another similar methodology is also applied in *UAM* and *FESC-UNAM*, through simulated cases where a real or fictitious problem is posed so that the students of the second year can solve the ethical dilemmas by integrating the scientific and legal principles to make an informed ethical decision.

Welfare contests in which teams compete to determine the better of two situations (for example gestation stalls versus pen group housing in sows), is another gamification strategy, developed by Heleski et al. [52], that might be useful to include as an educational source in Latin America vet schools, it could be within a class or between institutions. All these approaches seem to be promising methodologies to teach AW and ethics to veterinary students.

Teaching animal welfare requires multidisciplinary groups that integrate the results of research in everyday situations of the professional practice of VZ. To ensure veterinary students will be better equipped to graduate with OIE day 1 competencies in AW, teaching approaches are needed that support “project-based on original research” and gamification, critical thinking, reflection and collaborative learning.

5. Recommendations

We believe that covering AW contents in a cross-sectional manner impedes students from achieving a comprehensive understanding of the concept of AW. Hence, we consider it is necessary to include courses that deal specifically and exclusively with AW, preferably after learners have studied cellular biology, physiology, general and systemic pathology, and deontology.

Finally, we recommend the third edition of the book Bienestar Animal: Una Visión Global en Iberoamerica [Animal Welfare, a Global Vision in Ibero-America], edited by Elsevier-Barcelona publishing company in Spain, as a key tool for teachers who wish to offer courses on AW and suitable for the students who attend such courses.

6. Conclusions

Currently the curriculum of veterinarians must take into consideration in their training programs animal welfare, and adapt constantly to respond to educational, social, economic and legal demands.

Teaching AW is not an easy task, since it requires trained teachers who can integrate science, ethics and legislation for the benefit of animals.

Training in AW must be included in both undergraduate and graduate programs and be emphasized in scientific research. It is equally important that the teaching of AW be implemented in conjunction with lines of research supporting the principles that will later be taught in the classroom. In this way, students can be led to confront specific cases, carefully structured to resolve problems of local or national interest.

The modular system shows to be a practical model for conducting competence-based learning on AW based skills. The curriculum maps for VZ must not only train students to prevent cruelty and pain, but also endow them with the abilities and skills necessary to propose alternative systems using strategies founded on the species-specific behavioral repertoire.

University instruction in the 21st century must endow learning processes with a sense of practicality and usefulness. Although significant advances have been made in introducing AW into veterinary education, including the creation of research groups at several universities in Latin America, there is still much to do with regards to the future of such courses in veterinary teaching in Spain and Latin America countries, as well as their inclusion as independent courses in undergraduate programs.

Competing interests

The authors declare no conflicts of interest regarding the publication of this paper.

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