

Development of an Interactive Canine Central Nervous System Atlas and Initial Outcomes

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ABSTRACT

Neuroanatomy encompasses one of the most important and complex topics in anatomy. An accurate interpretation and thorough understanding of the nervous structures could be helpful for students and clinicians. Therefore, this work aimed to perform an interactive atlas viewing software of the canine central nervous system (CNS) using images acquired by osteology, gross dissection, and sections in different planes that could serve as anatomic references for this region. We believe this atlas can help students during the teaching and learning process, providing them with digital support that they can consult online while enrolled in our course. Thus, facilitating autonomy and activity, and promoting the leadership of students in monitoring their training process.

Keywords: neuroanatomy, interactive atlas, dog.

INTRODUCTION

Neuroanatomy is an independent discipline, encompassing one of the most important and complex topics in anatomy. This section studies the nervous system and its different parts, and the organs that involve fundamental senses for the daily clinic¹. Therefore, anatomical training is essential to carry out different aspects of professional practice, where among the most valuable teachings are animals, cadaveric dissections, books, and conferences¹⁻⁶. Despite this, society tries to reduce the use of animals and carcasses as a learning model. However, it has been indeed one of the most used teaching resources for decades⁶⁻¹⁰. On the other hand, the processing and preparation of different types of samples are laborious, costly work, taking into account the fragility of some organs and, therefore, the difficulty that it carries, in addition to the lousy image that society can perceive¹¹. Different teaching-learning processes are currently used, such as integrating theoretical classes with their respective descriptive texts, the study of pieces and cuts preserved in formaldehyde, plastination, and dissection techniques⁹. If we put all these aspects together and add the inevitable reduction of hours in the process of teaching, the current student requires more time to carry out his correct learning^{1,5,12,13}. Fortunately, technology advances rapidly in the world of teaching, the internet, networks, and new technologies are available to the vast majority of the world, allowing access to multiple resources with just one click. Thus, the study through virtual and interactive techniques can help the student by encouraging their study and understanding, without the presence of teachers and avoiding the use of material that is scarce and fragile. This is why computer-assisted learning has improved the quality of teaching in Anatomy, helping the students to promote their study and understanding individually^{2,9,14}. Hence, the main objective of this research was to develop an anatomic interactive atlas using images obtained via osteology, gross dissections, and sections in different planes that could serve as anatomic references for this region.

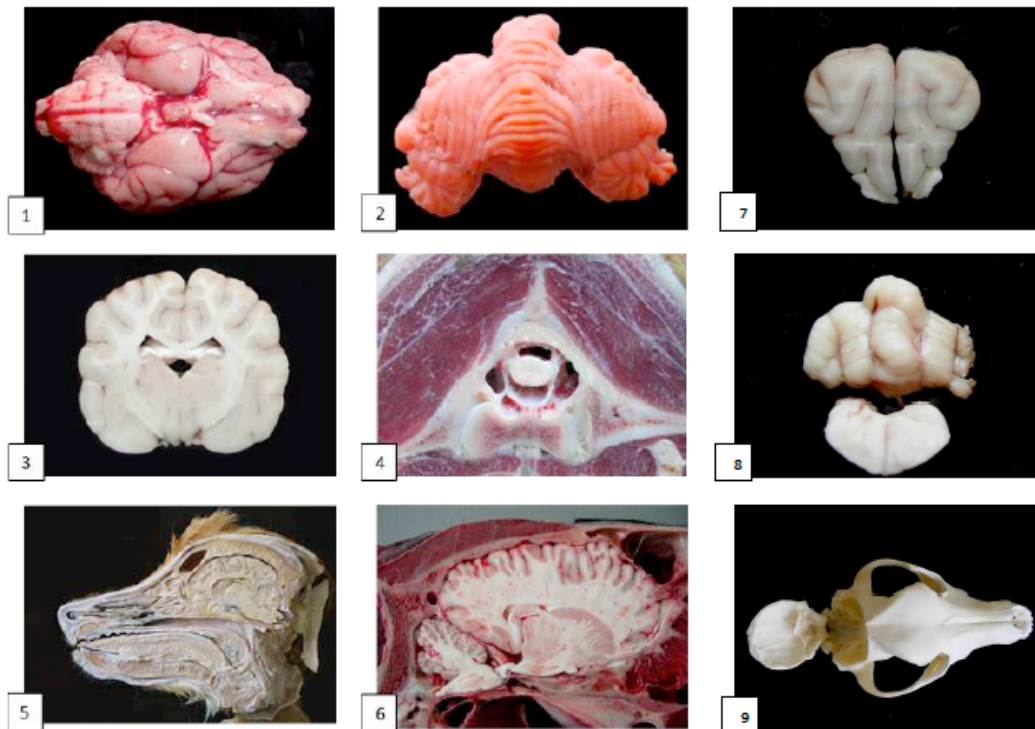
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MATERIAL AND METHODS

2.1.1. Sampling

A total of 800 initial photographs of domestic species that belonged to the archive of the Veterinary Anatomy and Embryology Teaching Unit of Las Palmas de Gran Canaria University were collected. Different sections, and structures of the CNS were selected (Figure 1). Most pictures were obtained from fresh brains, and from fixed specimens using a 10% formaldehyde solution. It is important to highlight that no animal was sacrificed for this work. In addition, we added other species to do an adequate comparative study and offer the students the visualization of the differences that can be described in the domestic animals.

Figure 1. Nine of the total selectionated images. Brain, basal side (1); Cerebellum, dorsal view (2); Brain, cross section (3); Meninges (4); Dog head, sagittal section (5); Equine head, sagittal section (6); Brain, cross section (7); Cerebellum and Medulla Oblongata (8); Brain fossa, canine (9).



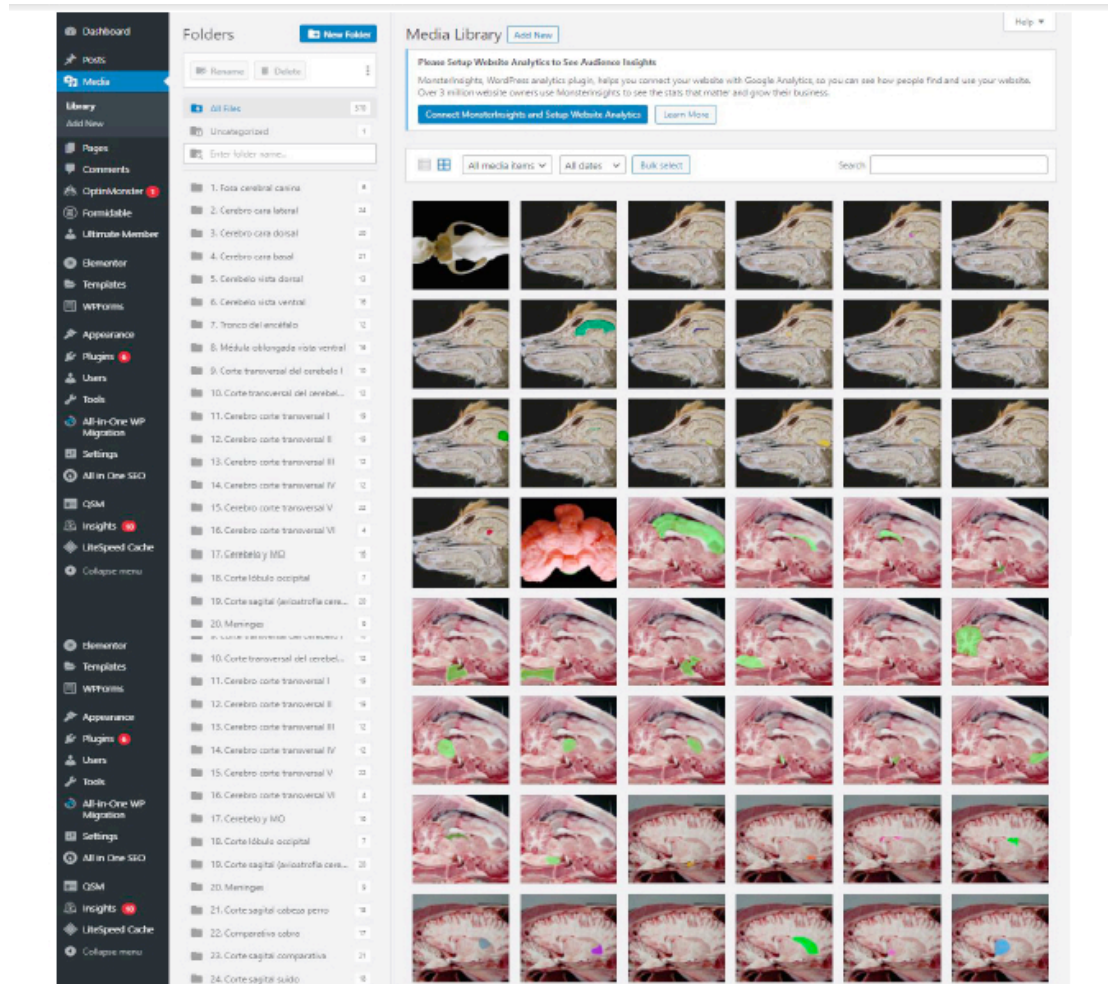
2.1.2. Image processing

The pictures were obtained with a camera EOS 450D (Canon, Tokyo, Japan). Later, this material was downloaded to a computer with Windows operating system (Microsoft Corporation, Washington, USA). The images selectionated were duplicated according to the structures coloured over the initial sample. These images were transferred to an iPad PRO (Apple, California, USA) to do the labelling using the Procreate APP (Savage Interactive Pty Ltd., Hobart, Australia). With this program, we created different layers superimposed on the initial photograph. Each figure had several layers depending on the number of labels, which were shown with colours to highlight the specific structure.

2.1.3. Library

For the creation of the Library, all the images, previously edited by layers, were imported back to the computer and divided into different folders according to the different sections, species, and structures studied (Figure 2). The Library was transferred to the Atlas website and included 24 different folders, where a total of 350 images were housed to be part of the different interactive pages of the Atlas.

Figure 2. Atlas library screenshot.



2.2. Questionnaires

In order to know the utility of the Atlas and the opinion of the people, two questionnaires were done on a Likert scale, one for students and clinicians, with a sample of 53 individuals, and another one conducted to 12 students that were taking the second course of anatomy, where neuroanatomy is coursed. This type of scale is the most common method to know a variety of individual information and testimonials, used to obtain a popular opinion¹³.

The first questionnaire was filled out by students and professionals, which had coursed Anatomy in the past. It was constituted of 10 questions related to the use of technology in this field (questions 1-3 were dedicated to personal characteristics, 4-7 to the subject characteristics, and 8-10 to technology usefulness) (see Table 1).

Table 1. Items description of the questionnaire to evaluate level of the use of new technologies in the educational and professional field

Questions
1. Age
2. Sex
3. What course are you enrolled in?
4. In which call did you pass the course of Anatomy II?
5. In your passage through the subject, which part has been the most difficult for you?
6. From 0 to 5, how difficult was the neuroanatomy section for you?
7. Do you think that a Virtual Interactive Atlas could help to better understand and identify the different structures that constitute the Central Nervous System?
8. Do you think that this type of tool can serve for training and understanding of this subject?
9. Do you consider that a good knowledge of anatomy is essential to understand and successfully pass other subjects?
10. Could this type of virtual and interactive tools help you in your day-to-day life, both in your university and professional life?

The second questionnaire was composed of 10 questions (see Table 2). Here, different questions were asked to the students enrolled in the course of Veterinary Anatomy II to know the degree of satisfaction with the information provided by the Atlas.

Table 2: Items description of the questionnaire to analyze the satisfaction among the students

Questions
1. What call are you in?
2. How many times have you taken the examination sessions of the subject?
3. From 1 to 5, how difficult is the neuroanatomy part included in the subject?
4. Do the images proposed in the Atlas coincide with those taught in the course of Anatomy II?
5. Do you think the Atlas design is entertaining and entertaining?
6. How useful has the learning been for you?
7. Do you think that these types of tools could help you when studying this subject?
8. Would you like to have access to the Atlas during the follow-up of the subject?
9. Do you think that the use of technology can promote study and help in academic training?
10. From 1 to 5, how would you rate this Virtual Atlas?



RESULTS

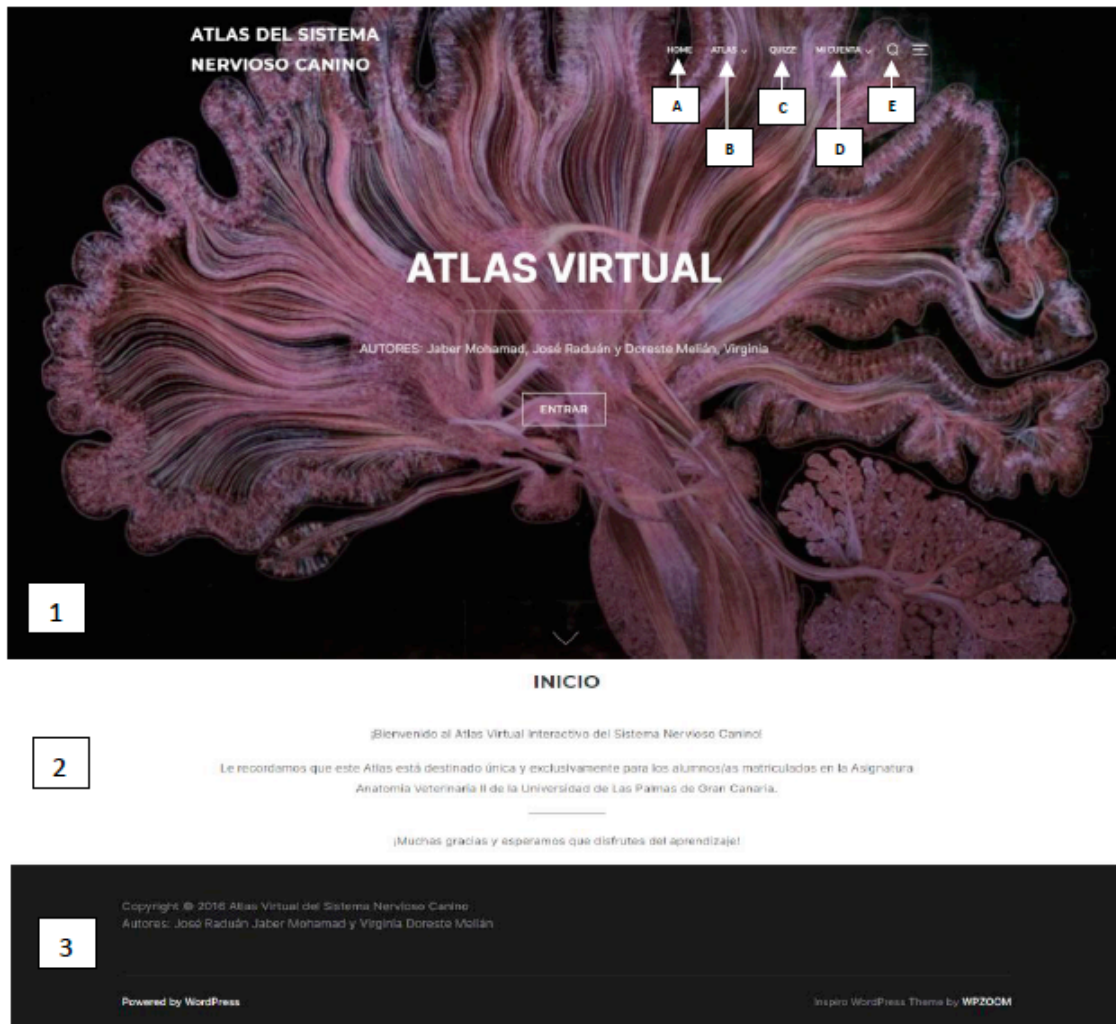
3.1. Atlas design

The structuring and final design of the website according to its different entries and pages are described below.

3.1.1. Front page

When we access the Atlas, the first thing we come across is the main menu, which allows access to different pages and content. This front page is divided into three different sections (Figure 3).

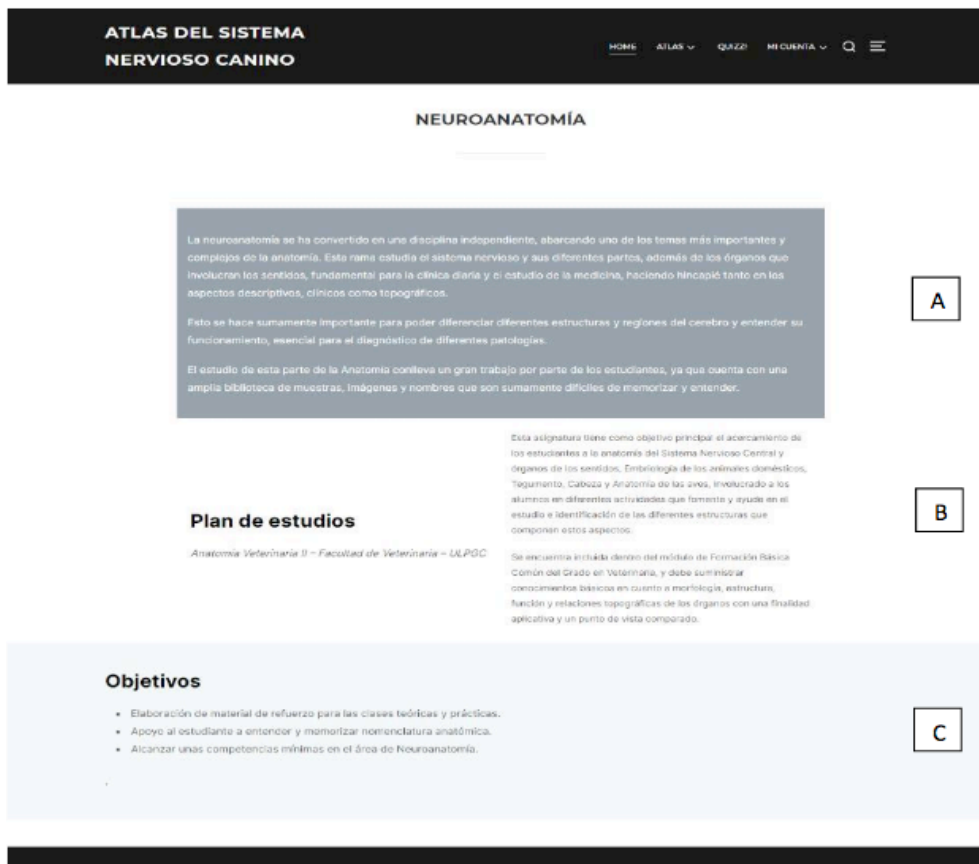
Figure 3. Initial page screenshot with 3 sections (1-3). At the top of menu we can find different buttons: (A) HOME, (B) ATLAS, (C) QUIZZ, (D) MY ACCOUNT, (E) SEARCH.



3.1.2. Home

When we access to the Home tab, a presentation menu with three sections is displayed (Figure 4).

Figure 4. (A) Describes a brief summary at the approach to Neuroanatomy; (B) Provides the curriculum of the Anatomy II in Veterinary Medicine; (C) highlights the main objectives of this project.



3.1.3. Atlas

In this section, by positioning the mouse over it, we can discover a drop-down list with all the options that we can find (Figure 5), and their respective pages and views as shown in the figures 6-7.

Figure 5. Atlas drop-down example. Brain.



Figure 6. An interactive image of the basal brain view (A) with the buttons (1a). When the mouse is put over the button chosen, the structures are identified and segmented with colors (B).

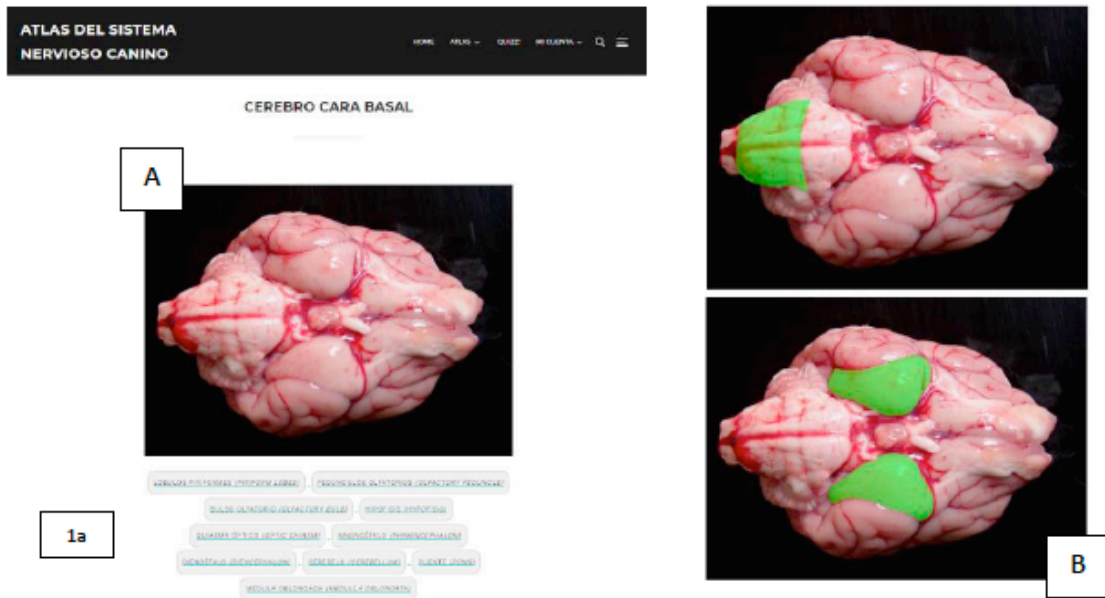
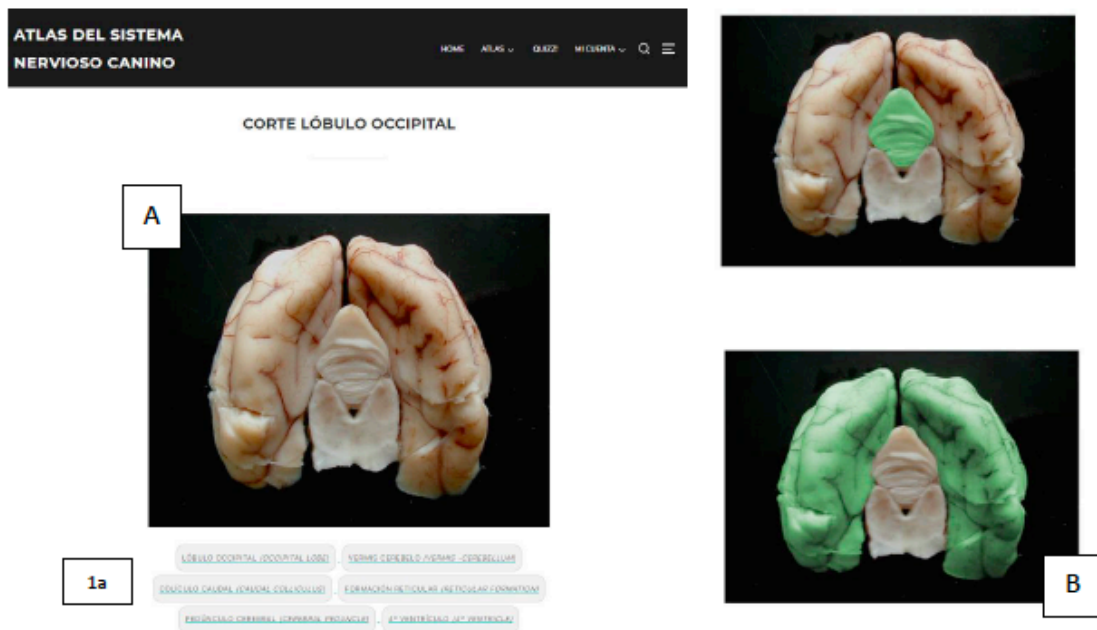


Figure 7. An interactive image of the occipital lobe section (A) with the buttons (1a). When the mouse is put over the button chosen, the structures are identified and segmented with colors (B).



3.2. Questionnaires

3.2.1. Use of New technologies in the educational and professional field.

Based on the data collected from a total of fifty-three questionnaires, 58.5% (n=31) were students that did not pass the subject of Anatomy II in the first call. In this case, our results show that Anatomy II is considered a difficult subject to pass, where more than half of the respondents had passed it in 2th and subsequent calls. Within this percentage, in terms of complexity, the participants believed that Neuroanatomy and Embryology form the most difficult part of the subject, with 62.3% and 32.1% of complexity, respectively..

Regarding the difficulty of neuroanatomy, 43.4% rate it 4 out of 5, where 5 is very difficult, and 0 corresponds with very easy. Most students (75.5%) highlighted that this subject is considered essential for the curriculum of Veterinary Medicine. Finally, a high percentage of the participants consider that this type of virtual tool can help better understand and identify the different structures that constituted the CNS (Fig. 8). Another relevant aspect as the utility of the atlas is considered (Fig.9).

Figure 8. Do you think that a Virtual Interactive Atlas could help you better understand and identify the different structures that constitute the CNS?

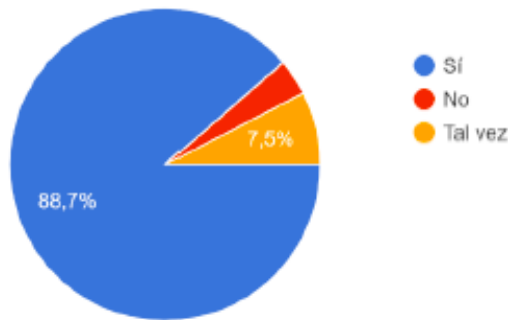
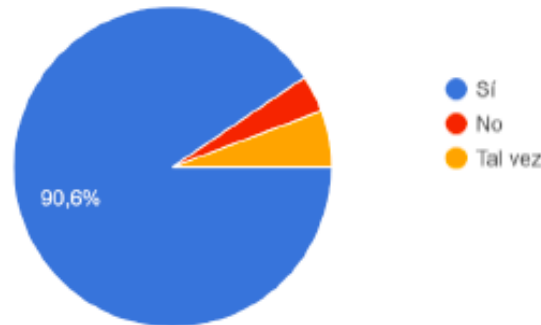


Figure 9. Do you consider that this type of tool can serve for the training and understanding of this subject?



3.2.2. Level of satisfaction among students that used the Atlas of the Canine Central Nervous System

Initially, each one of the participants was previously registered. Therefore, they could interact with the atlas and do the quizzes included in the platform. Concerning to the student-Atlas interaction, 100% of the respondents considered that the images provided coincide with those taught in the classroom (Figure 10), also agreeing that the design of this tool was enjoyable and entertaining when studying, adding the desire to be able to use it during the training process (Figure 11). We also assess the use of technologies in student learning processes, where 100% agreed that this tool could promote the study and help in their academic training. Finally, the students rated the Atlas with 4.67/5.

Figure 10. Do the images proposed in the Atlas coincide with those taught in the subject of Anatomy II?

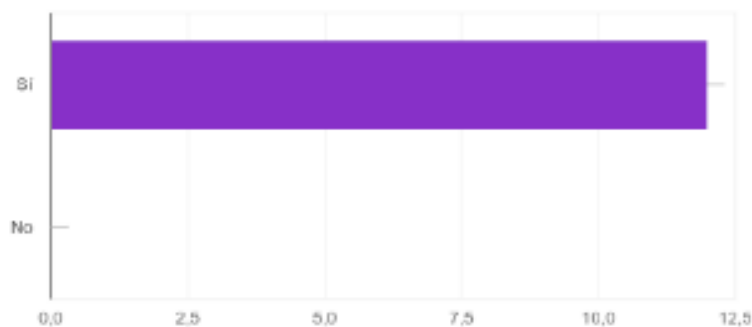
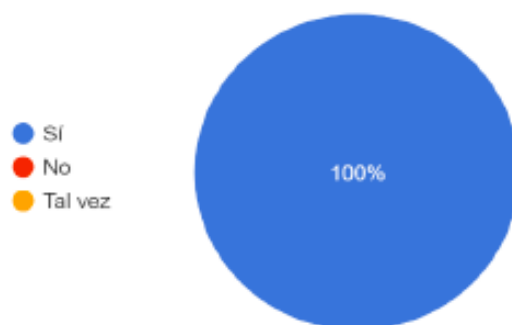


Figure 11. Do you think the Atlas design is entertaining and enjoyable?



DISCUSSION AND CONCLUSIONS

In this project, an interactive digital atlas focusing on the canine CNS and other domestic species was developed. The atlas was created using the WordPress platform, which is a free digital tool capable of creating web pages from scratch easily and by combining more advanced codes. The photographs that we used were generated from a library belonging to the department of Anatomy and Embryology of the University of Las Palmas de Gran Canaria. To date, there are several interactive digital atlases on the web, such as Equine Anatomedia¹, and that of the Head of the Loggerhead Sea Turtle⁵, but to the best of our knowledge none have included quizzes to perform self-evaluation among students.

As in other virtual tools^{1,5,9,14}, the initial purpose of this atlas was to create an instrument based on the needs of the students, trying to promote more autonomous and didactic teaching practically. Nonetheless, none of the atlases consulted evaluated the degree of satisfaction of the students after its use. This fact is quite important when the subject to study is difficult. In the case of Anatomy, it is an essential and basic discipline in Veterinary Medicine, which is highlighted by its density and complexity. This fact can be truly overwhelming for students as they must be able to retain a large number of names and information^{1,6} with practical applicability in clinical, surgery, public health and animal husbandry, among others, that must be mastered^{4,5}. One of the questions of the questionnaire confirmed that the CNS was considered as a challenge, and the most difficult according to students and veterinarians questioned.

This virtual atlas was composed of images obtained from fresh and preserved specimens to prepare reinforcement material for face-to-face classes, helping students during the teaching and learning process. With this purpose, we wanted to provide digital support to students, which can consult online

at any time while they are enrolled in the course of Veterinary Anatomy II, facilitating autonomy and activity, as well as promoting the leadership of students in monitoring their training process. Another benefit derived from this virtual work was to help the students understand and memorize different names and locations, using an easy-to-use technological model. Therefore, different entries with their respective labels are illuminated by coloured marks according to the area studied, just positioning the mouse over the structure that we wish to visualize and carrying out self-evaluation to be able to carry out individual follow-ups. From the 65 questionnaires done, 12 were currently studying Veterinary Anatomy II. The opinion of these 12 students was of the utmost importance to verify the operation of the atlas and their satisfaction in terms of content, design and functionality, and to know the future of this atlas, which was scoring with an excellent rating.

In conclusion, the implementation of this tool can mean a great change to introduce the students to Neuroanatomy. In addition, this atlas can help the students to identify and understand nervous structures in the different planes in space, highlighting the knowledge of the structures that constitute the CNS of domestic animals, as well as the identification of the bone and other soft tissue components through the use of different colours.

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