THE USE OF AN INTERDISCIPLINARY DIDACTIC SEQUENCE FOR IMMUNOLOGY TEACHING

UTILIZAÇÃO DE UMA SEQUÊNCIA DIDÁTICA INTERDISCIPLINAR PARA O ENSINO DE IMUNOLOGIA

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Abstract. An interdisciplinary Didactic Sequence was the strategy used for teaching Immunology in a class in the 2nd year of high school at a state public school in a rural area in Minas Gerais, Brazil. The development of the sequence had the participation of the disciplines of Arts and Portuguese, being divided into five stages, with the application of questionnaires, creation of an immunological domino, making of comics, and textual productions. The research was qualitative-quantitative, with analysis methodologies appropriate to each stage. The results showed that the use of diversified and previously planned activities contributed significantly to students' learning, making them more active, creative, and participatory.

Keywords: Following teaching; High school; Immunology.

Resumo. Uma Sequência Didática interdisciplinar foi a estratégia utilizada para o ensino de Imunologia em uma turma do 2º ano do Ensino Médio de uma escola pública estadual situada em uma zona rural no estado de Minas Gerais, Brasil. O desenvolvimento da sequência contou com a participação das disciplinas de Artes e de Língua Portuguesa, sendo dividida em cinco etapas, com a aplicação de questionários, criação de um dominó imunológico, confecção de histórias em quadrinhos e produções textuais. A pesquisa foi quali-quantitativa, com metodologias de análise adequadas à cada etapa. Os resultados demonstraram que a utilização de atividades diversificadas e previamente planejadas contribuíram significativamente com a aprendizagem dos estudantes, tornando-os mais ativos, criativos e participativos no processo.

Palavras-chave: Sequência Didática, Ensino Médio, Imunologia.

1. INTRODUCTION

Studying Immunology adds relevant knowledge to understand health and the relationships between organisms and the environment, and since it deals with matters related to health, pathologies, vaccines, etc., it is considered an essential field for Public Health. Such knowledge can result in attitude changes (Andrade et al., 2016).

The content of immunology is relevant to teaching biology due to its impact on people's health and lives. It is commonly taught through biology textbooks in high school, which, in addition to the theoretical approach, also contain images that enable students to understand the material better (Miranda et al., 2022). However, an analysis of the textbooks of the Brazilian new high school integrative projects (PNLD 2021) showed deficiencies in terms of the approach to production, the biological functioning of vaccines and their immunological process, and the history of science. The knowledge about vaccines is relevant to learning, as it contributes to the processes of scientific literacy and citizenship training in school science education (Umere & Venturi, 2024).

Working with scientific concepts with Basic Education students through appropriate methodologies leads to better knowledge and quality of life (Silva et al., 2018). However,

applying a methodology in the classroom requires careful planning that aims not only to avoid unforeseen events but also to go beyond the traditional transmission of knowledge.(Queiroz et al., 2017).

Good planning enables teachers to monitor teaching activities systematically, diagnose the results of their work, and check weaknesses and possibilities of changing (Patias et al., 2018). Teaching planning aims mainly to develop actions that contribute to the teaching and learning process. However, such actions do not always address scientific, technological, and social issues, and that ends up reducing basic education to the teaching of fragmented content (Cavalcanti et al., 2020).

Interdisciplinary didactic sequences, which are teaching plans elaborated in stages, emerge as a way to minimize the content fragmentation, constituting a mechanism that results in meaningful learning through linking contents, thus facilitating understanding of concepts (Lima, 2019). Their construction becomes more effective when applying active methodologies, a set of didactic procedures that break with the traditional way of teaching. They center the teaching process on the student, value previous knowledge focusing on dialogue, collective action, contextualization, interactivity, and engagement, and they make the teacher a mediator of the teaching-learning process (Valério et al., 2019, Wommer et al., 2019).

The emergence of the new coronavirus (SARS-CoV-2) in 2019 raised pertinent questions regarding the basic and necessary knowledge of Immunology due to the spread of fake news and misinformation. In this context, the urgency to use educational activities in a playful and dynamic way to bring Immunology closer to the integral training of citizens was revealed by Da Silva & Luna, 2023. The authors presented a didactic sequence, used during remote teaching, as an alternative to approach the contents of immunology in high school and showed that it was possible to encourage student protagonism, stimulate curiosity, and, above all, counter fake news with knowledge. Teaching about immunization at school is a way of educating about health, as it equips students, even if in a conceptual way, with concepts relating to the dynamics of health and diseases. The lack of content related to Immunology in Brazilian high schools can affect students' learning regarding vaccines, for example, as this has suffered a decline in coverage in recent years due to fake news (Sousa et al., 2024).

The implementation of the National Common Curricular Base (BNCC) highlighted the need to adopt new methodologies aimed at helping students achieve competencies and abilities, thus raising their performance indices in high school. In this context, focusing on the student's protagonism and leaving aside the accumulation of contents, new methodologies can promote a more contextualized and engaging teaching-learning process in the school environment (Piffero et al., 2020).

These methodologies contribute to the production of knowledge and meaningful learning by presenting a problem to the student as a way to motivate them and reframe their discoveries (Machado & Quaresma, 2019). Although its application is still not so evident in Basic Education, it is believed that the use of a didactic sequence emerges as a potential tool to innovate in classes, increase the acquisition of knowledge and develop skills, collaboration and autonomy (Almeida, Natale, and Mello, 2021).

In this sense, the present work proposes to analyze the application of a Didactic Sequence, suggesting a circuit of activities for the Biology teacher to work with the Immunology content in high school classes. This work aims to make the interdisciplinary approach possible with the Disciplines of Arts and Portuguese for the resolution of different stage-divided activities. When working with a didactic sequence, the teacher is free to intervene and make changes, or even insert new activities to improve their classes and make them a facilitator in the students' learning process (Maroquio, 2021).

2. METHODOLOGY

The present work was carried out in a state school in a rural area in the state of Minas Gerais, Brazil. It is characterized as qualitative-quantitative research, seeking to understand phenomena through interpretations, comparisons, and the use of statistical analysis (Fontelles et al., 2009).

The target audience was students enrolled in the second year of high school in the morning (group A) and evening shifts (group B), whose ages ranged between 15 and 16 years old, classified as adolescents, according to the World Health Organization (Onis et al., 2007). Of these, 25 students (Group A, n = 16, Group B, n = 11) participated voluntarily after collecting the signatures of the Free and Informed Consent Term (TCLE) from the parents and the Free and Informed Assent Term (TALE) from the students. These classes were chosen because the Immunology content is taught for the second year in an interspersed manner with content on body systems (Brasil, 2018).

The present study was authorized by the school's management and approved by the Research Ethics Committee of the University responsible for the research.

2.1. Stages of the Didactic Sequence

This work was developed in stages, reaching a total of five Biology classes.

2.1.1. First stage: a survey of prior knowledge and assessment of the level of complexity of the questions

A survey questionnaire with 20 closed questions worth one point each was applied in this initial stage. The quantitative methodology used to analyze the results considered the average number of correct answers. The second analysis considered the qualitative character. The questions were classified according to the levels of easy, medium, and difficult complexity and the cognitive domain, using Bloom's Taxonomy or taxonomy of educational objectives (Bloom et al., 1956).

2.1.2. Second stage: making and analyzing the content of the pieces of the immunological domino

At this stage, an expository class about the Immune System and its basic concepts was taught remotely. Explanations were given about the activity that would be developed and the availability of bibliographic material for consultation: the textbook adopted by the school (Modern Biology by Amabis and Martho, volume two), video lessons, slides, and animations. In the proposed activity, each student was assigned the name of an organ or cell of the Immune System to briefly conceptualize and represent through a drawing or photograph and send it to the teacher through a message applicative (this activity was carried out at home).

The domino pieces underwent two qualitative assessments. First, a content analysis was carried out, divided into pre-analysis (objectives and hypotheses), exploration of the material (cuttings and category), and treatment of the results (inference and conclusion). This technique objectively, systematically, and quantitatively describes the content expressed in communication (drawings of the parts) with the purpose of its interpretation (Bardin, 2011).

The drawings were also analyzed according to the Iconological Method, divided into three levels of understanding: pre-iconographic, iconographic, and iconological (Panofsky, 2017). This method explores the field of interrelations between image and art, having Aby Warburg as its greatest representant (1866 - 1929). However, the art historian Erwin Panofsky made it concrete in his work entitled Meaning of Visual Arts. He called iconography the study of the conventional meaning of images, and iconology the interpretation beyond the visual field, centered on the deeper meaning of the image (Moreira, 2018).

2.1.3. Third stage: the creation of comics

After having a Portuguese class on the structure of a comic story and how to create it, the students were challenged to create their own story, having ample freedom to choose and approach any subject that was interesting to them, having it as an axis guiding the Immune System. It was verified that all participants had access to the internet at home, therefore, it was suggested that they use a digital platform to create and edit the stories. Students created comics about the Immune System and returned the file in pdf format. The process of assisting in the creation, correction and revision of the stories was under the responsibility of the Portuguese teacher.

For content analysis of the Comics, we used the MAXQDA software (https://www.maxqda.com/brasil) (Neves & Santos, 2018) and the contextual analysis, according to Chico (2020). MAXQDA works by marking parts of the material, also called coding. A code can generate subcodes as a way of associating ideas. Once encoded, the software releases the data for further interpretation and analysis (Alonso et al., 2021).

2.1.4. Fourth stage: textual productions on subjects related to the Immune System

Themes related to the Immune System were made available for this stage, where each student freely chose the one they would like to use on their dissertation. The texts were sent to the teacher through an application, after which they were printed. The correction was done independently by the English and Portuguese teachers, based on the competencies expressed in the Reference Matrix for writing found in the Brazilian National High School Examination (ENEM) and on the associated knowledge levels (Brasil, 2020). Subsequently, all text productions were rewritten by the students on a specific sheet duly customized for this purpose. This stage had the participation of 15 students from both classes.

2.1.5. Fifth stage: reapplication of the questionnaire

In this final stage, aiming to assess the knowledge acquired and evaluate the methodologies used, the students answered the survey questionnaire again in the classroom and without prior notice.

2.2. Minimizing potential confounding factors

As this research aimed to apply a Didactic Sequence in an interdisciplinary way to work on the Immunology content in high school classes, some factors that could influence the results obtained were considered.

In this investigation, it was possible to work with individuals with the same characteristics, as the students were all from the same age group, regularly enrolled in the 2nd year of high school, and lived in the same region. Participation was voluntary, and each student had the same chance of equally receiving teaching on Immunology content. The study design did not divide the classes into intervention/exposure or control groups, minimizing confounding factors.

Another strategy adopted in the execution of this work to reduce the risk of confusion was the restriction of the studied population, adopting well-defined and justified inclusion and exclusion criteria.

Factors linked to socioeconomic conditions, such as internet and electronic device access, essential for carrying out this work, were previously verified. The texts were corrected by peers based on the evaluators' expertise, minimizing biased grades. In the last stage of the work, the questionnaire was reapplied without prior notice, which reduced the possibility of individual differences in grades due to study time.

The best way to deal with confounding factors is to plan in advance (Fumo-dos-Santos & Ferreira, 2023). In the present work, there was a strategic planning for executing all stages because the activities started during the COVID-19 pandemic, requiring maximum care to minimize errors in the results.

2.3. Data analysis

Data analysis consisted of descriptive analysis, using the calculation of frequency distributions, means and percentages, summary and global description of the data, and construction of tables and graphs. Inferential statistical analysis was performed to verify the existence of significant differences in the questionnaire results in the two applications (1st and 5th stages). The software GraphPad Prism version 7.0 was used to evaluate the student's performance at different times. The assumptions of the normality and homoscedasticity test were met. Data distribution was verified using the Shapiro-Wilk normality test, and the averages were evaluated using the paired student's t-test. A p-value < 0.05 was used to consider statistically significant differences.

3. RESULTS AND DISCUSSION

The results showed a significant improvement in grades after applying the didactic sequence ($p = 0.0001$), as seen in Figure 1.

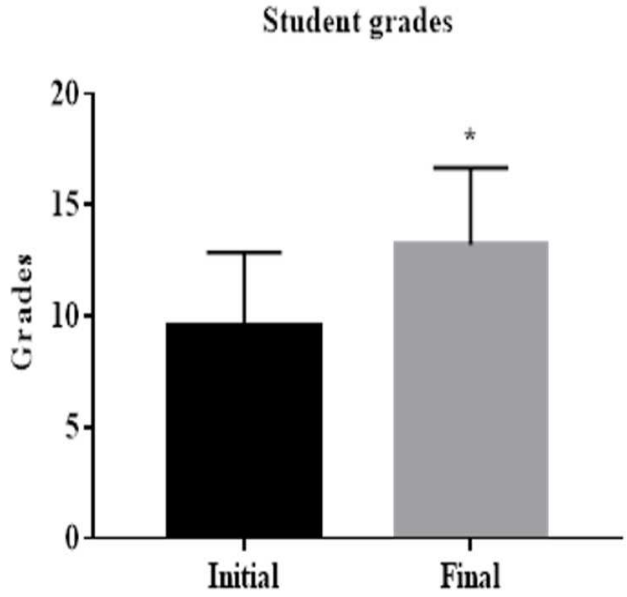


Figure 1. Student grades
* statistically different, $p<0.05$

The results showed an average score of 9.5 (47.5%) in the first application (Initial), and in the second one (Final), an average score of 13.23 (66.15%), presenting an average increase of 39%. This result indicated an improvement in learning the Immunology content taught through the application of the sequence. It is worth mentioning that all students obtained a higher score in the second application and all of them had a significant advance in grades, considering the average required by the public network in the State of Minas Gerais, which is 60% (Minas Gerais, 2022).

Pereira et al. (2017) carried out a study with 140 3rd year high school students from two public schools in Imperatriz, MA, using a questionnaire to evaluate the learning of the Biology

content "Evolution". They found an increase of 46.6% in the average grade, showing the positive contribution of the methodology applied. Another study with questionnaires (pre and post-test) with 22 undergraduate students from the 5th semester of the BSc Biological Sciences course during the Mycology discipline at the University of Pernambuco showed a significant improvement in grades (Freitas et al., 2020).

The categorization of the questions contained in the questionnaire according to Bloom's Taxonomy (1956) revealed that 45% of the questions were classified as the cognitive domain of the "Knowledge" type and of easy level, 40% of the cognitive domain "Analysis" and medium level and 15% of the cognitive domain "Assessment" and hard level. The number and average percentage of correct answers for questions classified according to levels of complexity are shown in Table 1.

Table 1. Relationship between the levels of complexity and the number of correct answers in 20 questions

CLASSIFICATION	AVERAGE NUMBER OF CORRECT ANSWERS	AVERAGE PERCENTAGE OF CORRECT ANSWERS
Knowledge – Easy level	15,44	77,22
Analysis – Medium level	13,88	69,38
Evaluation – Difficult level	12,33	61,67

Source: Author (2023)

In the present work, there was a predominance of questions belonging to the following cognitive domains: Knowledge (easy level) (45%), Analysis (medium level) (40%) and Assessment (difficult level) (15%). However, questions classified as Comprehension and Application domains were not found. It was found that the easy-level questions had a higher average percentage of correct answers compared to the medium and difficult-level questions. It is inferred, therefore, that questions with a hierarchically higher cognitive domain are considered "difficult" since the student is challenged to create, integrate, and combine ideas into a product, plan, or proposal. The verbs used in the "evaluation" domain (difficult level) corroborate this information since they are characterized as creating, planning, developing, and elaborating. The reality that traditionally occurred in the classroom through the type of class taught rarely contemplates these dimensions, which contributes significantly to the emergence of difficulties.

The domain "Knowledge" (conceived as "Remember" in the Revised Taxonomy), with 77.22% of correct answers, is related to recognizing and reproducing ideas and contents, it requires distinguishing and selecting information to reproduce and memorize them. This result is easily explained since the questions are of an easy level. On the other hand, when continuing with a subject, the teacher constantly uses the strategy of remembering the content of the previous class, trying to logically order the concepts seen so that students can understand the process. The same occurs when introducing a new subject using previous knowledge.

The domain "Analysis" with 69.38% of correct answers, exposes the relevance of the contents. The presence of questions related to this domain made it possible for students not only to understand but to relate ideas, make reformulations, and see hidden implications. The median number of correct answers in this domain showed that students still have difficulties in relating facts and choosing those that are more or less relevant.

The "Evaluation" domain (61.67% of the correct answers) is related to making judgments and defending a point of view, being a dimension that encompasses all the others. From a cognitive point of view, this enriched the questionnaire, as the development of abstraction capacity was implicit in the questions.

Other studies carried out in evaluations applied in Dentistry and Medicine courses at Brazilian public universities showed that the questions classified in the domains "Analysis"

and "Assessment", considered as major cognitive domains, had a lower rate of correct answers when compared to the dimensions of the other domains (Moimaz et al., 2017, Bórnea et al., 2014).

Regarding the predominance of questions that also privilege the cognitive domain "Knowledge", some authors stressed the importance of considering more complex domains for a better understanding of students' theoretical-conceptual learning (Tombi et al., 2022).

Regarding the construction of the Immunological Domino pieces made by the students in the 2nd stage of the present study, 28 drawings and concepts were produced and subsequently edited to make the Immunological Domino, as shown in Figure 2.

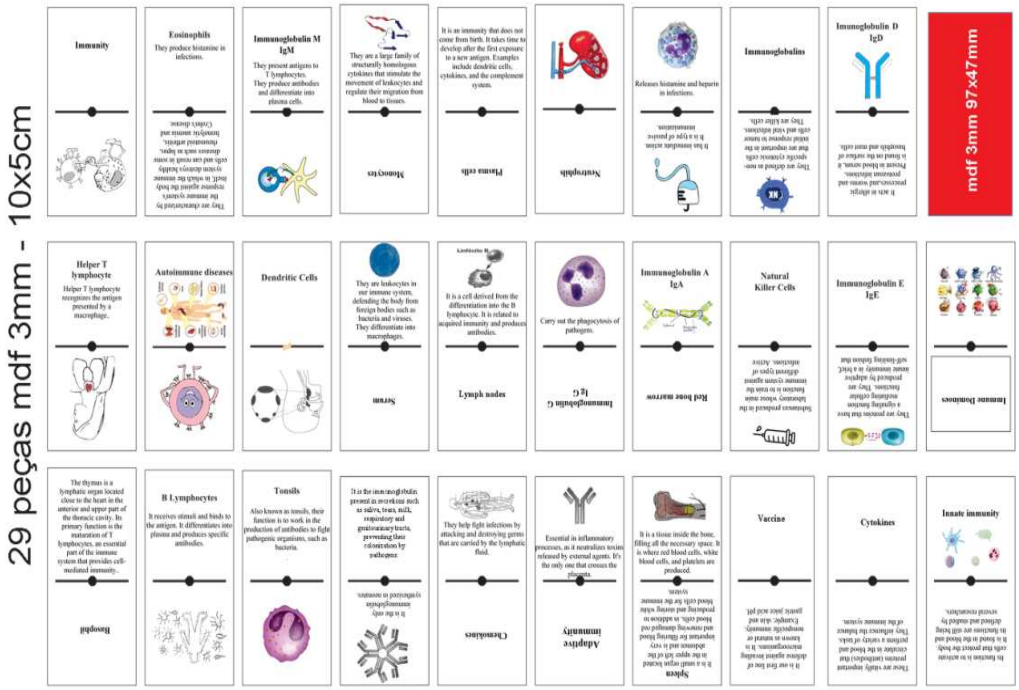


Figure 2. Immunological Domino (29 Pieces)
Source: Author (2024)

The domino pieces were analyzed considering the style, and the description of the characteristics of the drawings contained in each piece can be seen in Table 2.

Table 2. Style, quantity and characteristics of the drawings present in the pieces

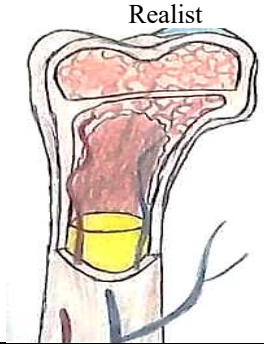
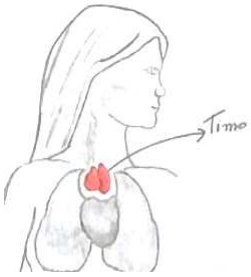
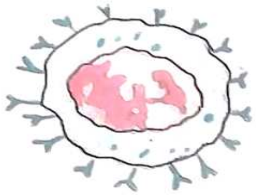
STYLE	QUANTITY OF DRAWINGS	FEATURES
Realistic draw	1	Clear image and closer to reality, such as a photo.
Observation drawing	3	Production of a model from direct observation.
Hyper-realistic drawing	21	Ready-made images, where the characteristics are identical, but they are not a real expression of the image.
Cartoon drawing	3	A non-verbal language that exposes situations through graphics and humor.

Adapted from Barcellos et al. (2018).

Of the 28 drawings analyzed, the hyper-realistic category stood out as the most evident in the pieces, totaling 75% of the total.

After this analysis, a drawing of each style of the image presented in Table 2 was drawn to carry out the iconological analysis (Panofsky, 2017), which considers the analysis of a drawing starting from its primary or natural, secondary, or conventional description, culminating in with an in-depth analysis regarding the extrinsic content, as shown in Table 3.

Table 3. Iconological analysis of the pieces of the Immunological domino

Style	Pre-Iconographic Analysis (Primary or natural theme)	Iconographic Analysis (Secondary or conventional theme)	Iconological Analysis (Deep theme or content)
Realist 	Drawing representing a bone with blood vessels, marrow, and evident connective tissue.	There is a tissue present in the interior of the bone where red blood cells, white blood cells and platelets are produced.	There is the red bone marrow, which is the site of generation of all circulating blood cells in adults, including immature lymphocytes, and the site of B cell maturation.
Observation 	Drawing showing some internal organs of a woman with emphasis on the thymus.	The thymus is located in the chest in front of the heart. Its main function is the maturation of T lymphocytes.	The thymus is a bilobed organ located in the anterior mediastinum.
Hyper-realistic 	Drawing showing a cell with a large nucleus and evident genetic material, some adhered granules, and receptors.	There is a T lymphocyte from stem cells, which migrates to the thymus, where it undergoes selection and maturation.	T lymphocytes differentiate in the thymus. There is a CD4+ T lymphocyte that activates B lymphocytes and macrophages, coordinating the immune response and producing cytokines.
Khartoum 	Drawing representing the encounter between two cells of the immune system. One of them containing receptors delivers something to another.	The macrophage engulfs, processes, and presents the antigen to the helper T lymphocyte, which recognizes it and starts to produce cytokines.	T lymphocytes activate macrophages and promote inflammation in cell-mediated immune responses and promote antibody production by B cells in humoral immune responses.

Source: Author (2023)

The four styles of drawings of the pieces analyzed by this methodology represented elements related to both innate and adaptive immunity, showing that the students expressed, in the form of a drawing, the content transmitted in the didactic sequence of this work. In this sense, the important thing was not just to build a drawing, but to understand that it brings deep

meanings not always explored in the classroom. The in-depth analysis of a drawing contributed significantly to a better understanding of the content in question.

The elaboration of the drawings only to fulfill the task of the didactic sequence would not have a formative or significant character for the students. However, it was noticed that carrying out the iconological analysis allowed the students to enrich their knowledge by adding new information, which, contrary to the traditional context, would not occur. Consequently, students were free to make inferences and discuss with the group the ideas to formulate a response that goes beyond what is generally considered "correct" by the textbook.

A work with 34 students in the 8th year of Elementary School II involving alternative methodologies to teach Science on Cellular Biology was carried out in a public school located in the municipality of Independência, in the interior of the state of Ceará. Data from practical classes in the laboratory and construction of the cell with biscuit were submitted to iconographic analysis, allowing students to actively participate in group work and discussions about the characteristics of cells, which demonstrated the implementation of concepts already consolidated from other experiences and previously worked activities (Almeida et al., 2021).

After making the pieces, the game was applied in the classroom so that students could play and make considerations for later discussion, as shown in Figure 3.



Figure 3. Students playing the immunological domino
Source: Author (2023)

During the game, the students researched hitherto unknown concepts, aiming at the correct fit of the pieces. At one point, they stopped the game due to a lack of parts, leading them to conclude that it was necessary to have repeated parts. Based on this observation, the teacher arranged for the making of the pieces suggested by the students. Students showed interest in the game through effective participation, the search for answers regarding questions still unknown, and suggestions for improvement.

The construction and implementation of a game by the students make them active subjects as they study the topics, thus enhancing their learning. When a game is designed by someone else, out of context, its character becomes instructional and students only play according to established rules (Conceição et al., 2020).

In the drawings researched and/or elaborated by the students, it was observed that they were careful with the details through the tracing, which made it possible to infer that the graphic work awakened the interest in the classroom for the content worked since the field of Biology is also visual. The use of graphic language as a language decoding tool, mainly in Science disciplines, is not widespread and explored as a teaching strategy, but more than 50% of students would like to experience this practice (Costa et al., 2006).

Another proposal of the present study was the elaboration of Comic Stories, a textual genre constructed by written visual and verbal codes, characterized by presenting images, pictures, balloons and subtitles, which, once well-articulated, give it meaning. Developing the reading and production of these stories can be a way of inserting digital communication technologies in the school, which enriches the pedagogical work (Prado et al., 2017). Seventeen comics were produced by students, individually or in pairs. Figure 4 shows one of the comics drawn up and randomly selected.



Figure 4. Antibody comics.
Source: Author (2023)

The results of the content analysis present in the Comics created by the students can be seen in Figures 5 and 6.

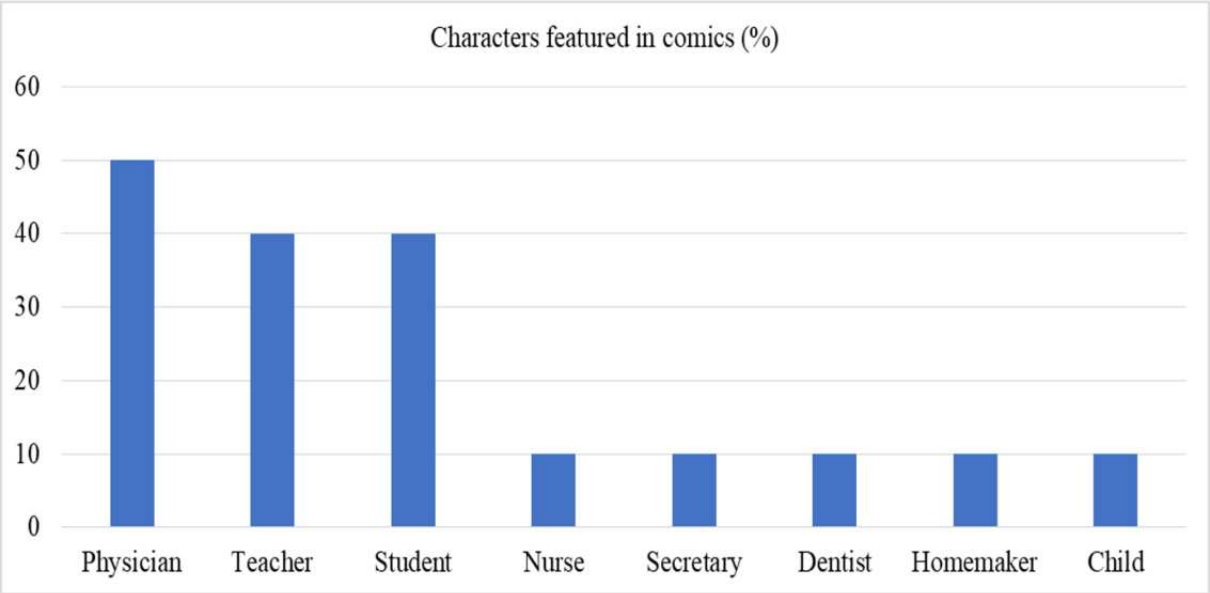


Figure 5. Characters featured in comics
Source: Author (2023)

The results presented show that the most cited characters in comics were "physician", "teacher" and "student".

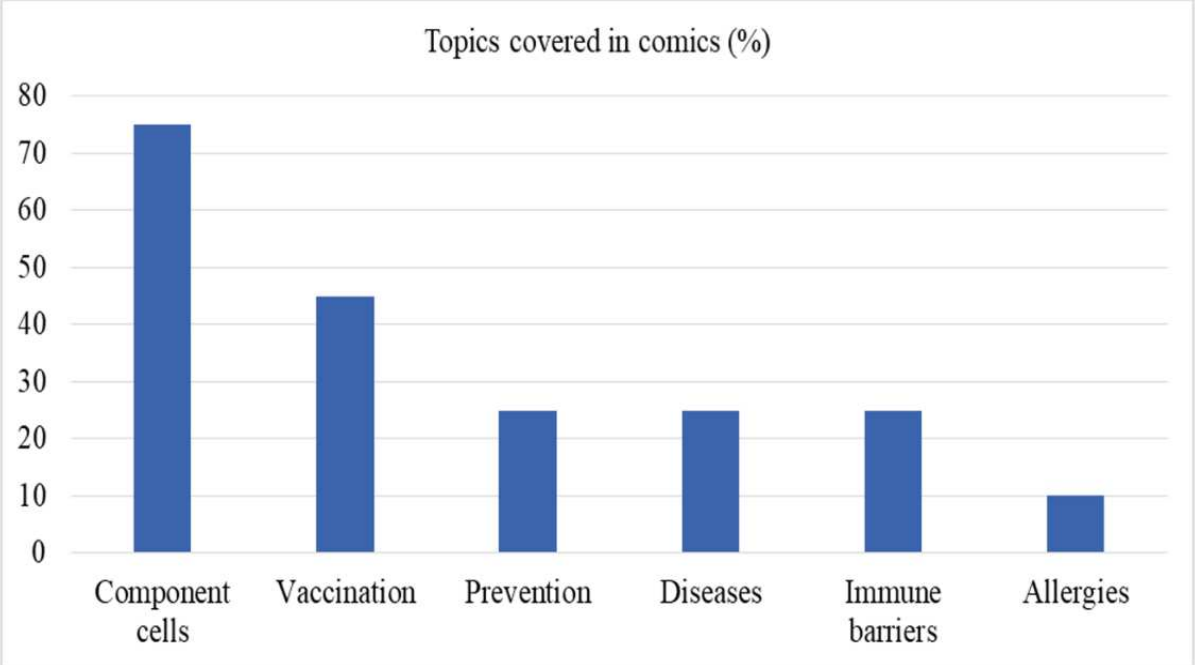


Figure 6. Topics covered in comics
Source: Author (2023)

The results presented show that the topics most addressed by students in the comics were: the component cells of the Immune System (which included location and function), vaccination, prevention, diseases, immunological barriers and allergies.

The comics constructed in the present work had their contents analyzed according to Bardin (2011) with the contribution of the MAXQDA software. Coding the data from the Stories made it possible to present the frequencies with which some results became more evident. As for the

highlighted characters, the physician (50%), the teacher and the student (40%) stood out as the most prevalent. The most recurrent themes used in the Stories were Component Cells of the Immune System (75%), Vaccination (40%), Prevention, Immune Barriers and Diseases (30%). It is inferred, therefore, that the current social context and the characters that students interact with daily are factors that could explain these results.

Other authors carried out a similar analysis and sought to establish relationships between the plots of the comics and the actions promoted by the American government after 9/11, and found that the analysis process of the Stories was one of the most difficult parts and required better interpretation since the same word could be used in different senses. The percentages released by the software when quantifying the codes (categories) were consistent with the concepts. The high repetition of terms (frequency) made it possible to validate hypotheses since every comic book produced, carries its meanings constructed through social relations (Alves et al., 2019).

In the present study, the use of comics as a stage of the didactic sequence made it possible to produce texts within a genre that mixes visual and narrative language, which contributed to the learning of Portuguese. In the field of Biology, there was greater freedom in choosing topics beyond those suggested by the teacher, which substantially enriched the productions. It was noticed that some stories contained relevant information, usually little mentioned in textbooks and a greater students' participation where the creative potential of each one was explored, which consequently added new knowledge, given the interest and participation.

A didactic sequence using comics, enabling the content of Kinematics in Physics teaching, was carried out with four classes of the 1st year of High School (with an average of 22 students per class, in a total of 88 students), at the state elementary and high school Governor Petrônio Barcelos), located in the city of Porto Velho, in Rondônia. The general analysis of the results evidenced the importance of this methodology for the teaching of Physics, concluding that the use of the construction of Comics was a differential, because during the course of the activities, the students were participatory and interested, in addition to having an improvement in grades (Pereira, Olenka & Oliveira, 2016).

According to the results observed in the present study, it is noted that the texts produced in the comics were also loaded with subjectivity in terms of the choice of subject and the way of writing. Some stories were long and packed with information, others, however, were objective and mentioned only essential information without emphasizing or adding new knowledge, which in summary, demonstrates the interest in the subject. By approaching a certain theme related to the Immune System through the creation of a comic strip, the students of this research showed interest in the methodology and managed, in a playful way, to communicate their knowledge and perceptions.

Likewise, Oliveira & Aragão (2018), when applying a didactic sequence on ethnic-racial issues from the use of comics to undergraduate students in Pedagogy at the State University of Vale do Acaraú (Campina Grande-PB), observed better learning and positioning of undergraduates on ethnic-racial issues.

A total of 15 texts were produced in step 4, with free choice among themes related to the Immune System that had been previously distributed to students. The results of the analysis of these texts are shown in Table 4.

Table 4. Scores assigned to the texts according to the competencies of the ENEM reference matrix (BRASIL, 2020)

STUDENT	CLASS	GENDER	C1	C2	C3	C4	C5	FINAL GRADE
1	A	M	8	6	6	6	0	5.2
3	A	M	8	8	8	8	8	8.0
4	A	M	8	8	6	6	0	5.6
5	A	F	8	8	8	8	0	6.4
7	A	F	8	6	8	8	0	6.0
8	A	M	8	6	8	8	0	6.0
9	A	M	8	8	8	8	0	6.4
10	A	M	8	8	8	8	0	6.4
11	A	F	8	8	8	8	6	7.6
12	A	M	8	6	8	8	6	7.2
13	B	F	8	8	8	8	8	8.0
14	B	F	8	8	8	8	6	7.6
16	B	F	8	8	8	8	0	6.4
18	B	F	8	8	8	8	6	7.6
21	B	F	10	10	8	10	8	9.2
AVERAGE GRADE	-	-	8.1	7.6	7.7	7.8	3.2	6.9

Source: Author (2023)

It is possible to verify that the average scores referring to competencies 1 to 4 (C1 to C4) were above average, showing that the students mastered the formal written modality of the Portuguese language (average score 8.1). They were also able to write a dissertation-argumentative text according to the theme and to argue and conclude (average grade 7.6). In addition, they were able to select, organize and interpret information to defend a point of view (average score 7.7) and had the necessary linguistic knowledge to build an argument (average score 7.8). It was also observed that the average score for competence 5 (C5) was 3.2, showing that students had little mastery in preparing an intervention proposal to solve a problem respecting human rights. On the other hand, the overall average score of the texts produced was 6.9 points, higher than the average score of 6.34 achieved by students in the ENEM essay for the year 2021 (Brasil, 2021).

Regarding the free choice of themes to compose the textual productions and the proposal of a solution to the problem encountered, Locatelli, Crestani & Rosa (2020), it was shown that interdisciplinary work is linked to the problematization of discussions of situations that are close to the students, involving social aspects and cultural surroundings. Some problems addressed by the students participating in the present study were: How to combat fake news about vaccination? How to make people aware of the importance of vaccination? Why is it important to know the difference between serum and vaccine? How to prevent yourself from Covid-19? What is the importance of the formed elements of blood? How important is the immune system to the body?

A study carried out in 2017 with students in the last year of high school from some public schools in the state of Paraná analyzed 23 textual productions, showing that only 30% of the evaluated students were able, even precariously or vaguely, to build proposals for intervention to the problem addressed (Striquer, 2018). In the present work, the total number of students who achieved grades above 6, regarding competence 5 in textual production, corresponded to 33%. These results infer that scientific literacy occurs differently in the classroom, showing that each student is at a different level of learning.

The insertion of the textual production stage and the correction in line with the ENEM reference matrix is due to two main reasons. Firstly, it was a way of assessing students' knowledge that was not restricted to the traditional assessment model since textual production is rich in information not always included in an objective test. Secondly, it is necessary for high

school students to become familiar with this type of assessment since it will have a relevant importance in their later studies, and also because the production of argumentative essays is a reality in selection tests in the main competitions in the country, including the ENEM.

A study involving 28 students in the 3rd year of high school at a private institution in the interior of São Paulo also used textual production as a working tool in a didactic sequence for teaching Writing, in which the authors obtained satisfactory development of students in the five competences of the ENEM reference matrix, thus showing its effectiveness for teaching (Moretto & Wittke, 2018).

Textual production is inserted in the context of active methodology, as the student has the freedom to infer and expose his knowledge. The scores attributed to the texts prepared by the students in this work were not competitive, punitive, or classifying. The objective was only to diagnose the levels of understanding of the listed competencies of the textual type in question. According to Belão & Menin (2005), the texts produced by the students provide information that helps the teacher to know and interpret their learning. The production of a text is not an instrument used to pass or fail the student but to identify and analyze the different domains of writing, which does not mean simply assigning a grade as an indicator of learning.

A study carried out with teachers and students of a Pre-ENEM course of the private education network located in the city of João Pessoa-PB showed that 53% of the students demonstrate difficulties in detailing the elements of the intervention proposal, which reveals the need to a greater appropriation of the agent's interventional action, the mode of execution and the effect (Sousa, 2020). Historically, competence 5 of the ENEM curricular matrix is the one with the lowest scores compared to the others, which ends up reflecting considerably on the final grade of the essay (Nakazone & Bortolotti, 2021). For Massi (2017), this competence is considered superficial, as the candidate needs to prepare a fictitious intervention proposal for a real problem.

4. FINAL CONSIDERATIONS

With this study, it was possible to perceive that learning can be stimulated and it also carries a portion of subjectivity, showing that the desire and search for knowledge also depend in part on the student. It was noticed from the first stage that previous knowledge was explored, and this became evident in the questions and in the demonstration of interest in the accomplishment of subsequent activities. The active and creative potential was evidenced in each step performed. It was possible to make very deep analyzes regarding the creations of the immunological domino pieces, the comics, and the textual productions.

A relevant factor to be highlighted was the interdisciplinary work involving the disciplines of Art, Portuguese, and English. The approach to any subject, whether in Biology or another area, requires elaborating a good plan with activities that arouse the student's interest. In this context, reaching the end of the application of a didactic sequence with students' participation in remote classes and measuring satisfactory quantitative and qualitative results clearly shows that some of the educational challenges faced are persistence and well-elaborated planning.

The final products developed in this study can be used and adapted by other teachers according to the reality in which they are inserted, aiming at a meaningful teaching of Immunology for high school students.

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