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Didactic Models in the Teaching of the ABO System and the Rh Factor: A Review of the Methods and Factors that Influence Learning

Modelos Didáticos no Ensino do Sistema ABO e Fator Rh: Uma Revisão dos Métodos e Fatores que Influenciam a Aprendizagem

Modelos Didácticos para la Enseñanza del Sistema ABO y el Factor Rh: Revisión de Métodos y Factores que Influyen en el Aprendizaje

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Abstract

The adoption of didactic models in the teaching of the ABO system and the Rh factor is an alternative for reducing the difficulties encountered by students in the learning process. The aim of this study was to gather up-to-date information, describing the types of didactic models and associating the conditioning factors that contribute to the teaching-learning process of the ABO system and the Rh factor. This is a scoping review, conducted following the recommendations of the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR). The study's guiding question was constructed using the PCC strategy (population, concept and context) and searches carried out on the Dimensions platform, resulting in 289 articles, of which 8 samples were eligible for analysis. The use of didactic models made from recyclable materials, the construction of comic strips (HQs), as well as the implementation and programming of digital games applied in the learning process of the ABO system and the Rh factor, and in the teaching of genetics when it involves consanguinity, was verified. The samples revealed that the models adopted increase the power of assimilation of the content, making classes more dynamic by facilitating abstraction and contextualization, configuring themselves as expressive and reflective pedagogical strategies, allowing for the collective construction of knowledge, representing conditioning factors in the teaching-learning process, when methodological resources are implemented that involve genetics, the ABO system and the Rh factor, as up-to-date information in the teaching-learning process.

Keywords: Biology Teaching, active methodologies, didactic sequences, ABO system and the Rh factor

Resumo

A adoção de modelos didáticos no ensino do sistema ABO e do fator Rh apresenta-se como alternativas para diminuir as dificuldades encontradas pelos alunos no processo de aprendizagem. O objetivo deste estudo foi reunir informações atualizadas, descrevendo os tipos de modelos didáticos e associando os fatores condicionantes que contribuem no processo de ensino-aprendizagem do sistema ABO e do fator Rh. Trata-se de uma revisão de escopo, conduzida seguindo as recomendações da *Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews* (PRISMA-ScR). A questão norteadora do estudo foi construída por meio da estratégia PCC (população, conceito e contexto), e de buscas realizadas na plataforma *Dimensions*, resultando em 289 artigos, dos quais 8 amostras foram elegíveis para análise. Constatou-se a utilização de modelos didáticos confeccionados com materiais recicláveis, construção de histórias em quadrinhos (HQs), além da implementação e programação de

jogos digitais aplicados no processo de aprendizagem do sistema ABO e do fator Rh, e no ensino da genética quando envolve a consanguinidade. As amostras revelaram que os modelos adotados aumentam o poder de assimilação do conteúdo, tornando as aulas mais dinâmicas ao facilitarem a abstração e contextualização, configurando-se como estratégias pedagógicas expressivas e reflexivas, permitindo a construção coletiva do conhecimento e representando fatores condicionantes no processo de ensino-aprendizagem, quando se implementam recursos metodológicos que envolvem a genética, o sistema ABO e o fator Rh como informações atualizadas no processo de ensino-aprendizagem.

Palavras-chave: Ensino de Biologia, metodologias ativas, sequências didáticas, sistema ABO e o fator Rh

Resumen

La adopción de modelos didácticos en la enseñanza del sistema ABO y del factor Rh es una alternativa para reducir las dificultades encontradas por los alumnos en el proceso de aprendizaje. El objetivo de este estudio fue reunir información actualizada, describiendo los tipos de modelos didácticos y asociando los factores condicionantes que contribuyen al proceso de enseñanza-aprendizaje del sistema ABO y del factor Rh. Se trata de una revisión de alcance, realizada siguiendo las recomendaciones de la extensión para revisiones de alcance de los Elementos de Información Preferidos para Revisiones Sistemáticas y Metaanálisis (PRISMA-ScR). La pregunta guía del estudio se construyó utilizando la estrategia PCC (población, concepto y contexto) y las búsquedas realizadas en la plataforma Dimensions, dando como resultado 289 artículos, de los cuales 8 muestras fueron elegibles para el análisis. Se verificó el uso de modelos didácticos elaborados con materiales reciclables, la construcción de historietas (HQs), así como la implementación y programación de juegos digitales aplicados al proceso de aprendizaje del sistema ABO y del factor Rh, y a la enseñanza de la genética cuando involucra la consanguinidad. Las muestras revelaron que los modelos adoptados aumentan el poder de asimilación del contenido, dinamizando las clases al facilitar la abstracción y la contextualización, configurándose como estrategias pedagógicas expresivas y reflexivas, permitiendo la construcción colectiva del conocimiento, representando condicionantes en el proceso de enseñanza-aprendizaje, cuando se implementan recursos metodológicos que involucran la genética, el sistema ABO y el factor Rh, como información actualizada en el proceso de enseñanza-aprendizaje.

Palabras clave: Enseñanza de la Biología, metodologías activas, secuencias didácticas, sistema ABO y factor Rh

Introduction

The ABO system and the Rh factor represent great clinical interest due to their relevance in the performance of blood transfusions, with antibodies involved in erythrocyte destruction and in organ and tissue transplants, in addition to preventing hemolytic disease of the newborn in humans (Nussbaum et al., 2008). In addition, they are widely used in studies that address the Natural Sciences tests, in the National High School Exam, in college entrance exams, and exams for public positions (Souza, 2019).

Genetics and molecular biology constitute a branch of Biology whose object is the study of distinct phenomena (Alberts et al., 2017). As with a blood transfusion, it is necessary to perform pre-transfusion tests, which end up being part of the topics to be

addressed by the teacher in the classroom. Often, this requires methodological adaptation on the part of the teacher to attract the attention of students and, simultaneously, arouse interest in the topic, in order to make the learning of this content more dynamic and with the lowest possible degree of difficulty (Farias et al., 2021).

The teaching of Sciences, in recent years, has presented approaches related to the ABO system and the Rh factor in a more comprehensive way, allowing connections between the areas of knowledge, whose concepts are developed, worked on and focused exclusively on the area of Natural Sciences, which make the student develop a vision connected with biological systems (Viliczinski, 2017). This means that it is pertinent to apply it through activities that promote the formation of students in a more integrated way, creating conditions for cognitive development based on learning that is more contextualized and aligned with the students' context (Santana, 2021).

Mostly, the content about the ABO system and the Rh factor are taught in the traditional way, which is limited to what is found in books and other materials available, such as booklets (Silva, 2020). As it is a subject that has a large number of concepts, which are also related to the content of genetics, this aspect has required great capacity for abstraction on the part of the students to fully understand and interpret the content worked in the classroom (Temp & Bartholomei-Santos; 2015).

The use of didactic models made with colored recyclable materials, which integrate three-dimensional, semi-plane structures and, lately, the use of educational technological resources in the creation of comic books, which can be used as a didactic sequence (DS), enables practical interaction with the materials by students and teachers and facilitates the observation of the content in the classroom, allowing the complementation of the theoretical learning by identifying, from different angles, the components of the blood system covered during the classes (Orlando et al., 2009).

Aguiar et al. (2024) state that, by employing didactic models as a methodological resource in embryology content, a significant contribution is observed in the understanding of complex themes, favoring both problem-solving and the establishment of relationships between the structures represented in the models. In addition, this strategy encourages collaborative integration between students and teachers, promoting engaging participation in the learning process.

Similarly, Luz et al. (2018) highlight that practical classes mediated by didactic models make the content more interactive, motivating, and articulated to the educational context of the students, contributing to the effective assimilation of knowledge. Furthermore, these strategies favor the improvement of teacher performance and the consolidation of pedagogical practices through the use of these models.

The adoption of the didactic-pedagogical resources helps in the memorization of specific content involving genetics, the ABO system and the Rh factor, and allows students to develop skills that define the concepts, as well as their purpose and importance for the human body, especially in the continuity of the learning process, due to the assimilation of topics that are difficult to absorb (Bacich, 2018).

Given this, and thinking about the contextualization of the topic in the context of teaching-learning in Biology, this study aimed to gather updated information, describing the types of didactic models and associating the conditioning factors that contribute to the teaching-learning process of the ABO system and the Rh factor.

Methodology

The present study is a qualitative scoping review, whose objective is to map important conceptions of an area of knowledge, as well as to investigate the magnitude, extent and nature, synthesizing and disseminating the results found in order to highlight gaps that make it possible to expand knowledge — especially in the field of Biology teaching (Arksey, 2005).

The study was conducted following the recommendations of the *Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews* (PRISMA-ScR), based on the checklist (Tricco et al., 2018). The guiding question of the study was developed through the PCC strategy, described below:

- P (Population): igh school students;
- C (Concept): studies that address the didactic models in the teaching of the ABO system and the Rh factor;
- C (Context): didactic models in the teaching-learning process.

Thus, the study was guided by the following question: *Does the use of didactic models contribute to the teaching-learning process of the ABO system and the Rh factor for high school students?*

The study was based on the *Dimensions platform*, as it is a database that brings together an extensive set of research information published worldwide.

From the following descriptors: *science teaching* OR *Rh factor teaching* OR *didactic sequences* OR *high school* OR *ABO system teaching* OR *teaching with comics* OR *ABO system* OR *Rh factor* OR *DSs* OR *active learning* OR *comics* AND *comic books*, it was possible to identify the studies to be included in the research.

Considered relevant productions for inclusion, scientific articles and other studies available in the gray literature were appreciated, which had their conclusions with outcomes on the use of didactic models in the teaching-learning process of the ABO system and the Rh factor, answering the study's guiding question.

The studies were exported to *Rayyan*, which is a web application used primarily to aid in systematic review and meta-analysis research (Ouzzani et al., 2016), and independently selected by two reviewers. The identification, selection, and inclusion stages comprised the period between March and April 2024. All those that evaluated the use of didactic models in the teaching of the ABO system and the Rh factor were included, with no restrictions on the follow-up time and location of the studies, and preprints, case reports, narrative reviews, and conference proceedings were excluded.

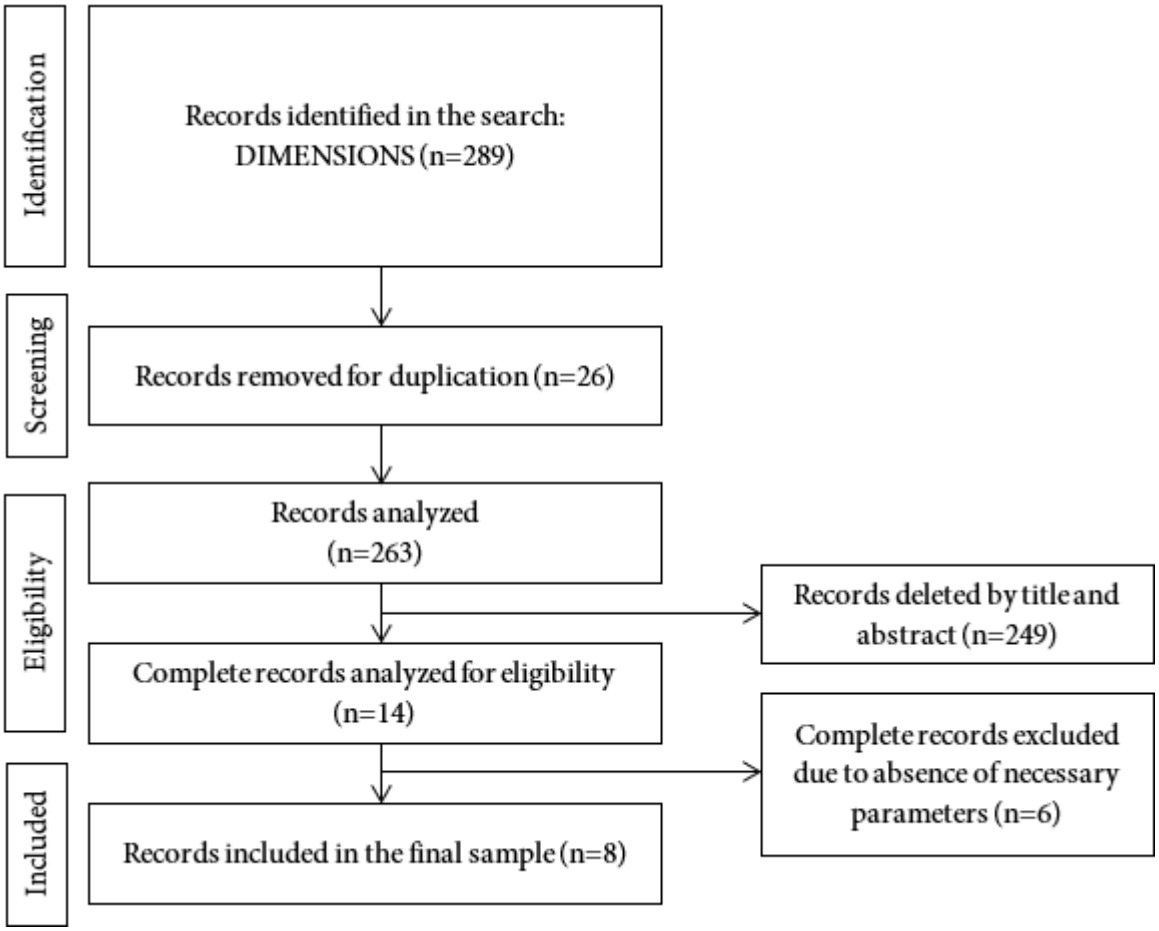
In the descriptive analysis and for the characterization and presentation of the results, tables and graphs were used. As this was a study that did not involve research with humans, there was no need to submit it for evaluation by the Research Ethics Committee, as it complies with CNS Resolution 466/2012, guaranteeing the ethical principles in force.

Results

A total of 289 studies were found and, with the help of *Rayyan*, 26 duplicates were removed, leaving 263 articles for analysis and selection based on the reading of titles and abstracts. After applying the eligibility criteria, 249 articles were excluded because they were not relevant to the study question, leaving 14 to be read in full. After reading, 8 studies were included in the final sample, as shown in Figure 1.

Figure 1

Identification of studies through databases and records



Source: The authors.

Information was extracted, and the data were organized and ordered, including the study, type of study, title, authors, year, didactic model strategy, objectives, as well as the main results of each sample. The type of study of these samples was observational and qualitative, carried out from 2020 onwards, and addressed the use of various methodological resources as didactic sequence strategies (DSs) in the teaching-learning process, as shown in Figure 2.

Figure 2

Characteristics of the samples included in the study

Study/type	Title	Authors(year)	Didactic Model Strategy	Objectives	Main results
A1 Observational.	Modelo didático aplicado no curso de Licenciatura em Ciências Biológicas da UFR/ MT para interpretação genotípica do Tipo sanguíneo deduzido pela sequência hipotética de DNA.	Medeiros et al. (2023)	Construction of didactic models involving the relationship of data from serological tests, which allow the recognition of the phenotypes of blood types for the ABO system with the Anti-A and Anti-B reagents, in addition to another model showing a relationship of hypothetical sequences of DNA nucleotides of homologous chromosomes H1 and H2, which allow the recognition of the allele genes: I^A, I^B, i.	To present a simulation, using a didactic sequence of how the genetic variability of the erythrocyte phenotypes of the human ABO system can be identified through the process of agglutination reactions and by the method of analysis, with the use of restriction enzymes in DNA samples.	The didactic model adopted can be strategically applied as an integrating axis of themes involving genetics and molecular biology, facilitating the understanding of how the use of the restriction enzyme provides the determination of the genotypic characteristics of the blood groups of the ABO system.
A2 Observational.	Percepção de docentes de Biologia sobre o sistema sanguíneo ABO e a elaboração de modelo didático como ferramenta para o ensino-aprendizagem em Genética.	Silva et al. (2022)	Didactic model created for teaching Genetics — the ABO system blood types (AB, A, B, and O) — with representation of blood vessels (gray channel), red blood cells (cells in red), A antigens (white pins), B antigens (black pins); H antigens (headless pins), and antibodies around the cells (gray is anti-A; black is anti-B).	To know the perceptions of Biology teachers about genetics and, specifically, the theme of the ABO System, as well as to enable a didactic tool to better work on this content in the classroom.	The use of a didactic tool that facilitates the construction of knowledge related to the ABO system was approved by 92% of Biology teachers, who affirm the importance of using it during classes.

Figure 2

Characteristics of the samples included in the study (continuation)

Study/type	Title	Authors(year)	Didactic Model Strategy	Objectives	Main results
A3 Observational.	Criação e uso de materiais didáticos no ensino do sistema sanguíneo ABO.	Karasawa et al. (2022)	Representation of the ABO blood system illustrating the reaction between antibody and antigen, crossovers between A x A individuals; A x B; A x AB; A x O and B x B & B x AB; B x O; AB x AB; AB x O; O x O, through a model presented to the students.	Produce low-cost teaching material for teaching the ABO system, assess students' interest in the topic, and teachers' opinions on the use of the teaching material.	Statistical tests indicated positive results in improving interest in and understanding of the ABO system.
A4 Observational.	Utilização de uma sequência didática com metodologias ativas como proposta para o ensino de genética.	Cezana and Silva (2022)	Construction of didactic models of DNA and extraction of DNA from strawberries as an experiment to simulate the behavior of genes and chromosomes during meiosis with modeling clay and, thus, provide the construction of concept maps.	To develop and analyze a didactic sequence with active strategies for teaching Genetics, carried out with students from three classes of the 3rd year of high school in a public school in the city of Itabela/BA.	The use of alternative teaching methods can enhance the construction of knowledge regarding basic concepts related to genetics, with results that corroborate the critical competence used in objective or subjective evaluations.
A5 Qualitative.	Sequência didática para o ensino de genética: utilização de histórias em quadrinhos contextualizadas sobre o sistema ABO e o fator Rh.	Santana et al. (2021)	Elaboration of comics as contextualized DS about the ABO system and the Rh factor.	Propose a didactic sequence with the use of contextualized comics about the ABO system and the Rh factor for the teaching of genetics.	From the didactic sequence used, the content can be worked on in a playful way, using comics as a didactic resource, and taking into account everyday situations and students' previous knowledge.

Figure 2

Characteristics of the samples included in the study (continuation)

Study/type	Title	Authors(year)	Didactic Model Strategy	Objectives	Main results
A6 Qualitative.	Sequência didática para o Ensino Médio a partir da relação entre a herança dos grupos sanguíneos e o sistema imunológico.	Farias et al. (2021)	Construction of a didactic model, by the students, about blood types, involving blood donation with the simulation of blood types and the possibility or not of transfusions.	To investigate the process of a Didactic Sequence (DS) in the teaching and learning of Biology content about blood systems and their relations with the immune system in high school.	The activities proposed through DS allowed students to participate more actively in each moment, through questions, arguments, and reflections on the problems pointed out, fostering the stimulation and construction of knowledge. The less theoretical and more playful activities pleased most students, since they provide more proximity to the content and make them more active in the process of conceptual construction.
A7 Qualitative.	Proposta de jogo didático para ensino de genética como metodologia ativa no ensino de Biologia.	Carvalho et al. (2021)	Construction of a didactic game with the determination of genetic profiles used with students of the 3rd year of high school.	To present whether the systematization of a game, created and evaluated for the study, can contribute to increasing students' knowledge of genetics.	The game stimulated the development of important skills and competencies that cannot be measured and/or quantified through the test performed by the students. And the use of teaching support tools by teachers can make teaching more attractive and interesting.

Figure 2

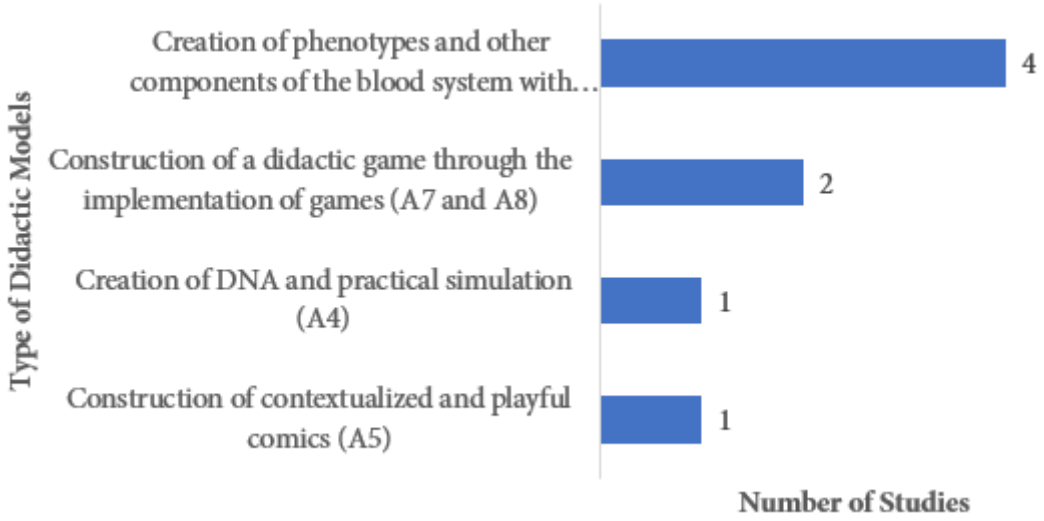
Characteristics of the samples included in the study (continuation)

Study/type	Title	Authors(year)	Didactic Model Strategy	Objectives	Main results
A8 Observational.	Contribuições da Construção de Jogos Digitais para o Ensino de Genética.	Marin and Vinholi Júnior (2020)	Construction of an electronic didactic game as instructional material to be used in the teaching of the ABO system and the Rh factor.	To analyze the contributions of the elaboration and construction of digital games, by the students themselves, to the assimilation of concepts of Genetics, blood systems subunit, using as theoretical and methodological framework the assumptions of David Ausubel's Theory of Meaningful Learning.	The tool used was configured as a favorable strategy, because the investigated class belongs to the technical course, which presents a technological axis, and allows pointing out a relevance in the evolution of the understanding of concepts related to the genetics of blood systems.

With the characterization of the articles, it was possible to observe the main methodological resources used as didactic models in the samples, which evidenced the results obtained in the investigations. The description of the strategies applied by each proposal in the teaching-learning process was also verified, as illustrated in Figure 3.

Figure 3

Characteristics of the methodologies used and distributed by samples



Source: The authors.

The samples prioritized the analysis of the events and behavior of the students involved with the application of different didactic models, including DSs, verifying a high degree of approval by the participants when compared to other theoretical methods previously adopted as the only methodological resource in the teaching-learning process.

It was evidenced the use of didactic models made with recyclable materials, the construction of comics as a form of entertainment, in addition to the implementation and programming of digital games, which were used as DSs, contributing significantly to the learning process of the ABO system and the Rh factor, as well as to the teaching of genetics, especially when it involves the concepts addressed in the blood system, cooperating effectively for the assimilation of the content by the students.

As conditioning factors in the teaching-learning process, the samples revealed the behavior of the students in the face of the new didactic strategies used in the understanding of the subject, which included models made with recyclable materials, the construction of comics, in addition to the implementation and programming of digital games as an instructional method. Such resources make classes more dynamic by allowing active participation, which is essential in the teaching-learning process, in addition to improving teaching practices in the classroom, providing satisfactory results for both those who study the topic and those who teach it.

It was evidenced that the updated information about the teaching-learning process of the ABO system and the Rh factor, using models based on recyclable materials in practical classes — such as the making of components of the blood system, the extraction of strawberry DNA, digital games, and comics —, studied in the final years of high school, with knowledge linked to Genetics, also address the study of hereditary factors. This has led to new forms of teaching, since the existence and implementation of methodological resources that integrate genetic content into the work with the ABO system and the Rh factor is observed, as reported in most of the samples. Such an approach enhances the results in the study of consanguinity, often explored in the teaching of genetics.

Discussion

The methodological application of the samples, through didactic models, is substantially favorable in practical activities. According to Souto et al. (2015), this type of activity provides students with the acquisition of skills by formulating their own ideas through the investigation of certain situations, allowing them to resort to knowledge acquired during the methodological course of the subject. This favors the development of learning in a participatory way and, through the elaboration of questions or the formulation of hypotheses, also allows students to analyze their own results.

For Orlando et al. (2009), the use of models that integrate three-dimensional structures and colors related to the components of the system studied makes learning easier due to the familiarization, complementing the content studied, even when they are verified in textbooks. Souto et al. (2015) characterize this proposal as significant, as it enables the development of views and knowledge on the topic, which does not occur when the practical activity is limited to situations that, unlike the didactic models mentioned and used as DSs, require only the repetition of steps as a way to obtain the results expected.

The samples A1, A2, A3, and A6 strategically addressed the use of each model made with different types of materials, which evidenced investigative learning, obtaining positive results in the teaching process. For Teotonio et al. (2019), the modality adopted as investigative practices deals with situations that enable the monitoring and follow-up of learning, making teaching focused on investigative practices associated with problematizing situations of everyday life, allow, in addition to the assimilation of the content studied, the development of mastery over the theme, supporting the student to deal with understandable and questionable information that are reflected in situations beneficial to the student.

The samples A7 and A8 emphasize the construction of didactic games centered on the theme, which stimulate the development of new skills and the interest in investigating the content addressed during the game. According to Messeder Neto (2019), the potential found in didactic games has the power to aid in the assimilation or review of content, favoring the students' understanding of the topic they have not yet observed, and creating conditions for mastering the information through the development of strategies that the games enable.

In this perspective, Oliveira et al. (2021) state that the didactic game, as a playful resource, used by samples A7 and A8, enhances the development of principles in students by facilitating the interpretation of more complex and easily accessible topics. For Melo et al. (2017), another relevant point in learning through these resources occurs when students visibly feel satisfied using them, which tends to arouse interest and determination to learn the topic. This means that when students are motivated by the didactic strategy, they can more easily assimilate the topics and situations of everyday life.

Sample A4 adopted as an active methodology the construction of a didactic model of DNA as a proposal in the teaching of genetics, highlighting the simulation of the transmission of characters and the behavior of genes, in addition to the extraction of DNA from strawberries carried out by the students, according to stages of the study that enhanced the construction of knowledge. For Giacomini and Muenchen (2015), activities such as this type of methodology enable students to become capable of employing knowledge, focusing on the articulation and scientific conceptualization of real situations experienced, such as DNA extraction. This didactic makes the teacher return to the initial questioning, presented in the first stage of the DS.

Sample A5 highlights a model based on the construction of comics that can work on the theme through playful activity. According to Souza et al. (2020), the use of this methodological resource provides the deepening of the content, modalizing teaching, as it consists of an activity that places the student at the center of the construction of knowledge, awakening reflection and creativity. For Xavier (2017), comics can achieve both an instructive and educational effect, which, for Souza, Miranda, and Coelho (2020), are great sources of fun.

Samples A1, A2, A3, A4, and A6 indicate that the use of didactic models equipped with the relationship of data that make up the ABO system and the Rh factor, or that also address the content of genetics in order to improve knowledge about these topics, make the classes more concrete, which, according to Souza (2007), allows the approximation with practice, aiming to increase the students' power of assimilation, in addition to having a greater probability of absorbing the content in the learning process, enhancing the construction of knowledge with less theoretical and more playful activities and, thus, providing greater participation of students during classes.

In this perspective, Neves (2015) states that, unlike the concrete concepts, in the studies of abstract concepts, it is common for individuals to express erroneous ideas about the scientific view. For Souza (2007), a well-conducted proposal involving the adoption of models, which incorporate strategies that integrate dynamic, practical, and interactive activities, enhances the DS, making it more interactive and engaging for the student, thereby enabling better learning.

Even with the effectiveness evidenced by the didactic models, it is relevant to highlight that the absence of further studies involving the use of different methodological resources in these topipcs for high school students limits the results of the research, because, with the technological advances provided by Information and Communication Technologies (ICTs) in the last decade — and evidenced in sample A8, which analyzed the contributions of the elaboration and construction of digital games in the teaching of the ABO system and the Rh factor —, can further enhance teaching and learning.

Thus, the need for more studies focused on new methodological resources, aligned with the use of didactic models, is reinforced, in order to bring greater approaches when working on this theme in the teaching of Biology and to implement strategies that enable students to understand the importance of learning about the ABO system and the Rh factor in blood donation and the relationships involving transplants in general, providing knowledge in practice of situations to strengthen learning and student autonomy.

Final Thoughts

The analyses of this review confirm significant advances in the teaching-learning process of the content associated with the ABO system and the Rh factor. The findings reveal that the didactic models, when applied in pedagogical practices, contribute significantly to the abstract understanding of the content, in addition to favoring their connection with practical experiences, such as the concepts of antigens, antibodies, blood compatibility, and heredity. Such practices establish links between scientific knowledge and concrete situations, promoting the creation of participatory and collaborative learning environments between students and teachers.

The analysis of the samples evidences the effectiveness of didactic models in the mediation of content with high conceptual complexity. Considering the identified variables, it is observed that the implementation of methodologies aimed at the construction of conceptual representations of the components of the blood system enables the transition from concrete to symbolic thinking in a more systematic and structured way.

The practical classes involving the ABO system, the Rh factor, and genetic concepts are configured as expressive and reflective pedagogical strategies because they integrate theory and practice. These approaches favor the contextualization of content, promote student engagement, and enable the active appropriation of concepts, strengthening meaningful learning. In addition, they enable simulations with the use of innovative didactic resources, enriching the training process.

On the other hand, expository classes are fundamental to introduce the concepts before exploring, in practice, the complex content in an organized way, because the joint use in the teaching of these topics allows students to build their learning without the need for another didactic modality, different from the model adopted in the samples, thus making a solid base of knowledge and resolution of exercises.

The adoption of didactic models brings improvements for most teachers who use some of the methodological resources, as seen in the samples, by innovating the teaching-learning process. It is noticeable how students evolve in their understanding of the content through the methodological resources that enhance learning, as they allow participation in the pursuit of a deeper understanding of the content studied.

The results show that these models facilitate the absorption of the content, providing opportunities for discussions and simulations that assimilate the relationships of kinship and heredity, seen in the processes of blood transfusions and in the relationship of genetics with the ABO system and the Rh factor, revealing themselves as valuable strategies in this process.

Furthermore, classroom discussions stimulate the active participation of students, favoring critical reflection and the collective construction of knowledge, especially when they make direct observations that enrich learning and make them more experienced, because, at the same time that they carry out simulations, they challenge the investigative side to face problematic scenarios that provide critical analysis and the practical application of the concepts studied.

Although this review identified consistent evidence on the application of didactic strategies that positively influence the teaching of the ABO system and the Rh factor, the corpus of analysis was predominantly composed of qualitative and descriptive studies. This characteristic may restrict the generalization of the findings to broader or distinct pedagogical scenarios. In addition, the heterogeneity of the methodological designs and evaluation strategies adopted in the studies limited the performance of direct comparative analyses between the effects produced by different didactic models in relation to student performance.

The significant absence of investigations that evaluate the effects of didactic models in a longitudinal perspective also imposes limitations on the results obtained, since this type of approach would be essential to assess the fixation of knowledge and the retention of complex content pertinent to the theme. In this sense, it is recommended that future research should focus on the application of expository and practical models that investigate, in an evaluative and comparative way, the various pedagogical models, especially in the contrast between active and traditional strategies in the teaching process of these topics.

Therefore, although the results of this review indicate that the use of didactic models is configured as a promising pedagogical approach for the teaching of complex content, there remains a gap to be filled concerning the theoretical and methodological deepening that supports the adoption of these practices in a more systematized way, aiming at the promotion of contextualized learning that is articulated, relating students' previous knowledge to the current demands in the teaching of Biology.

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