Int. J. Morphol.,
42(3):601-606, 2024.

Interactive Atlas of the Canine Brain, Heart and Kidney Created from Plastinated Samples

Atlas Interactivo de Encéfalo, Corazón y Riñón de Canino Creado a Partir de Muestras Plastinadas

**Ana Belén Toaquiza[1]; Verónica Alvear[1]; Bryan Velasco[2]; Luis Cartuche[3];
César Morales[2]; César Guanoluisa[4]; Nicolás E. Ottone[5,6,7] & María Revelo-Cueva[1]**

TOAQUIZA, A. B.; ALVEAR, V.; VELASCO, B.; CARTUCHE, L.; MORALES, C.; GUANOLUISA, C.; OTTONE, N. E. & REVELO-CUEVA, M. Interactive atlas of the canine brain, heart and kidney created from plastinated samples. *Int. J. Morphol., 42(3)*:601-606, 2024.

SUMMARY: Currently, training in the field of anatomy requires the implementation of learning and knowledge technologies (TAC). Therefore, the objective of this work was to use digital images taken of plastinated canine brains, hearts, and kidneys to create an interactive atlas that facilitates the teaching-learning of the anatomy of these organs. The research was carried out in 3 phases. In the first, canine brains, hearts and kidneys were obtained using the cold-temperature silicone plastination. In the second stage, photographs were taken, the images were edited with Adobe Photoshop and converted to SVG format using Adobe Illustrator. During the last phase, the 2D atlas was created using MongoDB and Node.js for the backend and Vue.js as the framework for the frontend. In addition, it was used three.js to render the 3D models. As a result, the 'Interactive Canine Atlas', ATINCA, was created. The atlas comprises 27 interactive images and 27 in atlas mode view (28 of the brain, 20 of the heart, and 6 of the kidney). Furthermore, the atlas features 3D models of the three organs. The developed atlas constitutes the first digital tool created in Ecuador based on local institutional needs, including a 3D format. Consequently, ATINCA will be integrated into the curricula as a digital material that will facilitate significant autonomous and collaborative learning of canine anatomical knowledge.

KEY WORDS: Tool; 3D; Silicone; Teaching-learning; Anatomy.

INTRODUCTION

The use of anatomical specimens is considered to be an effective way for students to retain knowledge efficiently (Bravo & Inzunza, 1995; Inzunza & Bravo, 1999). However, the use of cadaveric material must be carried out under ethical regulations. The Regulation for the Formation, Approval, and Monitoring Of Ethics Committees in Ecuador states that teaching and research work must be done under the international principle of animal welfare, which is based on the 3Rs: replacement, reduction, and refinement (Agencia de Regulación y Control Fito y Zoosanitario, AGROCALIDAD, 2021).

Learning and Knowledge Technologies (in Spanish, TAC) are information and comunication technologies (ICTs) that are aimed at improving learning and pedagogy (Parra *et al*., 2019; Yoza & Vélez, 2021). TAC when applied as virtual teaching programs, has become an efficient tool to reduce or replace the use of anatomical specimens (Hecht-López & Larrazábal-Miranda, 2018).

The utilization of virtual programs or tools for studying animal anatomy contributes to the reduction and replacement of the need for cadaveric or fresh specimens. This is because these tools provide digital images that offer a close-to-reality observation of anatomical structures. Throughout the history of anatomy as a scientific field, anatomical drawings were created to aid in the study, capturing the morphological details of structures dissected from

[1] Laboratorio de Anatomía Animal, Facultad de Medicina Veterinaria y Zootecnia, Universidad Central del Ecuador, Quito, Ecuador.
[2] Carrera de Ingeniería en Computación Gráfica, Facultad de Ingeniería y Ciencias Aplicadas, Universidad Central del Ecuador, Quito, Ecuador.
[3] Universidad Intercultural de las Nacionalidades y Pueblos Indígenas Amawtay Wasi, Quito, Ecuador.
[4] Facultad de Medicina Veterinaria y Zootecnia, Universidad Central del Ecuador, Quito, Ecuador.
[5] Laboratory of Plastination and Anatomical Techniques, Faculty of Dentistry, CEMyQ, Universidad de la Frontera, Temuco, Chile.
[6] Department of Integral Adult Dentistry, Center for Research in Dental Sciences (CICO), Dental School, Universidad de la Frontera, Temuco, Chile.
[7] Center of Excellence in Morphological and Surgical Studies (CEMyQ), Universidad de La Frontera, Temuco, Chile.
FUNDED. Subsidized by the Research Department of the Universidad Central del Ecuador under senior research project DI-CONV-2019-026.

Received: 2024-01-15 Accepted: 2024-03-03

deceasedbodies (Díaz & Silveiro, 2021). The inclusion of images in books and atlases has enabled the visualization and comprehension of the studied information, making learning more accessible (Bartoletti-Stella *et al*., 2021). In contemporary anatomy literature, traditional drawings have been supplanted by the utilization of digital images (Díaz & Silveiro, 2021). Consequently, the digitization of educational materials and the presentation of content in 2D and 3D formats, accompanied by features such as hypertextuality, navigability, and flexibility, have proven to be effective methods for acquiring anatomical knowledge. Moreover, they stimulate greater motivation and interest among students (Hecht-López & Larrazábal-Miranda, 2018; Suarez *et al*., 2020).

Digital technologies have been integrated into the teaching and learning process of anatomy, but they are not meant to replace dissections or prosections. Instead, these modern teaching methodologies propose a combination of methodological tools (Hecht-López *et al*., 2023). Most universities still rely on traditional teaching techniques such as cadavers, plastinated samples, master classes, and CT scans along with digital tools (Suárez *et al*., 2020; Hecht-López *et al*., 2023). The goal of this work was to create an interactive atlas in 2D and 3D format with the help of a multidisciplinary team. Plastinated organs from the Plastination Laboratory of the Faculty of Veterinary Medicine and Zootechnics (FMVZ) of the Universidad Central del Ecuador (UCE) were used as the base for this project.

MATERIAL AND METHOD

Initially, hearts, brains, and kidneys were sourced from six canine specimens that were generously donated by animal protection foundations. Consequently, the approval of the Faculty Research Commission (COIF) was not deemed necessary, as the research involved the use of deceased animals that had been euthanized beforehand. COIF ethical approval is typically required only for research involving live vertebrate animals. The organs underwent processing utilizing the cold silicone plastination technique (von Hagens, 1979, 1986; Ottone *et al*., 2015; Ottone, 2023), with the use of Biodur® brand reagents. In summary, the organs were initially fixed with a 10 % formalin solution for a period of 12 weeks. Subsequently, they were dehydrated over a span of 5 weeks using acetone at a temperature of -20°C. Next, they underwent vacuum impregnation with S10:S3 Biodur® at -20°C, a process lasting 5 weeks. Finally, the organs were cured with S6 Biodur® for a period of 2 weeks, as detailed in the study by Toaquiza *et al*. (2023). In total, the plastination process for canine brains, kidneys, and hearts encompassed 47 weeks, including 20 weeks of pre-curing and 3 weeks of post-curing.

The organs procured, consisting of six hearts, twelve kidneys, and four brains, underwent the cold plastination technique and were photographed using a Nikon D-3500 digital reflex camera paired with an 18-55mm f/3.5-5.6G objective lens. These photography sessions were conducted with the aid of a comprehensive lighting setup, which included light windows, a 180-degree adaptation stand, lighting umbrellas, and a single head light stand equipped with 45W bulbs. To ensure optimal positioning of the organs for different anatomical views, a black background, a camera tripod, and supports crafted from various materials such as plasticine and pins were employed. In total, a substantial collection of 1564 digital images was captured, with each photo session for individual organs lasting approximately 4 hours. This exhaustive photographic process amounted to 114 hours in total, equivalent to around 30 days of production.

From the camera the photographs were imported in JPEG format, with a resolution of 6000 pixels wide by 4000 pixels high. These digital images were viewed through Windows Photo Viewer, and only those that were focused, sharp, well-aligned, and appropriately bright were selected. The anatomical structures in the images were labeled, and titles were defined using PowerPoint. The generated files were saved with the .ppt extension and were used as a basis for the final editing with Adobe Photoshop CS6. The end result was a set of sheets for the "atlas view mode" section.

The images were edited and then converted to SVG format using Adobe Illustrator. This was done in order to animate anatomical structures with colors and create sheets for the atlas's "interactive view mode." The image editing process took approximately 5 months. Additionally, sequential 360-degree photographs were taken to serve as references for each organ's 3D modeling. From these sequences, 4 to 6 photos were selected to include anatomical structures in the atlas's 3D models.

The atlas was created as a web application that is accessible through computers and mobile devices. The Node.js tool was used to develop the 2D part of the atlas, which makes it easier to display information in an orderly manner on the user interface. HTML and CSS methods were used to label each image in the interactive 2D format, so that when the user clicks on any structure, the corresponding name is displayed. The images for the "interactive view mode" were organized on the hard drive of the UCE server so that the web application can access them.

Blender, a powerful yet lightweight 3D modeling tool, was utilized for 3D development. 360-degree photographic images were imported into the tool, and the views had to be adjusted to match those of each organ. The contour and vertex modeling technique was employed, requiring the matching of each organ's contour vertex by vertex. The end result was a low-polygon density 3D model that could be loaded into the application quickly. The 3D model was then textured, with the aim of achieving a balance between realism and the number of polygons saved. Texturing enabled the transfer of colors and features observed in the photographic images to the 3D model.

After the 3D modeling and texturing was completed, the three.js library was utilized, which uses the rendering engine called Webgl. In order to display the three-dimensional elements on the web application screen, the initial scenes of the 3D element were configured through the tools and methods provided by Webgl. Specifically, the camera elements were used, which determine how and what is going to be rendered, and the camera controls, which allow the user to translate, rotate and scale the 3D object. It is important to note that in the application, it is not the 3D model that moves, rather, it is the camera that renders it. Finally, the identification of anatomical structures was added within three.js using X, Y, and Z coordinates on the 3D model. The coordinates were calculated for each part of the organ that was going to be labeled. For educational purposes, the color of the text was matched with the color placed on the structure to which the name corresponded.

RESULTS

As a result of the project, the Interactive Canine Atlas (ATINCA) (from Atlas Interactivo del Canino), as the final product was called, was obtained in 2D and 3D formats for heart, kidney and brain (http://atlascanino.uce.edu.ec/organos). The atlas in 2D format has 27 sheets, 14 for the brain, 10 for the heart and 3 for the kidney. Each sheet is composed of two images, one image corresponds to the "interactive view mode" and the other image presents the "atlas view mode". In interactive view mode the user can touch a structure with the cursor or their finger, depending on the device they are using, to highlight the structure in color and see the corresponding name (Fig. 1). For its part, the atlas view mode corresponds to an image where the organ is presented with the identified structures and the

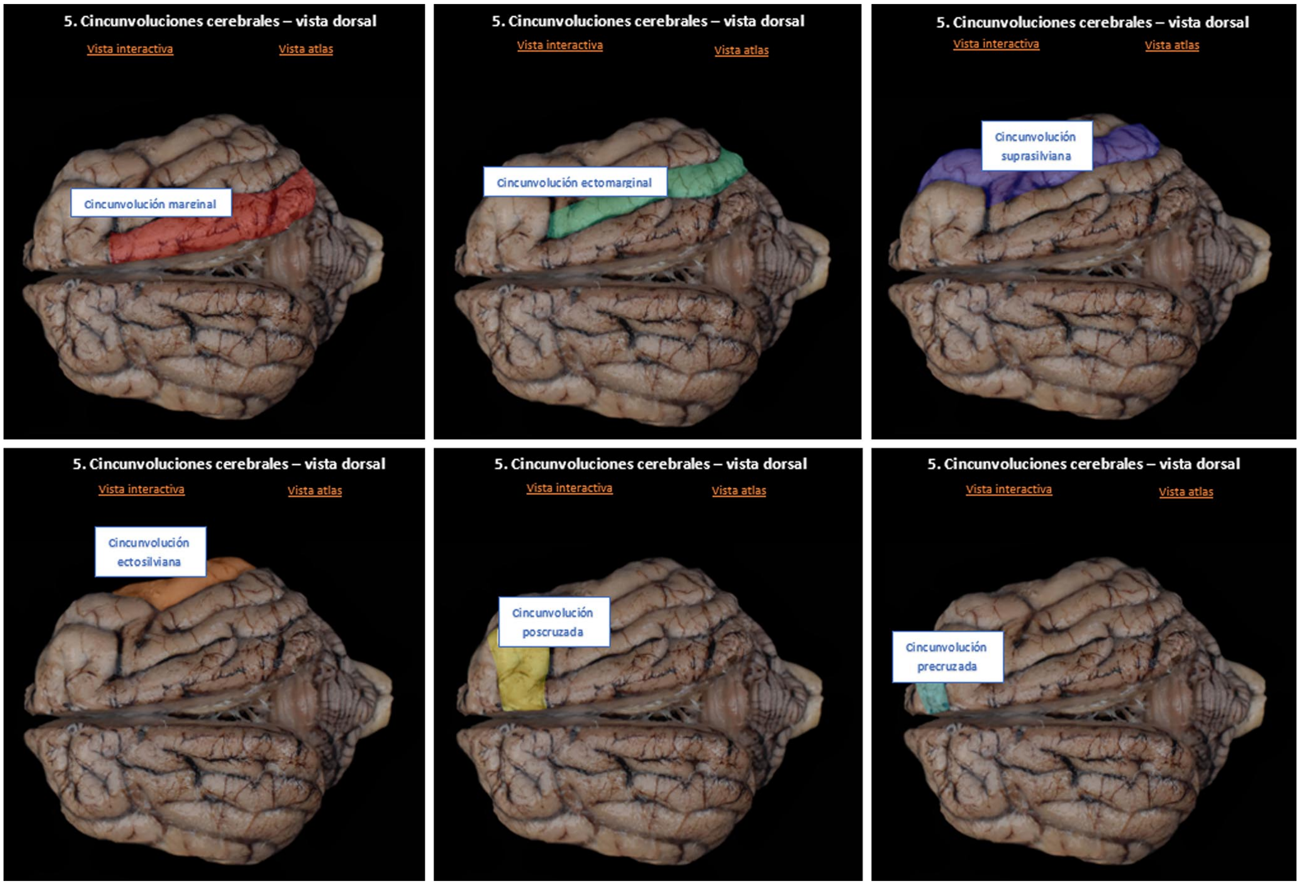


Fig. 1. Screenshots of the "Interactive View Mode" of plate #5 showing the different convolutions of the canine brain in ATINCA. The screenshots should present the dorsal view of the brain, where the convolutions can be clicked or touched interactively. Kindly provide 6 screenshots, if possible.

corresponding description in a text on the right side (Fig. 2). So, ATINCA has a total of 54 digital images in 2D format; while for the 3D format there is a base model for each organ (Fig. 3). In addition, each organ has 3D models with structures identified with colors on them: 5 for brain, 2 for heart and 2 for kidney.

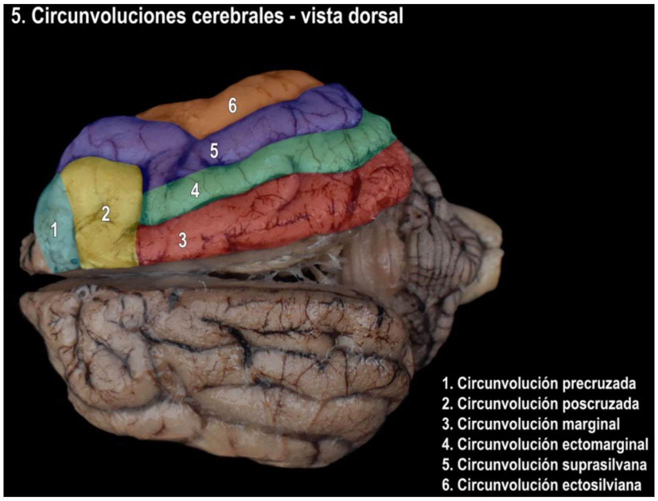
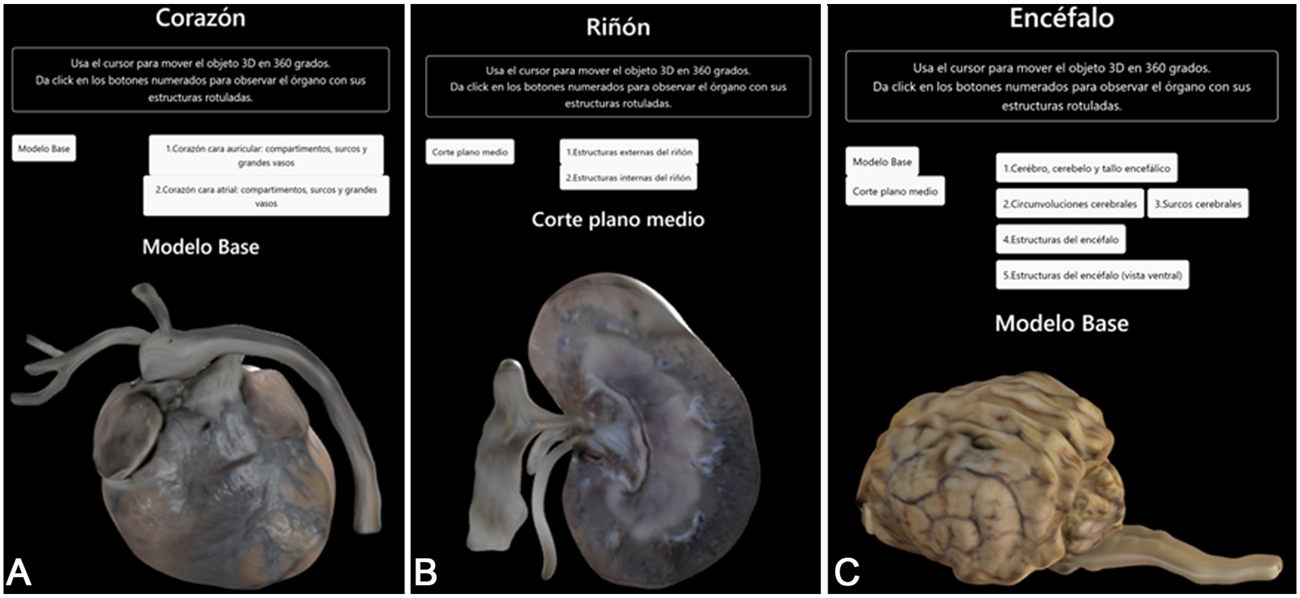

5. Circunvoluciones cerebrales - vista dorsal

Fig. 2. Screenshot for "Atlas View Mode" of plate #5 of the canine brain in ATINCA.


Corazón

Usa el cursor para mover el objeto 3D en 360 grados.
Da click en los botones numerados para observar el órgano con sus estructuras rotuladas.

Riñón

Usa el cursor para mover el objeto 3D en 360 grados.
Da click en los botones numerados para observar el órgano con sus estructuras rotuladas.

Encéfalo

Usa el cursor para mover el objeto 3D en 360 grados.
Da click en los botones numerados para observar el órgano con sus estructuras rotuladas.

Fig. 3. Screenshots of 3D models for canine organs taken from ATINCA. to. Base model for canine heart, b. Base model for canine kidney, and c. Base model for canine brain.

DISCUSSION AND CONCLUSIONS

In order to enhance student performance, the teaching-learning process must be constructive, meaningful, and student-centered, as stated by Mallo & Bertazzi (2019) and Crispín *et al.* (2011). The objective of this process is to achieve high levels of understanding through autonomous learning and collaborative work, as highlighted by Mallo & Bertazzi (2019) and Crispín *et al*. (2011). In the context of autonomous learning, TAC tools are designed to apply emerging educational models that facilitate self-learning (Mallo & Bertazzi, 2019). ATINCA is a web application that can be accessed from any browser, adapts to mobile or desktop devices, and is known for being responsive. It helps students with effective self-learning as it is a TAC tool that they can use independently, anytime, and anywhere they want. Moreover, as books and other digital resources foster collaborative methodologies, ATINCA serves as a digital atlas that supports collaborative learning (Gabinete de Comunicación y Educación de la Universidad Autónoma de Barcelona, 2016).

Collaborative learning has been found to result in better academic outcomes for students in subjects such as Anatomy, according to a study by Monzón *et al*. (2021). As a result, several universities, including the University of Murcia (https://www.um.es/web/anatvet/docencia/recursos-docentes), the Autonomous University of Barcelona (https://www.uab.cat/web/guias-tematicas/guia-tematica-de-medicina-y-sanidad-animal/atlas-1345736709155.html), and the University of Minnesota (http://vanat.cvm.umn.edu/WebSitesCarn.html) have developed digital resources for veterinary anatomy students (Alvear, 2021). This demonstrates that the use of digital tools has become an important aspect of the anatomy teaching curriculum (Hecht-López *et al*., 2023). Moreover, Bartoletti-Stella *et al*. (2021), argue that technological resources for educational purposes are crucial for improving anatomical knowledge, which is necessary for safe and competent medical practice. This assertion is equally applicable to veterinary medicine, thus, it can be inferred that ATINCA will enhance anatomical knowledge that can be used in veterinary practice.

It has been suggested that new digital and 3D technologies can complement the traditional teaching methods used in anatomy (Hecht-López *et al*., 2023). However, for these technological tools to be integrated effectively into higher education, institutions must consider the influence of society, the characteristics of the institution, and the traditional context of the subject matter (Domínguez, 2016). In Ecuador, educational institutions rely on international technology and content due to the absence of their own digital tools that are specifically designed to meet the needs of their students (Granizo & Haro, 2016). While there are free or open resources available from international universities, the lack of a culture of creating digital resources directly affects educational quality and competitiveness (Organización de las Naciones Unidas para la Educación, la Ciencia y la Tecnología, UNESCO, 2022). ATINCA is a technological tool created by Ecuadorians, designed to meet the needs of the FMVZ curriculum of the UCE, and considering the minimum knowledge required by the subject of Animal Anatomy 2. It is the first free atlas with 2D and 3D formats developed in Ecuador and can be harmoniously incorporated into the teaching-learning process because it was created to meet the specific needs of an institution.

It is important that TAC tools are not only created to fulfill a specific need, but also adhere to local legislation and regulations (Regatto & Viteri, 2018). In the case of ATINCA, the use of interactive images helps to reduce and replace the number of canine specimens required for veterinary anatomical study. This allows compliance with the principle of animal welfare of the 3Rs (replacement, reduction, and refinement) as well as with the Regulation for the formation, approval, and monitoring of ethics committees of Ecuador (Agencia de Regulación y Control Fito y Zoosanitario, AGROCALIDAD, 2021). Moreover, open source programs were used to create the atlas, which aligns with the technological policy of preferential use and implementation of free software outlined in articles 142 and 143 of the Organic Code of the Social Economy of Knowledge, Creativity, and Innovation (Ministerio de Telecomunicaciones y de la Sociedad de la Información, 2016).

The above information implies that ATINCA will serve as an ICT tool to aid in the independent and collaborative learning of anatomical knowledge related to the canine heart, kidney, and brain. This knowledge can be applied in veterinary practice. Additionally, the atlas can be incorporated into the Ecuadorian curricula because it aligns with national requirements and regulations.

ACKNOWLEDGMENTS. To the teachers and volunteers of the Animal Anatomy Laboratory of the FMVZ of the UCE. Subsidized by the Research Department of the Universidad Central del Ecuador under senior research project DI-CONV-2019-026

TOAQUIZA, A. B.; ALVEAR, V.; VELASCO, B.; CARTUCHE, L.; MORALES, C.; GUANOLUISA, C.; OTTONE, N. E. & REVELO-CUEVA, M. Atlas interactivo de encéfalo, corazón y riñón de canino creado a partir de muestras plastinadas. *Int. J. Morphol., 42(3)*:601-606, 2024.

RESUMEN: Actualmente, la formación en el campo de la anatomía requiere la implementación de tecnologías del aprendizaje y el conocimiento (TAC). Por ello, el objetivo del trabajo fue utilizar imágenes digitales tomadas de cerebros, corazones y riñones caninos plastinados para crear un atlas interactivo que facilite la enseñanza-aprendizaje de la anatomía de estos órganos. La investigación se llevó a cabo en tres fases. En la primera se obtuvieron cerebros, corazones y riñones caninos mediante la técnica de plastinación con silicona al frío. En la segunda etapa se tomaron fotografías, las imágenes se editaron con Adobe Photoshop y se convirtieron a formato SVG con Adobe Illustrator. Durante la última fase, se creó el atlas 2D usando MongoDB y Node.js para el backend y Vue.js como framework para el frontend. Además, se utilizó three.js para renderizar los modelos 3D. Como resultado se creó el Atlas Interactivo del Canino, ATINCA. El atlas cuenta con 27 imágenes interactivas y 27 en vista modo atlas (28 del cerebro, 20 del corazón y 6 del riñón). Además, el atlas presenta modelos 3D de los tres órganos. El atlas desarrollado constituye la primera herramienta digital creada en el Ecuador con base en necesidades institucionales locales y donde se incluye el formato 3D. Con lo cual, ATINCA podrá incorporarse en las mallas curriculares como material digital que facilitará el aprendizaje autónomo y colaborativo significativo de conocimientos anatómicos de los órganos caninos.

PALABRAS CLAVE: Herramienta; 3D; Silicona; Enseñanza-aprendizaje; Anatomía.

REFERENCES

Agencia de Regulación y Control Fito y Zoosanitario, AGROCALIDAD. *Reglamento para la conformación, aprobación y el seguimiento de comités de ética-Resolución 0227*. PDF. [Online]. 2021. Retrieved from: https://www.agrocalidad.gob.ec/wp-content/uploads/2021/11/DAJ-2021454-0201.0227-1.pdf

Alvear, V. A*tlas Digital de Osteología del Canino con Aplicación Radiológica. Tesis para optar por el título de Médico Veterinario Zootecnista*. Quito, Universidad Central del Ecuador, 2021.

Bartoletti-Stella, A.; Gatta, V.; Mariani, G. A; Gobbi, P.; Falconi, M.; Monzoli, L.; Faenza, I. & Salucci, S. Three-dimensional virtual anatomy as a new approach for medical student's learning. *Int. J. Environ. Res. Public Health, 18(24)*:13247, 2021.

Bravo, H. & Inzunza, O. Evaluación de algunos programas computacionales en la enseñanza de Anatomía y Neuroanatomía de la Facultad de Medicina de la Pontificia Universidad Católica de Chile. *Rev. Chil. Anat., 13(1)*:79-86, 1995.

Crispín, M.; Doria, M.; Rivera, A.; Garza, M.; Carrillo, S.; Guerrero, L.; Patiño, H.; Caudillo, L.; Fregoso, A.; Martínez, J.; *et al*. *Aprendizaje autónomo: orientaciones para la docencia*. Ciudad de México, Consejo Latinoamericao de Ciencias Sociales-CLACSO, 2011. pp.49-62.

Díaz, L. & Silveiro, E. Arte y Medicina, ciencia y belleza. Reflejo en las Artes Plásticas. *INFODIR, (36)*:1-16, 2021.

Domínguez, Y. La utilización de las Tecnologías de la Información y las Comunicaciones (TIC) en el aprendizaje universitario. *Univ. Soc., 8(4)*:158-63, 2016.

Gabinete de Comunicación y Educación de la Universidad Autónoma de Barcelona. *Perspectivas 2016 - Tecnología y Pedagogía en las Aulas. Barcelona, Centro Editorial PDA, Online, 2016*. Available from: https://www.gabinetecomunicacionyeducacion.com/sites/default/files/field/publicacion-adjuntos/dossier_perspectivas_2016_72dpi.pdf

Granizo, E. & Haro, S. Modelo de producción de contenidos digitales para la educación online. *MASKAY, 6(1)*:20-28, 2016.

Hecht-López, P. & Larrazábal-Miranda, A. Use of new technological resources in the teaching of a clinical anatomy course for medicine students. *Int. J. Morphol., 36(3)*: 821-828, 2018.

Hecht-López, P.; Maturana-Arancibia, J. & Parra-Villegas, E. New digital and 3D resources in the teaching of anatomy. International experience reported in the "Sectra Users Meeting 2019", Karolinska Institutet, Sweden, before the pandemic COVID-19. *Int. J. Morphol., 41(3)*:690-8, 2023.

Inzunza, O. & Bravo, H. Impacto de dos programas computacionales de Anatomía Humana, en el rendimiento del conocimiento práctico de los alumnos. *Rev. Chil. Anat., 17(2)*:205-9, 1999.

Mallo, A. & Bertazzi, G. TAC y Estrategia de Enseñanza para favorecer la Permanencia y Terminalidad en Educación Superior. *Rev. Tecnol. Educ. Doc. 2.0, 19(3)*:1-7, 2019.

Ministerio de Telecomunicaciones y de la Sociedad de la Información. *Código Orgánico de la Economía Social de los Conocimientos. Quito, Registro Oficial, Órgano del Gobierno del Ecuador, 2016*. Retrieved from: https://www.gob.ec/sites/default/files/regulations/2019-02/Documento_C%C3%B3digo-Org%C3%A1nico-Econom%C3%ADa-Social-Conocimientos-Creatividad-Innovaci%C3%B3n.pdf

Monzón, M. J.; Grandía, D.; Morejón, D.; Morejón, Y.; Peterssen, M. & Ramos, A. *Estrategia de Aprendizaje Colaborativo en Estudiantes de Medicina en la Asignatura de Anatomía Humana.* Holguín, X Jornada Científica de la Sociedad Cubada de Educadores en Ciencias de Salud de Holguín - SOCECS, 2021.

Organización de las Naciones Unidas para la Educación, la Ciencia y la Tecnología, UNESCO. 2022. *Estrategia de la UNESCO sobre la Innovación Tecnológica en la Educación (2022-2025)*. Washington D.C., Organización de las Naciones Unidas para la Educación, la Ciencia y la Tecnología, 2022. Available from: https://unesdoc.unesco.org/ark:/48223/pf0000378847_spa

Ottone, N. E. *Advances in Plastination Techniques*. Cham, Springer Nature, 2023. Available from: https://link.springer.com/book/10.1007/978-3-031-45701-2

Ottone, N. E.; Cirigliano, V.; Bianchi, H.; Medan, C.; Algieri, R.; Borges G. & Fuentes, R. New contributions to the development of a plastination technique at room temperature with silicone. *Anat. Sci. Int., 90(2)*:126-35, 2015.

Parra, H.; López, J.; González, E.; Moriel, L.; Vásquez, A. & González, N. Las tecnologías del aprendizaje y del conocimiento (TAC) y la formación integral y humanista del médico. *Investig. Educ. Med., 8(31)*:73-81, 2019.

Regatto, J. & Viteri, V. *El uso de las herramientas tecnológicas y su influencia en la práctica docente. Caso estudio: Universidad Estatal del Milagro*. Milagro, Contribuciones a las Ciencias Sociales, 2018.

Suárez, J.; Posada, M.; Bedoya, L.; Urbina, A.; Ferreira, J. & Bohórquez, C. Enseñar y aprender anatomía. *Acta Med. Colomb., 45(4)*:1-8, 2020.

Toaquiza, A.; Gómez, C.; Ottone, N. E.; Revelo-Cueva, M. Conservation of organs (heart, brain and kidney) of canine by cold-temperature silicone plastination in an Animal Anatomy Laboratory in Ecuador. *Int. J. Morphol., 41(4)*:1004-8, 2023.

von Hagens, G. (Ed.). *Heidelberg Plastination Folder. Collection of Technical Leaflets of Plastination.* Heidelberg, Biodur Products GmbH, 1986.

von Hagens, G. Impregnation of soft biological specimens with thermosetting resins and elastomers. *Anat. Rec., 194(2)*:247-55, 1979.

Yoza, A & Vélez, C. Aporte de las tecnologías del aprendizaje y conocimiento en las competencias digitales de los estudiantes de educación básica superior. *Rev. Innova Educ. 3(4)*: 59-70, 2021.

Corresponding author:
María Revelo-Cueva
Jerónimo Leyton S/N y Gatto Sobral
Quito
ECUADOR

E-mail:mcrevelo@uce.edu.ec