

**CREATIVE TOOLS FOR TEACHING NEUROANATOMY AND  
NEUROPHYSIOLOGY: AN EXPERIENCE IN THE PSYCHOLOGY COURSE**

***FERRAMENTAS CRIATIVAS PARA O ENSINO DA NEUROANATOMIA E  
NEUROFISIOLOGIA: UMA EXPERIÊNCIA NO CURSO DE PSICOLOGIA***

***HERRAMIENTAS CREATIVAS PARA LA ENSEÑANZA DE NEUROANATOMÍA Y  
NEUROFISIOLOGÍA: UNA EXPERIENCIA EN EL CURSO DE PSICOLOGÍA***



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**ABSTRACT:** With the return of in-person classes after the pandemic-related restrictions, numerous changes have emerged for teachers and students. The report highlighted the use of creative methodologies in the Neuroanatomy and Neurophysiology course, grounded in the theory of active learning. Education is constantly evolving, and the current challenge is to maintain student engagement and offer relevant knowledge. The approach involves students in teaching and learning by encouraging creation, modeling, prototyping, and collaboration, resulting in a positive learning and assessment experience. The activities mobilized empirical and scientific knowledge, promoting social interaction and dialogue and allowing students to create support materials for the course and individual studies. It was concluded that by creating an interactive teaching and learning environment in which students actively engage and apply their acquired knowledge, active methodologies enable a deeper and more meaningful learning experience.

**KEYWORDS:** Comic. Infographic. Innovation. Neuroanatomy. Neurophysiology.

**RESUMO:** Com o retorno das aulas presenciais, após as restrições da pandemia, surgiram diversas mudanças para os professores e alunos. No relato, foi destacado o uso de metodologias criativas na disciplina de Neuroanatomia e Neurofisiologia, embasadas na teoria da aprendizagem ativa. A educação está em constante evolução, e o desafio atual é manter o engajamento dos alunos e oferecer um conhecimento relevante. A abordagem visa envolver os alunos no processo de ensino-aprendizagem, incentivando a criação, modelagem, prototipagem e colaboração, resultando em uma experiência positiva de aprendizado e avaliação. As atividades realizadas mobilizaram conhecimentos empíricos e científicos, promovendo a interação social e o diálogo, além de permitir que os alunos criassem materiais de apoio para a disciplina e estudos individuais. Concluiu-se que, ao criar um ambiente de ensino e aprendizagem interativo, no qual os alunos se envolvem ativamente e aplicam o conhecimento adquirido, as metodologias ativas possibilitam uma aprendizagem mais profunda e significativa.

**PALAVRAS-CHAVE:** História em quadrinhos. Infográfico. Inovação. Neuroanatomia. Neurofisiologia.

**RESUMEN:** Con el regreso de las clases presenciales después de las restricciones impuestas por la pandemia, surgieron diversos cambios para profesores e estudiantes. En este informe, destacamos el uso de metodologías creativas en la asignatura de Neuroanatomía y Neurofisiología, basadas en la teoría del aprendizaje activo. La educación está en constante evolución y el desafío actual radica en mantener el compromiso de los estudiantes y ofrecer conocimientos relevantes. Buscamos involucrar a los estudiantes en el proceso de enseñanza-aprendizaje, fomentando la creación, modelado, prototipado y colaboración, lo que resulta en una experiencia positiva de aprendizaje y evaluación. Las producciones presentadas lograron movilizar conocimientos empíricos y científicos, promoviendo la interacción social y el diálogo, además de permitir que los estudiantes crearan materiales de apoyo para la asignatura y para su estudio individual. Concluimos que al crear un entorno educativo interactivo, en el cual los estudiantes participan activamente y aplican los conocimientos adquiridos, las metodologías activas permiten un aprendizaje más profundo y significativo.

**PALABRAS CLAVE:** Cómics. Infografía. Innovación. Neuroanatomía. Neurofisiología.

## Introduction

The return of in-person classes in 2022 was fraught with anxiety for teachers and students due to the significant impact of the two years of distance learning during the COVID-19 pandemic. The main questions from teachers were: What is the best method and tool for returning to teaching in-person classes? How do we maintain student engagement in the classroom? What will be the profile of the student who returns from this reality after two years?

Education has undergone changes in those two years that likely have taken decades if not for the pandemic, and educators' skills and abilities have been tested. Those who managed to reinvent themselves during the pandemic, develop new skills, learn new techniques, master new technologies, and above all, be creative and resilient, return to the in-person classes more confident, motivated and believe that we have succeeded (despite obstacles along the way) in achieving success.

During the pandemic, there were many hours of online meetings, webinars, lectures, courses, debates, and presentations of new tools and new applications, in other words, an avalanche of options that confused students and teachers who could not decide what, when, and how to use such a variety of products. Reflecting, it is necessary to evaluate and literally "separate the man from the boys" to return to in-person teaching without deluding ourselves that the arsenal of things presented to us in distance learning is the "Eden" of the educational process.

Several lessons were extremely important, and many products were of excellent quality, but how much of this arsenal is useful when returning to in-person instruction? In this paper, we would like to tell the history of the Neuroanatomy and Neurophysiology subject of the Psychology course at *Centro Universitário São Camilo*, returning from distance learning to in-person teaching. Furthermore, present some activities performed in the first semester of 2022 to maintain the student's commitment to work on skills that were dormant during distance learning and to assess them creatively and playfully but with clearly defined objectives, such as the initiative to make them recover their social skills, practice group communication, awaken their creativity and learn in a collective, playful, and visible way for the teacher.

An extremely relevant approach in this post-pandemic period, that the authors explored in developing the activities is the theory of active learning, which emphasizes students' active participation in constructing knowledge through practical and reflective exercises. In addition, intrinsic motivation theory emphasizes the importance of internal factors such as interest and autonomy in promoting student engagement (HATTIE, 2017). In this study, we aim to show

how different activities on the subject positively affect student learning. We have listed the following tools as models for creating activities: Design Thinking, Comics, and Infographics described and commented on below.

### **Design Thinking**

*Design Thinking* (DT) is a way of thinking and solves problems through empathy, collaboration, and prototyping ideas through experimentation (CAVALCANTI; FILATRO, 2017; LIEDTKA; OGILVIE, 2019). DT combines a positive *mindset* with an action plan to develop a product or solve a problem collaboratively. In class, we used DT to conclude the three-week telencephalon theme so that students could apply the knowledge they learned in a professional practice simulation.

The first pillar of Design Thinking is empathy, which presupposes that, to develop something, it is necessary to understand the target audience and define the problem. The proposed activity consisted of presenting a blank canvas to the students, featuring an image of the reception area of a fictitious clinic (Figure 1). Following this, a briefing was provided about the population served by the Psychology clinic occupying this space. The patients of this clinic are between the ages of 25 and 40, of both genders. Most clients seek treatment for injuries resulting from strokes (cerebral vascular accidents - CVA), presenting motor, speech, and sensory sequelae. Additionally, a portion of the patients seek treatment for behavioral changes. The clinic in question has a reception area similar to the one in the following photo. This space will be used to create a method to disseminate information about cortical regions and their functions.

**Figure 1** – Waiting room model (blank screen) for the start of the activity.



Font: Forte ([21--]).

The second pillar of Design Thinking is collaboration, in which groups think collectively and integratively, combining intelligence. For this stage, in classes, they discussed the audience and the space and came up with ideas on how to disseminate the information, knowing that they could use the area most excitingly, either aesthetically or visually. Each group put their opinions on various post-its without fear of using creativity, as it was advised at this moment that it was good to have many ideas, even if they seemed absurd (Fig. 2).

The next step was to filter the ideas from the post-its into three rows (fundamental concepts, reasonable, not so necessary, and suggestions to be discarded), then reduce it to just one row, choosing between the "very important" and "reasonable" ones. In this way, each group would have a path to create their product.

The third pillar of Design Thinking is experimentation, in which the groups move from ideas to hands-on work. Therefore, in this phase, it was indicated that the teams should discuss the following questions: how will the product reach the target audience? What content will be in it? What means will be used in the previously presented space? At this point, the prototyping process began on an A3 sheet, and in the end, each group presented their idea to their classmates (Fig. 3).

The results were exceptional, with products that demonstrated the teams' engagement and creativity of the teams but also entrepreneurship and humanization. Some groups focused on using technology to display the acquired knowledge, with ideas for three-dimensional models of a brain activated by touch with divisions of the brain lobes and voice information

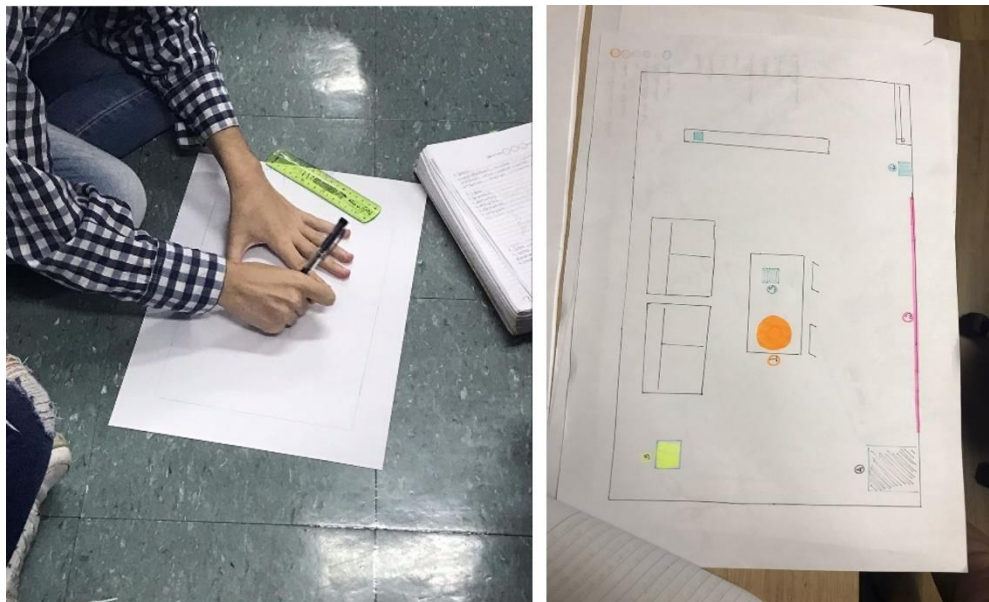
about cortical areas and their functions. Others focused on hospitality and sensitization, creating an interactive wall with games and ambient sound aimed at tranquility and customer loyalty through prizes for those who participated in the games.

**Figure 2** – Step of brainstorming using the post-its.



Font: Author's archive.

**Figure 3** – Step of prototyping on an A3 sheet assembling a sketch based on the first image provided



Font: Author's archive.

The stages of Design Thinking facilitate and encourage creativity, collaboration, communication among students, proactivity, and listening skills. During the process, students demonstrated their ability to search for innovative ideas, focus on the needs of the target audience, engage in debates with different teams, make collaborative decisions, materialize

ideas, even if fictitious, in the physical world, acquire practical skills, and accept criticism through feedback, among various other learning opportunities.

In the context of education, sparking students' interest and curiosity can be a constant challenge. Connecting complex concepts to students' everyday lives is essential for promoting meaningful learning. In a classroom dedicated to innovation and creativity, a question arises: how to approach complex and crucial subjects, which are also challenging, in a way that can enhance students' understanding?

## Comics

Another activity, now of an evaluative nature, realized by the students was the creation of a comic book (comics) on the theme of cranial nerves, in which each group randomly selected a cranial nerve and was encouraged to know the nerve in detail (type, function, location, route, etc.). Then, they were asked to create a short story that could explain aspects they considered attractive.

The use of comics is based on *storytelling* (telling a story or a narrative), and this tool, combined with Information and Communication Technologies (ICT), can contribute to the construction and sharing of knowledge in education (TENÓRIO *et al.*, 2020; XAVIER *et al.*, 2015). VIER *et al.*, 2015). The benefits of *storytelling* include closer communication with young people and the promotion of student engagement, as well as making the information more interesting, ensuring more efficient learning (PALÁCIO; TEREZZO, 2016).

The students were provided with guidelines that required adapting the comic book story to the theme of cranial nerve anatomy and function, with a minimum of three and a maximum of eight panels, and utilizing creativity and available online technologies. The rules were presented to the students through a comic book to initiate the engagement process and demonstrate that even activity instructions can be enjoyable (Fig. 4). (Fig. 4).

Figure 4 – Standards for creating the comic made available to students<sup>4</sup>



Font: Author's archive.

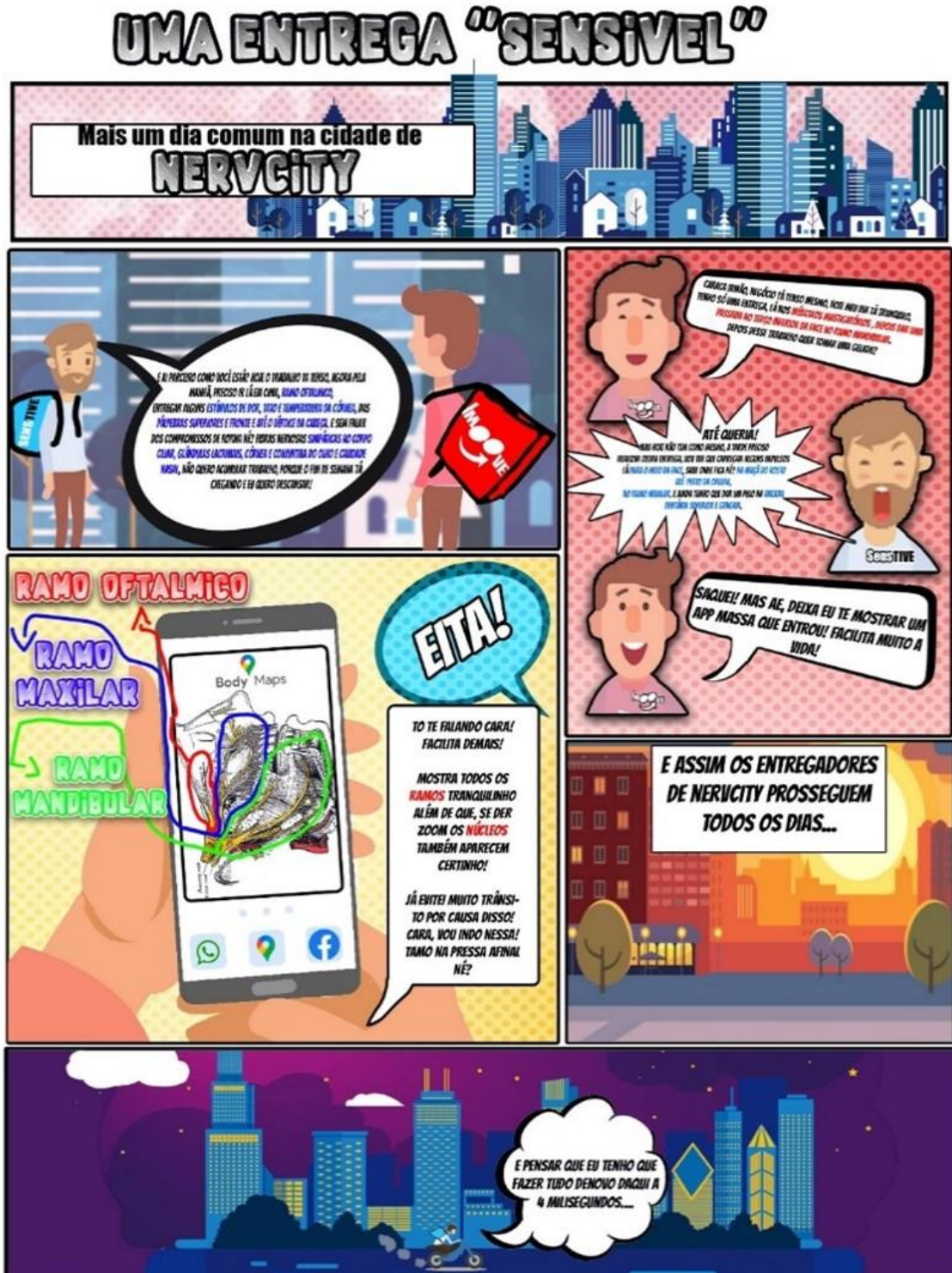
In a pedagogical context, storytelling is a reflective practice that leads to effective communication with a focus on understanding the content discussed, aiming to organize and structure ideas, besides strengthening the creative and thoughtful spirit, cooperating in the debate of ideas among students; all of this, permeated by playfulness and fun.

Tenório *et al.* (2020) reported that telling, creating, or recreating stories requires a lot of concentration and mental reconstruction of events based on the content studied. Therefore, the more students master the content, the better they will use it during the creation of the comic (Fig. 5). Furthermore, the pedagogical process is faster and better constructed when done through links and associations (PALÁCIOS; TERENCEZZO, 2016).

<sup>4</sup> Translation in Appendix A.



Figure 5 – Example of the comic created by students<sup>5</sup>



Font: Author's archive.

The presented comics showed that the students understood the proposal to extract from the theoretical basis of each nerve the strategic points that revealed its main characteristics

<sup>5</sup> Translation in Appendix B.

(name, type of nerve, primary function) through the told story and constructed well-designed comics according to the initial rules given by the teachers, masterfully using the available technologies and creativity in collaborative work (KELLEY; KELLEY, 2019).

We live in an ever-evolving digital age in which information is available with just a few clicks. In this context, understanding, interpreting, and communicating information effectively is essential for students to meet academic and career challenges. Given this need, the question is: “How can we engage and empower our students to become critical consumers and effective information producers?”.

### **Infographic**

The final successful activity employed during the academic semester consisted of creating an infographic covering various themes from the classes. Subsequently, the groups were allowed to exchange their products with each other for additional study.

Since an infographic is a tool that conveys information through images and drawings accompanied by text, its creation involves constant feedback on the content, consulted sources, the amount of information, and its accuracy. Additionally, an example created by the instructor was used to motivate and guide the groups, outlining what was expected from the product (Fig. 6). The central idea was for each group to translate the essential topics of their assigned theme into an “image-message” dyad.

Figure 6 – Standards for the creation of the infographic made available to students<sup>6</sup>

# INFOGRÁFICO

O objetivo desse infográfico é ser uma atividade avaliativa e também uma fonte a ser consultada em outras avaliações.

**PASSO 1. TEMAS**

O infográfico deve ter como base os vídeos do sistema nervoso postados em arquivos no Teams.

**PASSO 2. 7 GRUPOS-6 TEMAS**

Cada grupo fica com um tema e certamente um dos temas vai se repetir.  
 Infográfico de apenas uma página, sem padrão de medida.  
**Obrigatório** colocar no infográfico os nomes de todos os integrantes do grupo

**PASSO 3. CONTEÚDO**

Cada grupo deve agregar ao infográfico do seu vídeo-tema as informações apresentadas nos conteúdos tanto de anatomia quanto de fisiologia.

**PASSO 4. CONSULTEM OS LINKS**

O que é infográfico: <https://rockcontent.com/br/blog>  
**Ferramentas para a produção do infográfico:**  
<https://www.educamaisbrasil.com.br/educacao/noticias/conheca-os-sites-gratuitos-para-criar-infograficos-incriveis>

**LEMBRETES:**

- Valor: **2,0 pontos**;
- Data de entrega: **06/06** via tarefa do Teams.

CRITÉRIOS DE AVALIAÇÃO	Sim (0,5)	Não (0,0)
Integração dos conteúdos de anatomia e fisiologia		
Conceitos e informações estão transmitidos de forma fácil		
As ilustrações são adequadas ao assunto		
Os conceitos e informações estão corretos		

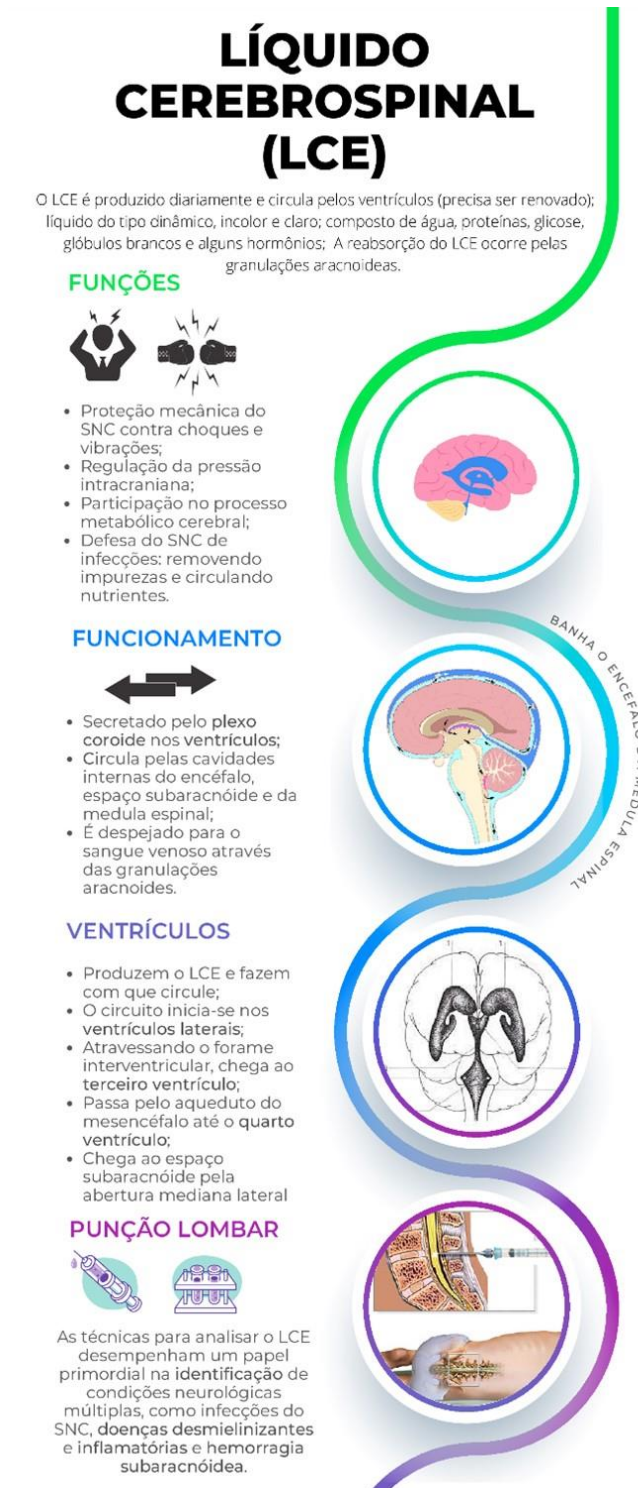
Font: Author's archive.

<sup>6</sup> Translation in Appendix C.

The use of the infographic is consistent with the theory of microlearning, which aims to absorb and capture knowledge without consuming too much of the students' time. In this way, when creating and learning infographics, the student does not lose focus and interest in the information explained, besides using visual appeal to increase interest. Hug (2005) clarifies that microlearning has several dimensions, such as a relatively small amount of time spent, content distributed in small units, and reduced topics in the format of knowledge pills. All these dimensions are addressed in a well-structured infographic.

The following elements characterize the infographics created: They are based on topics relevant to the subject but are fed by short and direct content; their design and content have become a strategic tool that provides agility in learning and are ideal for continuous reinforcement to mitigate the forgetfulness curve; they can be used as reference material in assessment activities (Fig. 7).

Figure 7 – Example of an infographic created by students<sup>7</sup>



Font: Author's archive.

In short, using the infographic methodology in the classroom has proven to be a highly effective teaching and learning resource, engaging students, facilitating the understanding of

<sup>7</sup> Translation in Appendix D.

complex information, and providing a more dynamic and efficient study. By combining visual synthesis with content distribution into small units, infographics have proven to be a powerful tool for academic success, strengthening student engagement and facilitating long-term knowledge retention.

## **Conclusions**

The return to in-person teaching was expected to bring joy; however, it also raised many doubts about how students and teachers would face this new challenge. Indeed, we did not get everything right in the first semester of 2022. Nevertheless, we implemented methodologies that we consider more aligned with an emerging future: the understanding that we can no longer confine ourselves to traditional lectures and assessments.

Students and teachers are transforming, and education requires an adaptation compatible with the new profile of both students and educators. A significant challenge lies in engaging the student, which is the primary objective. The obstacles to engagement include disenchantment, disconnection, distraction, and disempowerment of the student. Upon the resumption of in-person classes, efforts were made to use activities that could combat these obstacles, allowing the student to actively participate and experience these activities with the support of their teachers while feeling fully engaged in the teaching and learning process. This includes creating, modeling, prototyping, and collaborating, with the perspective of a positive experience in both learning and the assessment process.

Active teaching methodologies are intrinsically linked to the concept of visible learning, as both aim to promote a more participatory and meaningful approach for students, encouraging their active participation through practical activities, group discussions, and collaborative projects, placing them at the center of the learning process. Furthermore, by using active methodologies, educators have the opportunity to closely observe and monitor students' progress, identify their difficulties, and provide individualized feedback, making learning visible. In this way, active methodologies and visual learning complement each other, providing an enriching teaching and learning environment in which students are involved, engaged, and capable of demonstrating their learning tangibly.

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### ***CRediT Author Statement***

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**Conflicts of interest:** There are no conflicts of interest.

**Ethical approval:** Not applicable.

**Data and material availability:** Not applicable.

**Author's contributions:** All three authors of this paper participated actively in the preparation of this case report and in the development and implementation of the activities described here.

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Proofreading, formatting, normalization and translation.





## Appendix A

### COMIC

#### CRANIAL NERVES

This comic aims to be an evaluative activity (value 3.0 points) but also an activity that can be consulted in other evaluations.



Are we going to have to create?! A story?!? And in comics?!?!?



Calm down young apprentice, capable you will be

1. The comic has the Anatomy and Function of the Cranial Nerves as its theme.
2. The comic must have a minimum of 3 and a maximum of 8 comics.
3. The story must be related to the cranial nerve, its anatomy and/or function.
4. Use plenty of creativity and technologies available online.



Ohh, but I'm not creative!

We all have creativity!



That's right! First, study the cranial nerve of your group. The more you know about it, the easier it will be to create your story.



Ouch, this is too much work!  
(or) Jeez, what a hassle!

No way bestie! Can you imagine our little story being a huge success!?!?



Imagine your character(s), or look for models on the internet, a search for images and characters can inspire you!



Create a script of how your story will happen, let your imagination go! Everything is possible in the comic book universe!!!



Divide your story into moments, creating a beginning, middle (development), and end (conclusion) for each comic. Remember, your story must tell about the cranial nerve drawn, but you choose the way to tell this story!



Think outside the box!

It's going to be great!!!



My group will be better!

## Appendix B

### A “SENSITIVE” DELIVERY



Another ordinary day in NERV CITY



Got it! But hey, let me show you a great app that made it! It makes life a lot easier!



OPHTHALMIC BRANCH  
MAXILLARY BRANCH  
MANDIBULAR BRANCH

JEEZ!

I'm telling you, man! It makes it too easy!  
It shows all the **branches** clearly and, if you zoom in, the **nuclei** also appear correctly!  
I've already avoided a lot of traffic because of this! Dude, I'm going now! We're in a rush after all, right?



And so, Nercity delivery people continue every day...



Thinking that I have to do it all again in 4 milliseconds...

## Appendix C

# INFOGRÁFICO

O objetivo desse infográfico é ser uma atividade avaliativa e também uma fonte a ser consultada em outras avaliações.

### PASSO 1. TEMAS

O infográfico deve ter como base os vídeos do sistema nervoso postados em arquivos no Teams.

### PASSO 2. 7 GRUPOS-6 TEMAS

Cada grupo fica com um tema e certamente um dos temas vai se repetir. Infográfico de apenas uma página, sem padrão de medida. **Obrigatório** colocar no infográfico os nomes de todos os integrantes do grupo

### PASSO 3. CONTEÚDO

Cada grupo deve agregar ao infográfico do seu vídeo-tema as informações apresentadas nos conteúdos tanto de anatomia quanto de fisiologia.

### PASSO 4. CONSULTEM OS LINKS

O que é infográfico: <https://rockcontent.com/br/blog>  
**Ferramentas para a produção do infográfico:**  
<https://www.educamaisbrasil.com.br/educacao/noticias/conheca-os-sites-gratuitos-para-criar-infograficos-incriveis>

### LEMBRETES:

- Valor: **2,0 pontos**;
- Data de entrega: **06/06** via tarefa do Teams.

CRITÉRIOS DE AVALIAÇÃO	Sim (0,5)	Não (0,0)
Integração dos conteúdos de anatomia e fisiologia		
Conceitos e informações estão transmitidos de forma fácil		
As ilustrações são adequadas ao assunto		
Os conceitos e informações estão corretos		

### INFOGRAPHIC

The purpose of this infographic is to be an evaluative activity and a source to be consulted in other assessments.

#### STEP 1. THEMES

The infographic must be based on nervous system videos posted in files on Teams.

#### STEP 2. 7 GROUPS - 6 THEMES

Each group has a theme, and one of the themes will undoubtedly be repeated

Infographic with just one page, no measure pattern.

It is **mandatory** to include the names of all group members in the infographic.

#### STEP 3. CONTENT

Each group must add to the infographic of their video theme the information presented in the contents of both anatomy and physiology.

#### STEP 4. CHECK THE LINKS

##### What is an infographic:

<https://rockcontent.com/br/blog>

##### Tools for producing the infographic:

<https://www.educamaisbrasil.com.br/educacao/noticias/conheca-os-sites-gratuitos-para-criar-infograficos-incriveis>

##### Reminders:

- Value: **2.0 points**;
- Submission date: **06/06** via Teams task.

ASSESSMENT CRITERIA	Yes (0.5)	No (0.0)
Integration of anatomy and physiology contents		
Concepts and information are transmitted easily		
The illustrations are appropriate to the subjects		
Concepts and information are correct		

## Appendix D

# LÍQUIDO CEREBROSPINAL (LCE)

O LCE é produzido diariamente e circula pelos ventrículos (precisa ser renovado); líquido do tipo dinâmico, incolor e claro; composto de água, proteínas, glicose, glóbulos brancos e alguns hormônios; A reabsorção do LCE ocorre pelas granulações aracnoideas.

### FUNÇÕES



- Proteção mecânica do SNC contra choques e vibrações;
- Regulação da pressão intracraniana;
- Participação no processo metabólico cerebral;
- Defesa do SNC de infecções: removendo impurezas e circulando nutrientes.

### FUNCIONAMENTO



- Secretado pelo plexo coróide nos ventrículos;
- Circula pelas cavidades internas do encéfalo, espaço subaracnóide e da medula espinal;
- É despejado para o sangue venoso através das granulações aracnoideas.

### VENTRÍCULOS

- Produzem o LCE e fazem com que circule;
- O circuito inicia-se nos ventrículos laterais;
- Atravessando o forame interventricular, chega ao terceiro ventrículo;
- Passa pelo aqueduto do mesencefalo até o quarto ventrículo;
- Chega ao espaço subaracnóide pela abertura mediana lateral

### PUNÇÃO LOMBAR



As técnicas para analisar o LCE desempenham um papel primordial na identificação de condições neurológicas múltiplas, como infecções do SNC, doenças desmielinizantes e inflamatórias e hemorragia subaracnóide.



## CEREBROSPINAL FLUID (CSF)

The CSF is produced daily and circulates through the ventricles (needs to be renewed). It is a dynamic, colorless, transparent liquid composed of water, proteins, glucose, white blood cells, and some hormones. CSF reabsorption occurs through arachnoid granulations.

### FUNCTIONS

- Mechanical protection of the CNS against shocks and vibrations;
- Regulation of intracranial pressure;
- Participation in the process of cerebral metabolic;
- Defense of the CNS from infections: removing impurities and circulating nutrients.

### FUNCTIONING

- Secreted by the **plexus choroid** in the **ventricles**;
- Circulates through the internal cavities of the encephalon, subarachnoid space and spinal cord;
- Is poured into the venous blood through the arachnoid granulations.

### VENTRICLES

- They produce the CSF and circulate it;
- The circuit begins in the lateral ventricles;
- Crossing the interventricular foramen, reaches the third ventricle;
- Passes through the aqueduct of the mesencephalon to the fourth ventricle;
- Arrives in subarachnoid space through the median lateral aperture.

### LUMBAR PUNCTURE

Techniques to analyze CSF play a key role in identifying multiple neurological conditions, such as CNS infections, demyelinating and inflammatory diseases, and subarachnoid hemorrhage.