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In bioethical criteria in demonstrative and experimental practices with animals in the Career of Pedagogy in Chemistry and Biology

Criterios bioéticos en prácticas demostrativas y experimentales con animales en la Carrera de Pedagogía en Química y Biología

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Abstract

Demonstrative and experimental studies with animals over time have been part of the practical teaching of different contents that have contributed to the biological, medical and pharmacological sciences. However, progress in scientific and educational activity has brought with it bioethical difficulties from the academic perspective in the importance of using animals to consolidate theoretical knowledge and from the bioethical-legal perspective in the requirement of good animal management. The objective of the research was to analyze the application of bioethical criteria in demonstrative and experimental practices that use animals in the Pedagogy of Experimental Sciences in Chemistry and Biology. The study had a qualitative-descriptive approach. The interview technique was applied to three laboratory professionals and to an external teacher expert in animal practices. In addition, laboratory observation was carried out using an observation card with nine indicators and four dimensions in 32 practices with animals. A structured survey of 11 questions was also applied. These instruments were applied to a population of 155 students in their third, fourth and eighth semesters. The survey, interview and observation form were validated by three expert teachers. The results indicated that 68.75% of the practices work with dead individuals, 21.87% with insect vivisection and 9.38% with preserved exotic animals. In conclusion, most of the practices (78.13%) are in accordance with the framework of the Bioethical Regulations set forth at national and international level and have taken care of animal welfare, avoiding unnecessary sacrifice of animals.

Keywords

animals, bioethics, bioethical principles, didactic material, demonstrative practices.

Resumen

Los estudios demostrativos y experimentales con animales a lo largo del tiempo han formado parte de la enseñanza práctica en diferentes contenidos que han aportado a las ciencias biológicas, médicas y farmacológicas. Sin embargo, el avance en la actividad científica y educativa ha traído consigo dificultades bioéticas desde la perspectiva académica en la importancia de utilizar animales para consolidar conocimientos teóricos y desde la perspectiva bioética-legal en la exigencia del buen manejo animal. El objetivo de la investigación fue analizar la aplicación de criterios bioéticos en prácticas demostrativas y experimentales que emplean animales en la Carrera de Pedagogía de las Ciencias Experimentales Química y Biología. El estudio tuvo un enfoque cualitativo-descriptivo. Se aplicó la técnica de la entrevista a tres profesionales de laboratorio, y a un docente externo experto en prácticas con animales. Además, se realizó observación en laboratorio empleando una ficha de observación de nueve indicadores y cuatro dimensiones en 32 prácticas con animales. Así también se aplicó una encuesta estructurada de 11 preguntas. Instrumentos que se ejecutaron en una población de 155 estudiantes de tercero, cuarto y octavo semestres. Encuesta, entrevista y ficha de observación, fueron validados por tres docentes expertos. Los resultados indicaron que en 68.75% de las prácticas se trabaja con individuos muertos, 21.87% con vivisección en insectos y 9.38% con animales exóticos preservados. En conclusión, la mayoría de prácticas (78.13%) se ajustan al marco de las Normativas Bioéticas expuestas a nivel nacional e internacional y han cuidado el bienestar animal, evitando sacrificio innecesario de los mismos



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Palabras clave

Animales, Bioética, material didáctico, prácticas demostrativas, principios bioéticos.

1. Introduction

Throughout time, demonstrative and experimental studies have been carried out using animals for the development of the teaching-learning process. In this sense, animals have become an ideal resource for the advancement of several areas of knowledge related to the study of life and its processes; biological sciences, medical sciences and pharmacological sciences are an example of this.

Despite the benefits offered by these studies for the good of humanity, progress in scientific and educational activity has brought implicit bioethical difficulties. Complications from the point of view of respect for life that are framed in the bioethical-legal perspective and the demands of good animal management. The present research and the reality of the Universidad Central del Ecuador (UCE) in relation to laboratory practices are taken as a background. According to Altamirano, within the execution of demonstrative and experimental practices with the use of animals, the (UCE) through its Animal Research Studies Committee (CEIA) is organizing the regulatory support for the management of animal species (Altamirano, 2021).

In the I Course on Research and Bioethics in Animal Experimentation developed at the UCE, Gavilánez pointed out that the Higher Education Institution is developing a set of instructions for demonstrative practices in the classroom as part of the commitment to respect animal life (Gavilánez, 2023). In this regard, the present research constitutes a precedent of respect for the work with animals that is being carried out in the Faculty of Philosophy, Letters and Educational Sciences.

Bioethical criteria for experimental and demonstrative studies are one of the main topics of discussion in careers that are part of the area of Zoology, General Biology, Molecular Biology, Zootechnics, among others. Because at a practical level, animals or specimens are used pedagogically for anatomical and physiological explanations. In addition, the practices carried out may or may not include bioethical criteria in the sacrifice and waste management prior to the demonstrative or experimental practice. The objective of the research was to analyze the application of bioethical criteria in demonstrative and experimental practices that use animals in the Pedagogy of Experimental Sciences, Chemistry and Biology. It was a feasible study, since we had the time, financial, human and material resources. In addition, because it can help to solve a specific problem that is linked to the application of bioethics in the career.

The study consists of the following parts: introduction, where a brief vision of the investigated problem is simplified, theoretical framework that supports the research, description of the methods and materials, which indicate the type of research methodology. The results and discussion are also found, presented in relevant qualitative-quantitative data of the study. Finally, the conclusions are presented as a synthesis with the most significant findings regarding the objective of the research on bioethics applied in demonstrative practices with animals of the Pedagogy of Experimental Sciences, Chemistry and Biology career.



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2. Literature review

The use of animals in educational and experimental practices has allowed great advances in biological, medical, pharmaceutical and scientific knowledge. However, their use involves responsibility in welfare from the bioethical point of view, in good practices and animal management. In this regard, Rojas (2021) states:

teachers must be aware that working with students based on scientific and bioethical principles will contribute to the formation of responsible and critical citizens and thus to the construction of a more humane and just society. In this sense, it is recognized that education is a strategic way for students to assume a commitment to their environment, respect for all forms of life and the promotion of animal health and welfare (p.18).

The development of demonstrative and experimental practices with animals should offer the opportunity to work on improving learning, as well as the formation of students with scientific and bioethical principles. In this way, we seek not only to form critical students, but also good human beings who respect all forms of life and care for animal welfare. From the bioethical point of view, in laboratory practices with animals, good animal management should be taken into account through good animal husbandry practices:

- **Restraint.** When maneuvers or methods are applied to immobilize an animal they can be simple such as normal restraint of the animal using the hands; physical, when we use accessories or special surgical instruments; and chemical when we use tranquilizing drugs or anesthetics (Institutional Animal Care and Use Committee, 2021, p. 2).
- **Injection.** According to Varcellini and Principi, this technique uses agents or concentrated administration to cause depression of the nervous system and death (p. 247). According to the aforementioned authors, to avoid previous animal suffering, anesthetics should be used to inhibit pain in the animal. Needle insertion is an injection method that can be used for birds, fish, amphibians and reptiles by introducing a needle through the foramen magnum to the base of the brain. It is necessary to anesthetize the animal first to decrease pain (Varcellini and Principi, 2021, p. 250).
- **Analgesia.** "It is the absence or use of procedures that suppress pain in the animal" (Varcellini and Principi, 2021, p. 245).
- **Anesthesia.** "It is the temporary absence of sensation or pain of some part of the body or of an organ" (Varcellini and Principi, 2021, p. 239).
- **Euthanasia.** According to Varcellini and Principi it is the act of animal sacrifice with minimum pain, fear, anguish or stress. The technique should be painless and practiced by experts who have knowledge of the biology, physiology, handling and restraint of the species with which they are working. The choice of a method of euthanasia must be governed by current regulations and must be evaluated by a bioethics committee to endorse the experimental results (Varcellini and Principi, 2021, p. 243).

The academic knowledge for the good handling of animals in demonstrative and experimental practices in both teachers and students is important, since bioethical education will imply the critical development in the cognitive, affective, emotional and valorative, for this it is necessary to consider activities that forge the development and bioethical knowledge such as bioethical workshops; to expose fundamental elements of a bioethical topic on which teachers and students debate, reflect, and take perspective, in



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these they can share their personal experiences. In educational institutions it is necessary to organize seminars or conferences, since their attendance and participation will be important to be informed about bioethical dilemmas, which can be bibliographical or developed through different sources, and the critical level of the positions should always be present. In addition, formal courses encourage analysis and universal approaches to bioethics through sessions of diverse ideologies as foundations for studying bioethics. Creating research units is also beneficial because through the experience of the teacher or students will help to experience and feel the needs of this subject of study.

2.1 Bioethical Principles

They are important for the good training of professionals in a society where scientific progress prevails. According to the Bioethics Advisory Committee (2009) they mention that "the ethical endorsement is essential for the supervision of a research project for the welfare of living beings and compliance with bioethical protocols" (p. 23), which is considered that institutions using animals should rely on this document for compliance with bioethical protocols. According to the Bioethics Advisory Committee, environmental legislation allows for regulation through national and international statutes designed to protect the environment and enhance its ethical principles through standards. They are not considered laws, but act within a regulatory framework (Bioethics Advisory Committee, 2009, p. 23). This leads to responsibility, another bioethical principle that implies the proper practice of knowledge in bioethical regulations considered for the proper handling of animals, as it takes as a principle the sustaining of the life of an animal or a person (Bioethics Advisory Committee, 2009, p. 22).

Ethics committees in charge of coordinating and supervising activities and procedures aimed at animal care, as well as related research projects should be governed by institutional authorization according to their protocols (Institutional Animal Care and Use Committee, 2021, p. 13). With this, the principle of non-maleficence should be considered prior to the use of animals, i.e., harm-benefit balance. The use of animals is acceptable when their study is of significant importance (La Rosa, 2012, p. 253). Vilches and Zurita (2014) establish the principles of ethics and teaching with animal models, as follows:

The use of animals should be avoided when there is an alternative method that provides satisfactory results. The final benefit of the use of experimental animals should be clearly defined in each protocol. Tests that include animals as experimental models should be performed in registered user establishments. The minimum number of animals possible should be used in each trial to ensure statistically reliable results (p. 16).

The following principles of ethics and teaching are based on animal welfare. Hence, there must be a correct development of natural animal behavior, avoid using a maximum of animals for experimentation, let those involved lead a dignified life, and let them always comply with codes and principles for their mental, physical and emotional health. Furthermore, in order to avoid any kind of suffering, it is necessary to look for different but satisfactory alternatives.

2.2 Bioethical Principle of the Three Rs

Under the vision of sustainability and care in ethics, a set of strategies are presented on which international law is based when using animals in demonstrative and experimental practices. The principle of the three Rs (reduce, replace, refine) was established by Russell



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and Burch (Cardozo and Mrad, 2008, p. 46). The purpose of these three principles is to ensure that animals used for experimentation or demonstrative practices feel the least possible suffering or harm in the pharmacological or dissection processes. Cardozo and Mrad point out that the application of the three Rs implies an expression of values, quality and validity at the level of research because it promotes an awareness of respect on the part of researchers in the case of clinical experimentation or in students during the execution of demonstrative practices (Cardozo and Mrad, 2008, pp. 46-71).

Principle	Definition	Strategies or alternatives
Replace	Group those methods that allow experiments to be performed without the use of animals.	In vitro systems, audio-visual aids, dead animals, slaughterhouse equipment, models, software.
Reduce	Describe methods for obtaining comparable levels of information from the use of few animals in scientific procedures.	Animal model selection; sanitary quality, environmental genetics; cryopreservation, advanced statistical methods, data bank, access to specialized literature.
Refine	Group those methods that alleviate or minimize pain and distress to maintain animal welfare.	Animal care and welfare, personnel skills and training, improvement of pain detection methods, use of anesthetics, analgesics and tranquilizers or use of non-massive techniques, early euthanasia, etc.

Table 1. Bioethical principles of the three Rs. Garcés and Giraldo (2012, p.162)

As shown in Table 1, each of the bioethical principles has a simple and understandable definition for all audiences. It is also easy to understand that for each principle there is a specific alternative to avoid, reduce or minimize pain and thus offer welfare guarantees to the animal under study.

2.3 National and International Regulations

2.3.1 Animal Research Ethics Committee (CEIA) Universidad Central del Ecuador. Functions of the CEIA-UCE

In the I Course on Research and Bioethics in Animal Experimentation Vargas mentions that the functions established in the Committee are those that are directly related to the present research work. B). To evaluate, from the approach of ethics and welfare for the animals involved in the research, the methodological, ethical and legal aspects of the research and degree programs and projects presented. C). To know and issue recommendations to the guidelines for academic, research and social practices that include handling and experimentation with animals. D). To train researchers and teachers in their tasks and responsibilities regarding the ethical aspects of animal handling and experimentation, so that they are incorporated in the micro curricula of the pertinent professorships, which guarantee animal welfare. E). To guarantee that the personnel involved in animal handling procedures have the appropriate training to carry out the tasks entrusted to them and to execute the research protocol as established by the national and international regulations in force. Or suggest professionals with the appropriate training. G). Ensure that the animals subjected to research do not suffer unnecessarily and that they are provided, when



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necessary, with analgesics, anesthetics or other methods designed to eliminate pain, suffering or distress as much as possible (Vargas, 2023).

Of the nine functions established in the Committee, research work is related to six, that is, to most of them. It is therefore necessary to work according to the functions established by the CEIA in those mandatory practices that involve the handling of animals within the training process of new professionals. According to the I Course on Research and Bioethics in Animal Experimentation developed at UCE, the projects classified as exempt from review must be reported by COIF to the president of CEIA and will be those that meet the following characteristics:

- Make use of inanimate animal models or simulation software in curricular teaching areas.
- Research projects involving observation of animals or biodiversity with or without photographic or video recording. Studies that involve direct contact or observation of endangered animals, other species in conservation or that inhabit natural and/or protected areas in national or international territory will not be exempt from review.
- Review and use of specimens deposited in museums and biological collections.

2.3.2 Organic Law on Animal Welfare (LOBA)

Today, it is universally accepted that the use of animals in teaching is unavoidable due to learning objectives, which implies that it is necessary to examine the bioethical conditions that make it permissible. Hernandez and Fuentes mention that the five rules that Marshal Hall proposed in 1831 for scientific research were pioneering in establishing the goal of reducing animal suffering in science (Hernandez and Fuentes, 2018, pp. 112-113).

- Experimentation should not be performed if observation can be substituted for it.
- No experiment should be performed without a clear objective.
- Scientists, researchers and teachers should be well informed about the studies of their colleagues, to avoid unnecessary repetition in the use of animals.
- Justified experiments or practices should be carried out with as little pain as possible.
- Each experiment should be conducted under circumstances that give rise to clear results that avoid repetition.

Therefore, the LOBA translates into an international guide of respect for animal life and offers guidelines to teachers who need to carry out practices to ensure that these are optimal and that the maximum possible benefit is obtained from them.

2.3.3 World Organization for Animal Health (OIE)

In the I Course on Research and Bioethics in Animal Experimentation, Vargas mentions that the Terrestrial Animal Health Code established by the World Organization for Animal Health (OMSA) issues guidelines for the use of animals in research and education, and recognizes the essential role and accepts the use of live animals in research and education. The OMSA animal welfare guidelines stipulate that the use of animals offers an important contribution to human and animal welfare, as well as underlines the importance of the 3Rs. This worldwide code accepts the use of animals for educational purposes, however, it does not neglect the bioethical importance and therefore emphasizes the application of the 3Rs in the execution of academic and research practices (Vargas, 2023).



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2.4 Demonstrative and experimental studies with animals

In the 20th century, biomedical advances took place, with the appearance of anesthetics, which facilitated the use of live animals in experimentation, reducing their pain. Nowadays, society increasingly tends to demand that the welfare of animals be guaranteed during experimentation and there are ethics committees that determine when a project can be carried out with animals and under specific conditions. So it can be concluded that animal experimentation has always existed, although it is true that it is increasingly practiced with greater consideration for the animal (Vilches and Zurita, 2014, pp.5-9).

According to Vilches and Zurita as the years go by science and teaching about a field change, i.e., nowadays as in ancient times animal experimentation has played a fundamental role in the process of teaching and science. On the other hand, while experimentation has helped to decipher multiple aspects of health and its preventive diseases, it has also left ethical thoughts. That is why it is necessary to experiment based on certain protocols, articles, laws, etc., that guarantee animal welfare. Animal experimentation is defined as the use of an animal for a scientific purpose that may cause pain, suffering, distress, among others. These experiments can even cause births with malformations. An experiment begins when an animal begins to be prepared for its use and ends when no further observations are to be made on said animal, in addition the satisfactory use of analgesics or anesthesia or other methods, will not exclude the animal from being considered within this definition (Vilches and Zurita, 2014, p. 4).

It refers to the process of subjection of an animal for some purpose, scientific or demonstrative, however, the processes of experimentation are painful and traumatic for the animal. It begins with the preparation, observation, stay, among other aspects, and ends when it is no longer necessary to test the animal. It must be emphasized that all the analgesic aspects do not compensate for the pain in experimentation. With respect to demonstrative studies in educational institutions Arias, León and Reyes refer that "the use of animals for teaching is a practice that has been carried out for many centuries and has contributed great advances for the teaching of Anatomy, Physiology, Pharmacology, Zoology and Toxicology." (Arias, Leon, & Reyes, 2015, para. 3). Using an animal in teaching aims to put into practice theoretical concepts that allow the application in a model.

Given that the experimentation or use of animals in demonstrative practices are part of the teaching processes in different subjects in the biological sub-branches to avoid the excessive use of animals or the sacrifice of species that are in danger of extinction. Biotheriums are an alternative because they are spaces with animals used for laboratory purposes "where they are bred, kept and used for research as biological models. In it, species of mammals, birds, reptiles, amphibians and fish are kept in environments that provide them with the requirements and needs to survive and reproduce" (Vargas, Ambriz, Navarro, Trejo, Rodríguez, & González, 2018, p. 9). In addition, this ranch shelters species with excellent genetic and microbial quality previously studied in a laboratory. These animal farms examine that the species used do not present criteria of vulnerability (extinction), are domestic, of human consumption or of easy accessibility that are adjustable to the bioethical criteria exposed in the experimentation or use of demonstrative practices with animals.

2.5 Alternative methods to the use of animals

The end of the 20th century saw an increase in in vitro teaching studies, with alternatives accounting for more than 50%, as opposed to a decrease in the use of animals. This achievement is due to various factors, both ethical, logistical, scientific and economic. Among them are: audiovisual systems, computer simulations, virtual laboratories, virtual



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reality systems, in vitro tests, didactic material with preserved animals, where cell cultures or serum are used to observe cellular and molecular reactions or human and veterinary clinical practices, which allow the student to participate in the professional's routine.

However, the procedures are designed by the investigators themselves and are generally not validated, so that the only requirement for approval is acceptance by reviewers at the time of publication or if applying for research grants. However, legal compliance with animal welfare protection and safety regulations is of imperative (Vilches and Zurita, 2014, p. 42). In addition, Ortiz (2016) cited by Dewhurst (2005)):

He conducted an investigation to compare and evaluate the learning of two groups of upper level students in physiology and pharmacology classes at the University of Sheffield, UK. In one module of the physiology course, on epithelial transport, one group used a computer program simulating laboratory experiments, while the other was taught in the traditional method using rats to learn about isolated sacs and discharges from their small intestines. Apart from that difference, both groups were given conventional lectures and attended seminars. The result of that and several other studies reported by the researchers was that CAL (computer-assisted learning) can be effective in replacing or enhancing traditional laboratory lectures in undergraduate biomedical science courses, and it is clear that replacing a proportion of traditional hands-on lectures with computer simulators would not disadvantage students and could, in fact, enhance their learning (para. 8).

In this paragraph the author analyzed the use of animals in higher education, the research has two aspects, the first is pedagogical, which means that the option of using animals is didactically equal, less or more effective than doing it without them, and the ethical justification, which tries to answer the question of whether it is morally correct to use and/or kill animals for students to learn. In the field of teaching, teaching strategies are constantly changing and technology has become an indispensable tool for transmitting knowledge. The changes have been manifested mainly in biology, anatomy, physiology or related subjects, where the development of mathematical or virtual models that facilitate the integration of information and visuospatial learning of the student is sought. These alternatives favor the acquisition of knowledge without invasive manipulations on animals. In the experimental field of action, the use of animals is replaced by cells and tissues. However, in both fields it is stated that technology, in certain aspects, cannot replace the use of animals. That is why knowledge of the Bioethical Norms is considered as the starting point for the proper handling, manipulation and use of animals in the educational and scientific fields.

2.6 Vivisection and Dissection

According to García, dissection is a technique that consists of separating an organism into parts so that the structure and anatomical relationship with other species can be studied (García, Mejías and Castillo, 1999, para. 4). When talking about education, for Montemayor, dissection used as a way of learning "allows students to approach the object of study, the human body, in a real context, where small anatomical variations, origin and trajectories are highlighted" (Montemayor, 2008, p. 6). Therefore, it can be concluded that this method has a long history and is currently used as a form of teaching in higher education. The term "vivisection" derives from the Latin *vivus*, alive, cut, and refers then to the performance of cuts or dissections in a living organism, which has been practiced with defenders and



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detractors in different periods of history, both in human and non-human animals. In "antiquity vivisections were performed on death row inmates or prisoners; today it is clear that this practice is not ethically acceptable" (Alvarez, 2007, para. 1).

3. Methods and materials

The study has a qualitative approach. It aims at the global analysis of the application of bioethical criteria in demonstrative and experimental practices with animals. It is descriptive because it characterizes a phenomenon that is the application of bioethical criteria. It is a longitudinal study because it is carried out in the practices that are executed during the course of the semester with the same students and teachers. It refers to a laboratory study because it was carried out in a space of the Career destined to the manipulation of biological samples, and which has the adequate infrastructure for it. It is a feasible type of research, since it had the time, financial, human and material resources and because it tends to provide a solution to a specific problem that is linked to the application of bioethics in the career.

The interview technique was applied based on a questionnaire of six questions. These were focused on: 1. Conditions of maintenance, 2. Position of the researcher regarding animal sacrifice methods, 3. Bioethical training of the laboratory instructor, 4. Application of bioethical criteria, 5. This research instrument was directed to 3 laboratory professionals of the Pedagogy Career of Experimental Sciences, Chemistry and Biology. The questionnaire was also applied to 1 external teacher expert in animal practices who has experience in demonstrative and experimental practices, and is the Coordinator of the Ethics Research Commission of the UCE.

An observation sheet with six dimensions and nine indicators was applied in the laboratory in 32 practices with animals. The dimensions were: 1. Use of space for care, 2. Type of animals used in the practices, 3. Organization of groups of students as a mechanism for optimizing the number of animals sacrificed, 4. The nine indicators were: 1. domestication status, 2. conservation status, 3. vulnerability status, 4. extent of distribution, 5. use of virtual tools, 6. replacement of specimens, 7. reduction of specimens, 8. refinement of specimens and 9. Actors in the teaching-learning process.

Finally, a survey was applied whose questionnaire was structured by 11 questions, related to the six dimensions and 9 indicators mentioned above. This research instrument was applied to a population of 155 students in their third, fourth and eighth semesters. The three research instruments, survey, interview and observation form, were validated by three expert professors, including the Biology Area Coordinator. The data were processed using Atlas ti (interviews), Microsoft Excel (observation sheets) and Google Forms (surveys). The analysis of the information was carried out through triangulation of the results between the survey, interview and observation sheet.

4. Results

DIMENSION	CODES	RELEVANT DATES
Conceptual standards and scope of action	Animal housing conditions: sanitary and spatial (T, D)	"Provide the animal with water and food to carry out educational practices" (D).



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	<p>Academic training (T, D) Good practices (T, D, E)</p>	<p>"Basic sanitary measures such as apron, gloves, dissection kit are complied with" (T, D). "There is no suitable space for animal care" (T). "Live species are not handled in the laboratory because it does not have the space or resources" (T). "Our teaching and research orientation has to focus on bioethics" (D). "In the faculty of veterinary medicine, virtual atlases are used and plastinated organs can be requested" (D). "We are in the obligation to train ourselves to employ new methods or protocols of bioethics and teach students" (D, T). "Hand manipulation to observe limbs and external structures" (T, E). "Euthanasia was never applied in the course" (T).</p>
<p>Legal basis and bioethical principles</p>	<p>Reduction (D, T, E) Replacement (D, T, E) Refinement (D, T, E) Legal basis (D, T) University Code of Ethics (D, T)</p>	<p>"We work with collections or preserved specimens from the laboratory" (T, E). "There is less use of animals in demonstrative practices" (T, E). "Animals are replaced by computer models" (E). "In the Organic Law of Animal Welfare, the codes of ethics for handling species are complied with" (D). "Animals for human consumption that do not merit slaughter are used" (T, E). "It would be important to outline animal bioethics in the code of ethics" (T). "The University has certain regulations for animal handling; however, bioethics is not implemented due to lack of information" (D).</p>
<p>Didactic material</p>	<p>Audiovisual tools (D, T, E)</p>	<p>"Most of the laboratory practices use animal biological material" (T, E).</p>



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	Laboratory practices with biological material (T, E)	"Alternative methods to the use of animals are employed: 3D videos, simulators, mock-ups, virtual reality, preserved specimens, taxidermic boxes" (T, E).
	Laboratory practices without biological material (T, E)	"The best teaching is complemented with the experimental part by applying the principles of bioethics" (D, T)
Animal experimentation	Animal utilization (T, D, E)	"Working with specimens is required because they contribute significantly to student learning" (D, T).
	Dissection (T, D, E)	"Dissection techniques are applied to dead specimens and vivisection of insects" (T, E).
	Vivisection (T, D, E)	"It is possible to work with collections or preserved specimens available in the laboratory" (T).
		"It is necessary to have a balance of when it is necessary to use a live animal to sacrifice it in the laboratory" (D, T).

Table 2. Dimensions and codes with relevant quotes. T= Technician; D= Teacher; E= Student.

With respect to the application of bioethical criteria in the demonstrative and experimental practices with animals in this study, this was analyzed from the following dimensions: 1. Conceptual standards and scope of action, 2. In the first instance, the results of the first dimension corresponding to conceptual standards and field of action in experimental and demonstrative laboratory practices using animals are presented (Figure 1). In this graph, the triangulation of results between the survey, interview and observation sheet indicates an association of three components: 1. Under the component of animal housing conditions, three categories emerged: nutritional, sanitary and spatial conditions. It was evident that the experts and interviewees were aware of the terminology and the aspects involved in each of the categories. This is reflected in the expressions "provide the animal with water and food", "maintain hygienic conditions to maintain the animal's integrity..." and "comply with basic sanitary measures" indicated by the interviewees.

Similarly, there was criticism regarding the educational reality. The interviewees indicated that the Central University of Ecuador does not have the space or infrastructure to establish the bioethical conditions in a suitable manner and as stipulated in the International Regulations, for nutrition, sanitary and spatial protocols. This is supported by the expressions "there is no suitable space for animal care", "live species are not handled in the laboratory because they do not have the space or resources" and "there is no classification for waste in the laboratories" (See Figure 1). In the academic training component, a cause called field of action is annexed, referring to research and teaching. The research shows that there is continuous training of research teachers and implementation of new methods or bioethical protocols. The teachers seek alternatives to animal experimentation, for example:



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virtual atlases, plastinated¹ organs and courses for future professionals linked to bioethics. Thus, the interviewees expressed expressions such as "in the Faculty of Veterinary Medicine, virtual atlases are used and plastinated organs can be requested", "we are obliged to train ourselves to use new methods or protocols of bioethics and to teach students".

The codes corresponding to good practices are: restraint, injection, anesthesia, analgesia and euthanasia. Restraint is one of the most commonly used practices, according to experts, laboratory technicians and students. This is ratified by expressions such as "manipulation with the hands to observe the extremities and external structures". It is also revealed that injection, analgesia and anesthesia are the least used methods in good practices. The analyzed group affirms that injection, analgesia and anesthesia are the best methods due to their lethargy and decrease of pain in the animal. However, they are not frequently used due to the demand of economic resources that they imply.

In euthanasia, there is a contradiction between the information collected from the respondents, interviewees and the observation sheet. The students affirm that euthanasia has been performed, but the technical teachers affirm that in the Pedagogy of Experimental Sciences, Chemistry and Biology career, this practice has never been performed and the concept is not addressed in its entirety during the experimental practices. The following is the network of relationships within the dimension 1. Conceptual standards and field of action.

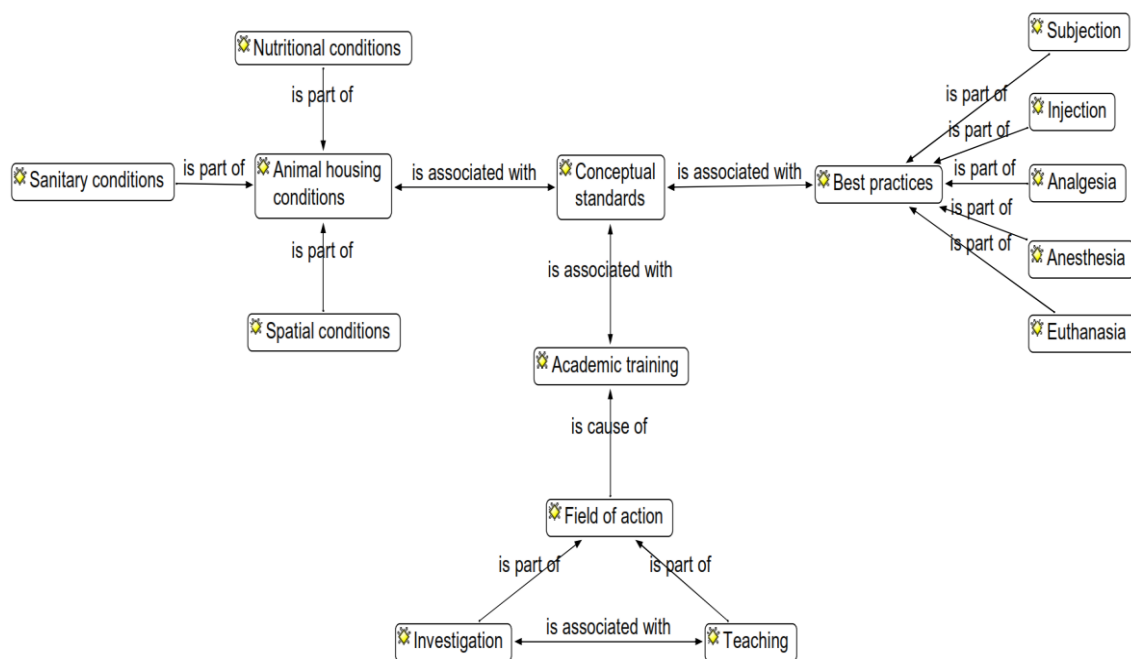


Figure 1. Conceptual standards and scope of action

It is evident that although the Universidad Central del Ecuador has supported the implementation of training processes in the area of animal handling, it has neglected to provide the necessary infrastructure for animal maintenance. Regarding the techniques

¹ Plastinate is a technique of animal preservation through the formation of plastic models.



used, it is clear that the best ones are injection, analgesia and anesthesia; however, the lack of economic resources makes it necessary to use the restraint technique.

Regarding the second dimension related to Bioethical Principles, International Regulations and the Code of Ethics of the Central University of Ecuador, three categories are considered in the experimental and demonstrative laboratory practices that use animals. These categories are shown in Figure 2 and are: reduction, replacement and refinement. In this dimension it was specified that the three categories in the University are used in the execution of practices on a smaller scale, in a limited way and adjusting to a great extent to the basis of the principle. This is due to the fact that there is less use of demonstrative practices. This is supported by the expressions "we work with preserved collections or specimens available in the laboratory" and "there is less use of animals in demonstrative practices". For this reason, improvement alternatives are sought with computer and didactic models.

In addition to the above, the responsibility of the person, the integrity of the animal in relation to demonstrative and experimental practices is added. It is pointed out that these seek animal welfare, as well as the presentation of responsibility reports when using species in experimentation or observations that are in accordance with the University's code of ethics. From the legal principles, the interviewees were supported by the Organic Law of Animal Welfare, International Regulations for Animal Research, Environmental Legislation and the Code of Ethics of the University. This can be evidenced by expressions such as "the Organic Law on Animal Welfare complies with the Codes of Ethics for handling species", "Animals for human consumption that do not merit slaughter are used" and "it would be important that the Code of Ethics outlines animal bioethics". It was clarified that it is not necessary to work with a large number of species.

It should be noted that after the study of this second dimension, it was determined that there is a Code of Ethics of the Universidad Central del Ecuador, as well as protocols, but not an approved and current regulation that allows regulating demonstrative and experimental practices with animals. The Code of Ethics in turn can regulate the links, research with the use of animals and propose a bioethical profile that relates in a respectful and considerate way the human and the animal and these can be extended to the level of faculties. Currently, the Formative Research Commission and the Animal Research Ethics Committee as a regulatory body (CEIA) are working on the Regulation to grant ethical endorsements and carry with them the responsibility of complying with environmental legislation, the Organic Law on Animal Welfare and the International Regulations for animal research.



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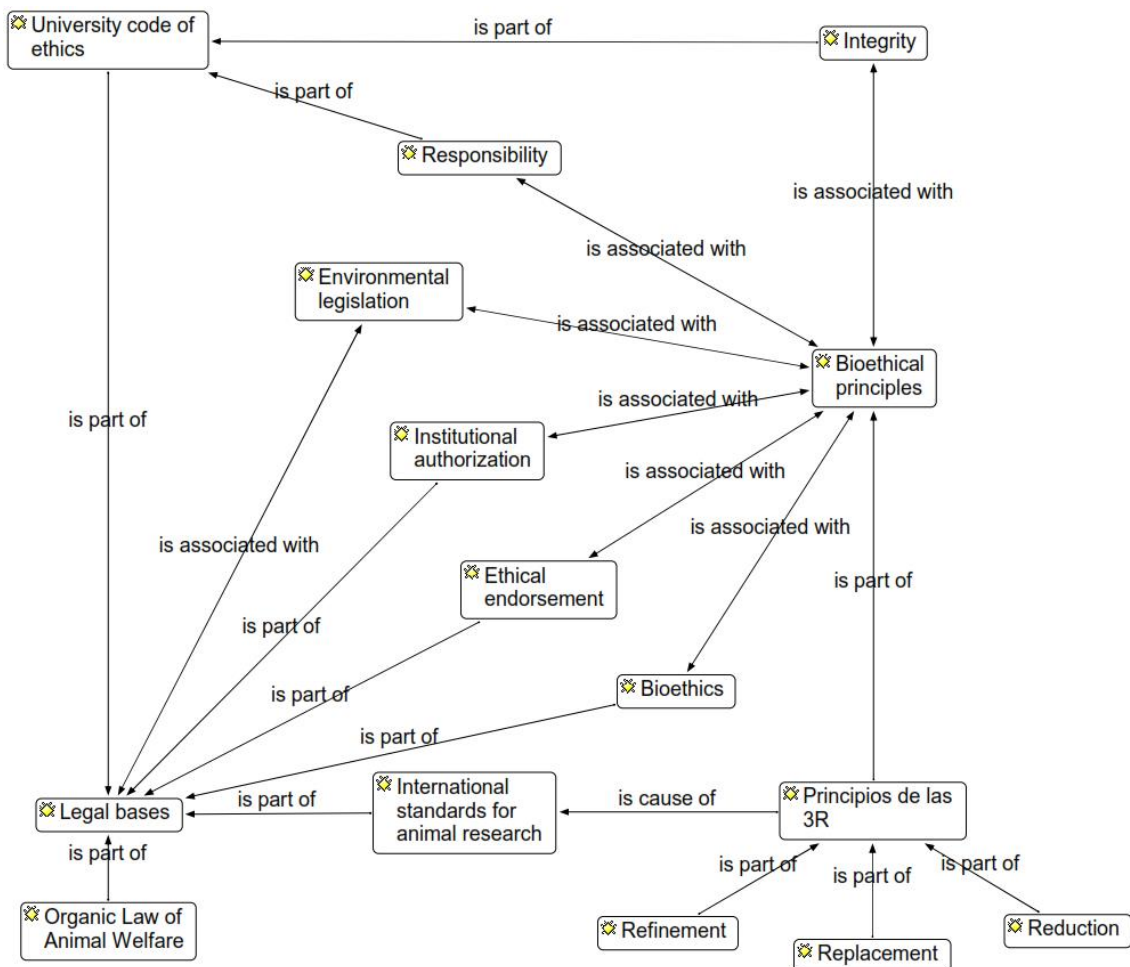


Figure 2. Legal Bases and Bioethical Principles

Through the work it has been determined that reduction, replacement and refinement as components of the dimension studied, are used on a smaller scale and in a limited way, so alternatives are sought with computer and didactic models. One aspect that is added to the respect for animal integrity, in addition to those mentioned above, is the responsibility of the person who performs the practices. The professionals who carry out practices with



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animals are supported by international and national laws. For its part, the University is working on the regulation to grant ethical endorsements for animal studies and thus comply with the regulations.

With respect to the third dimension, related to didactic material as a replacement or alternative to the use of animals in experimental and demonstrative laboratory practices (Figure 3), it is indicated that there is the use of various materials. On the one hand, there are audiovisual tools, laboratory practices without biological material and, on the other hand, laboratory practices with biological material. In both cases, the existing alternative material satisfies the learning demand because they complement each other. The alternatives for the use of animals are specified in the use of videos, 3D videos, practices with reality and computer simulators, mock-ups, preserved specimens and taxidermic boxes, which are combined with demonstrative practices using biological material such as prepared plates and specimens for human consumption.



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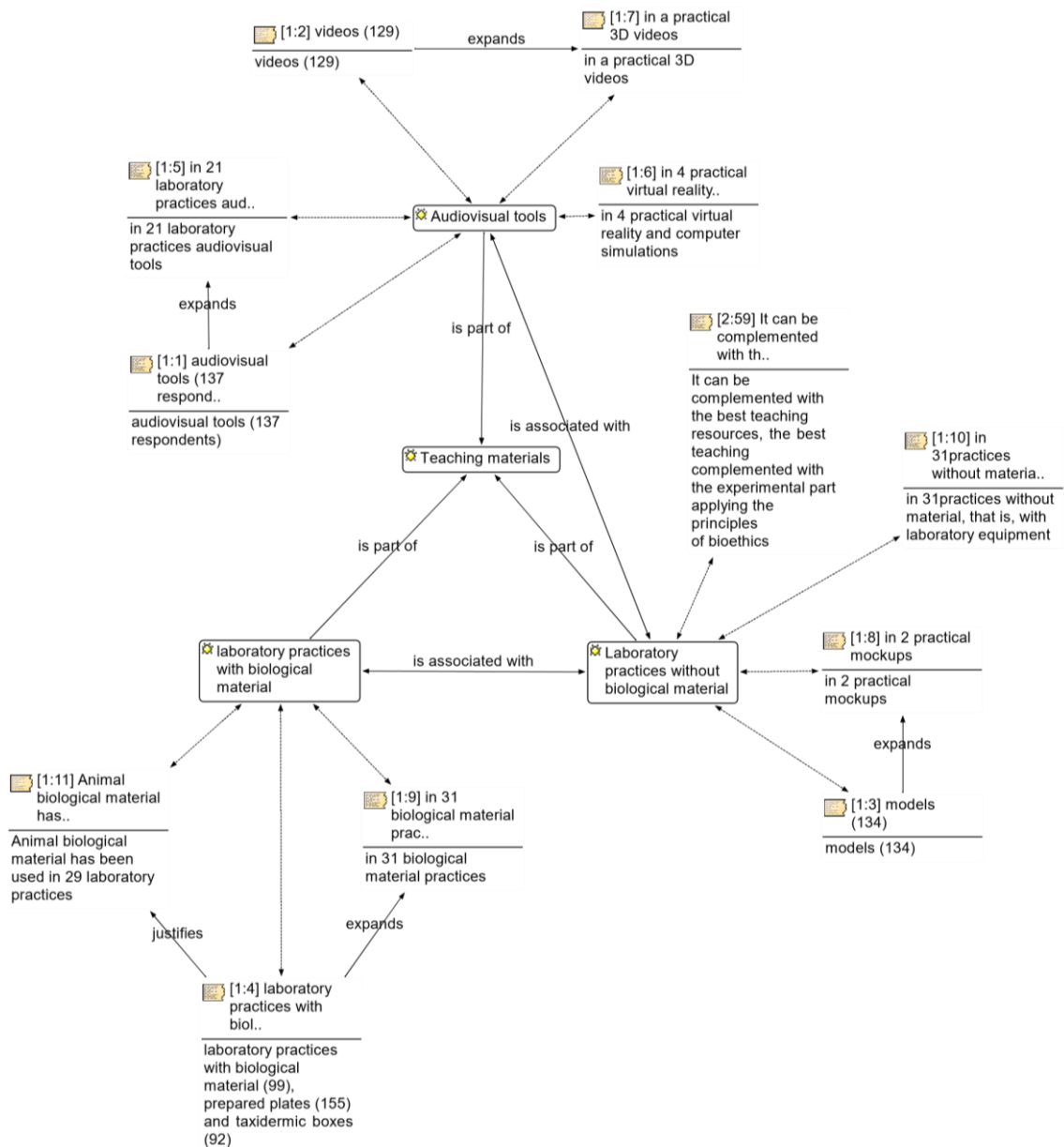


Figure 3. Didactic Material

Therefore, in this third dimension, there is the feasibility of having a variety of didactic material that is combined with biological material, which favorably affects student learning. It should also be noted that, although there are no approved internal legal regulations, teachers have worked in accordance with the principles of international regulations.

The analysis related to the fourth dimension of study, called animal experimentation practices, is shown in Figure 4. Here, it is indicated that animal experimentation carried out in laboratory practices at a demonstrative level is necessary for students' training. This affirmation is given because they contribute significantly to learning, to mental functions, as well as to the relationship and comparison of anatomical structures. This is evidenced in expressions such as "it is necessary to work with specimens since they contribute



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significantly to the students' learning", "dissection techniques are applied to specimens and vivisection of insects".

It is worth mentioning that the need to work with technological alternatives with connections or preserved specimens was mentioned in order to have a balance between the practices that require and do not require the use of animals. Expressions such as "it is possible to work with collections or preserved specimens available in the laboratory" and "there must be a balance between when it is necessary to use an animal and when technological alternatives can be an option" were remarked.

Among the most used methods of animal experimentation, it was determined that dissection is one of the most used at the level of demonstrative practices, while vivisection is the least used method because it requires a live animal to be sacrificed in the laboratories. The results were contrasted with the information obtained in the observation sheet, where out of the 32 practices, dissection was applied in 22 of them, and vivisection was performed on fly larvae in 7 practices. Among the specimens most used for animal experimentation are those for human consumption because they do not require sacrifice and are more accessible to students. Finally, three practices used exotic animals due to their protected and vulnerable status. In addition to the contribution to the ecosystemic balance, field trips are used to observe the fauna, taxidermic boxes and preserved specimens, which are kept at the Gustavo Orcés Zoology Museum.



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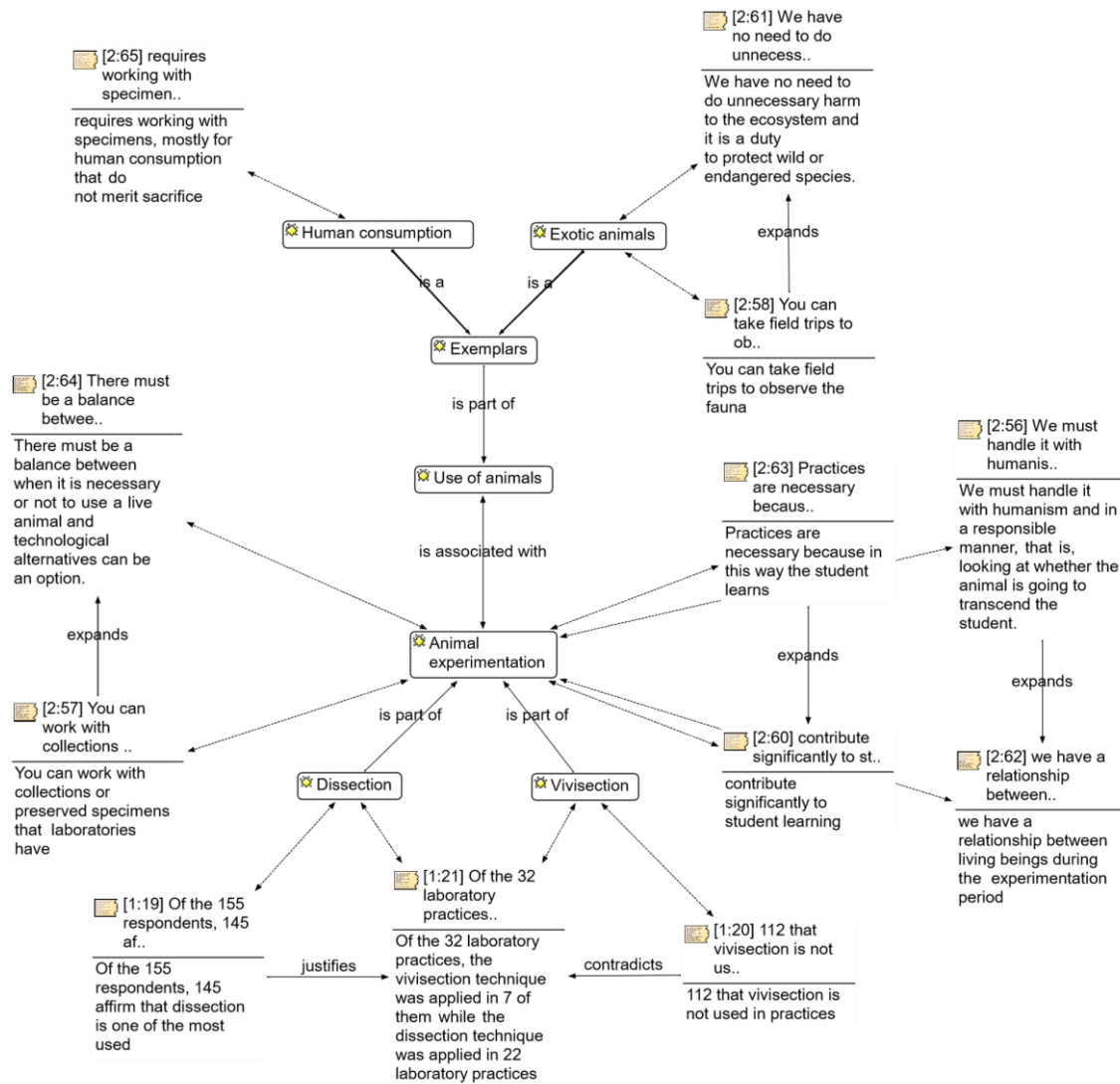


Figure 4. Animal experimentation

In this dimension, emphasis is placed on the need to use live material because there is a greater guarantee that students will achieve significant learning and contribute to the relationship and comparison of anatomical structures. However, technological alternatives and preserved specimens help to achieve a balance between practices that require animals and those that do not. In relation to the most used methods in demonstrative practices, dissection is the most common, while vivisection is the least used method. Finally, it should be pointed out that the practices with exotic, protected or vulnerable organisms are not used, but are alternated with field trips that allow observation of the fauna, preparation of taxidermical boxes and preserved specimens.

5. Discussion

After the analysis of the application of bioethical criteria in the demonstrative and experimental practices with animals, it was determined that in dimension 1. Restraint is the



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animal technique most frequently used in the laboratory of the career. This is possibly due to

to the easy understanding of the term and the simple application of this good practice by the students. This is in agreement with what is expressed by Nicasio, Bermúdez, Lemus and Salvador, who point out that among the practices of graduate students are restraint, manipulation and sexing (Nicasio et al., 2021). This allows inferring that, although there is a variety of practical aspects of manipulation in laboratory work with animals, nevertheless, the restraint technique is a common procedure within the academic practices.

On the other hand, injection, analgesia and anesthesia as opposed to restraint were shown to be the least employed codes. This is due to the demand of economic resources required for their application. However, they are the best methods to decrease pain in the animal. Varcellini and Principi state that the criteria for selecting the use of anesthetics and analgesics depends on the animal biology, the experience of the person and the easy acquisition of equipment and resources for the practice (Varcellini and Principi, 2021, pp. 236-239). According to what has been expressed, it can be evidenced that the economic factor is one of the determining elements at the time of choosing the technique to avoid suffering in the animal during its manipulation, and from the context it is determined that this is a limiting condition, not only in the higher education center in which the research has been carried out.

The bioethical principles of the "3Rs" (Reduction, Replacement and Refinement) are important to apply in order to value the respect, care for the health and life of animals for use in research and demonstrative practices. The principle of the three R's was established by Russell and Burch. The aforementioned researchers state to reduce the number of animals used, to replace live animal material with other techniques, to refine the techniques to reduce animal suffering (Mrad, 2005, pp. 163-183; Sanchez, 2000, pp.199-208). The bioethical principles of the "3Rs" are applied to a limited extent in the laboratories of the Race. The most frequently applied principle is "Replacement", since alternatives to the use of animals are sought. The options that help in the replacement of animals are audiovisual tools, videos, 3D videos, computer simulators, among others. The use of didactic material available in the laboratories, such as preserved specimens and prepared plates, allows the practice of "reduction". In the absence of didactic resources, live animals must be used in the practices as long as the experience is significant in the training of the students and the specimen to be sacrificed is really irreplaceable.

Regarding "Refinement", it is a bioethical principle that in the career, the respondents indicate that it is applied in the demonstrative practices. However, in the observation sheet it was not possible to determine any procedure that allows ratifying what was expressed by the surveyed population. Regarding what was stated, Martinez points out that "in some cases the methods have been modified, including reduction and/or refinement, but replacement methods are increasingly accepted" (Martinez, 2021, pp. 81-97). It can be inferred from the above that the application of refinement methods is less frequent due to the tendency to include other methods. One of the most used techniques in the present study was dissection in animal structures. This is also supported by the results of an anonymous survey applied by Romero-Reverón, where students described dissection as 52.22% positive and 34.25% very positive (Romero-Reverón 2007, pp. 848-849). This shows that dissection practices are a resource frequently used in laboratories that carry out demonstrative practices.



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6. Conclusions

With respect to the bioethical criteria in the demonstrative and experimental practices in the laboratories of the Pedagogy of Experimental Sciences, Chemistry and Biology, these are adjusted to the educational reality and to the economic situation of the students. They also adhere to the procedures socialized in the University, since there is no specific regulation governing the demonstrative practices established in the syllabus as an educational process of professional training in the teaching of anatomical structures in various subjects. Regarding the 32 laboratory practices in which animals were used, it is indicated that most of them are animals for human consumption that are easy for students to acquire (cow, hen, pig, bull, guinea pig, duck), which do not require sacrifice in the laboratory, but rather are dead specimens where the dissection technique is used.

On the other hand, among the least used techniques is vivisection, which in the case of practices is used with invertebrate animals for the study of fly larvae, cultivated in banana by the students. Experimental practices in the career are not applied because the institution has an educational purpose and not an experimental one. In addition, because within the training of the students of the career there is a connotation of replicability in the educational institutions of secondary education. In relation to bioethical management in demonstrative practices that use animals, the bibliographic study indicates that these should be governed by the International Regulations set forth by the UN, MERCOSUR, the Organic Law of Animal Welfare (LOBA) and the Bioethical Principles associated to the 3Rs. Under the framework of the National Legal Regulations, the environmental legislation, Municipal Ordinance and the Ethics Committees formed in the higher education institutions, which are in charge of regulating, regulating and supervising the demonstrative and experimental practices in research and educational training processes. However, in the Pedagogy of Experimental Sciences, Chemistry and Biology career, they still work under the criteria given by a biosafety manual.

Finally, the study can be replicated in different faculties of the university to identify whether the application of bioethics is part of the professional training of university students in faculties that use animal organisms in their training.

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