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ENERGY DUELS: A PLAYFUL-DIDACTIC APPROACH TO TEACHING ENERGIES IN PHYSICS

DUELOS DE ENERGIA: UMA ABORDAGEM LÚDICO-DIDÁTICA PARA O ENSINO DE ENERGIAS EM FÍSICA

DUELOS DE ENERGÍA: UN ENFOQUE LÚDICO-DIDÁCTICO PARA LA ENSEÑANZA DE LA ENERGÍA EN FÍSICA

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ABSTRACT

Teaching Physics is considered difficult and educational games are mechanisms that facilitate learning. This work describes the development and application of "Energy Duel," a didactic board game designed for teaching Physics concepts, specifically the different forms of energy derived from nature. Faced with the challenges of abstraction and students' lack of interest, the research proposes an active methodology that employs playfulness to promote more dynamic and meaningful learning. The game, originally conceived and crafted with accessible materials such as cardboard and modeling clay, is played by two pairs of students on a board with squares, including, at random, "luck" and "misfortune" spaces. The dynamic involves two types of cards: "challenge," which presents a higher level of difficulty and requires the pair to explain the energy concept on the card; and "dribble," which addresses various forms of energy (mechanical, nuclear, solar, etc.). Collectible pins provide strategic powers that can be used during the match. The practical application revealed that the game enhances engagement and collaborative interaction among students, facilitating learning in a didactic way. Results indicated that participants demonstrated greater familiarity with everyday energy sources, while more complex forms required deeper understanding.

Keywords: Physics. Board Game. Energy Sources. Active Methodology.

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RESUMO
O ensino de Física é considerado como difícil e os jogos didáticos são mecanismos facilitadores da aprendizagem. O presente trabalho descreve o desenvolvimento e a aplicação do “Duelo de Energias”, um jogo de tabuleiro didático concebido para o ensino de conceitos de Física, especificamente sobre as formas de energia provenientes da natureza. Diante dos desafios da abstração e da falta de interesse dos estudantes, a pesquisa propõe uma metodologia ativa que utiliza o lúdico para promover um aprendizado mais dinâmico e significativo. O jogo, pensado originalmente e elaborado com materiais acessíveis, como papel cartão e massa de modelar, é jogado por dois pares duplas em um tabuleiro com casas, entre elas, aleatoriamente, casas de sorte e azar. A dinâmica inclui dois tipos de cartas: "desafio" que tem um nível de dificuldade maior, a qual a dupla deve explicar o conceito da energia contida na carta; e "drible" cartas que abordam conceitos de energia (mecânica, nuclear, solar etc.), e pins colecionáveis que conferem poderes estratégicos que são utilizados durante a partida. A aplicação prática revelou que o jogo potencializa o engajamento e a interação colaborativa entre os alunos facilitando o aprendizado de forma didática. Os resultados indicaram que os participantes apresentaram maior familiaridade com energias de uso cotidiano, enquanto as energias mais complexas exigiram maior aprofundamento.

Palavras-chave: Física. Jogo de Tabuleiro. Fontes de Energias. Metodologia Ativa.

RESUMEN
La enseñanza de la física se considera difícil, y los juegos educativos son mecanismos que facilitan el aprendizaje. Este artículo describe el desarrollo y la aplicación de "Duelo de Energía", un juego de mesa educativo diseñado para enseñar conceptos de física, específicamente sobre las formas de energía presentes en la naturaleza. Ante los desafíos de la abstracción y la falta de interés de los estudiantes, la investigación propone una metodología activa que utiliza el juego para promover un aprendizaje más dinámico y significativo. El juego, originalmente concebido y creado con materiales accesibles como cartulina y plastilina, se juega con dos parejas en un tablero con casillas que incluyen, aleatoriamente, casillas de la suerte y de la mala suerte. La dinámica incluye dos tipos de cartas: "desafío", de mayor dificultad, en la que la pareja debe explicar el concepto de energía que contiene la carta; y "dribble", cartas que abordan conceptos de energía (mecánica, nuclear, solar, etc.) y pines coleccionables que otorgan poderes estratégicos que se utilizan durante el juego. La aplicación práctica reveló que el juego fomenta la participación y la interacción colaborativa entre los estudiantes, facilitando el aprendizaje de forma didáctica. Los resultados indicaron que los participantes estaban más familiarizados con las energías cotidianas, mientras que las energías más complejas requerían un estudio más profundo.

Palabras clave: Física. Juego de Mesa. Fuentes de Energía. Metodología Activa.

1 INTRODUCTION

The teaching of Physics still faces challenges related to the abstraction of concepts and the difficulty of arousing the interest of students in the classroom. Traditional methodologies, centered on the transmission of content by the teacher, often lead to mechanical and insignificant learning (Benassi; Bório; Strieder, 2021). In this scenario, didactic games emerge as methodological alternatives aligned with active methodologies, capable of making the teaching-learning process more dynamic, participatory and contextualized. In this way, by introducing playfulness in science teaching, an environment is created that stimulates motivation, social interaction and autonomy of students, favoring meaningful learning and the development of investigative skills.

Several recent studies have pointed to the potential of board games in the teaching of Physics. According to this, Coelho *et al*. (2025), when developing the "Energy Board", showed that the exploration of different forms of energy through an interactive proposal enabled greater student engagement and facilitated the assimilation of contents. In turn, Sousa (2022), in his dissertation, also verified the effectiveness of a didactic card and board game, the "Master of Matter and Energy", as a learning and evaluation resource, emphasizing its applicability in elementary school. Similarly, Quaresma, Gonçalves, and Ferreira (2023) observed that the game "Dynamis", applied to high school classes, contributed to increasing student participation, promoting both conceptual understanding and motivation in the classroom. These results reinforce that games, when planned with clear pedagogical objectives, constitute effective tools for teaching complex content, in the same way that they open space for critical reflections on sustainability and the role of renewable and non-renewable sources in contemporary society.

In this context, the present work presents the proposal of a board game about the forms of energy in nature (solar, wind, hydraulic, thermal, chemical, electrical and nuclear) elaborated as an evaluative activity, with assigned scores, and aimed at a wide audience. The objective is to combine the playful character with the pedagogical function, promoting the construction of scientific knowledge in a collaborative, investigative and motivating environment. Thus, at the same time that it allows you to review and consolidate concepts, the game also stimulates critical reflection on the different sources of energy and their impacts on society and the environment. Unlike methodologies focused on memorization, games provide an environment for experimentation and decision-making,

in which error can be reinterpreted as part of the learning process, and not just as a failure.

In addition to the development, the game was applied and submitted to an evaluation of acceptance by the participants, in order to verify aspects such as clarity of the rules, visual attractiveness, understanding of the objectives, willingness to recommend the resource and attribution of an overall score. This stage made it possible to gather complementary data to the analysis of the pedagogical potential of the proposal and to guide adjustments for its improvement.

2 METHODOLOGY

2.1 GAME CONSTRUCTION

The development of the didactic board game called Duel of Energies, which addresses the different forms of energy in nature, was carried out in stages, covering from the preparation of the material to the definition of the rules and the application proposal.

To make the game, some simple materials were used, but essential for the structure of the proposal: cardboard, cardboard, cardboard, glue, scissors and modeling clay.

This game consists of: a board; conventional six-sided numbered die; two sets of cards, called "challenge" and "dribble", in a total number of twenty-four (24); and eleven (11) "pins".

The tray (Figure 1) was made of cardboard, later glued to cardboard in order to ensure greater resistance and durability. This board is designed with 24 organized squares, including two special models that diversify the dynamics of the game.

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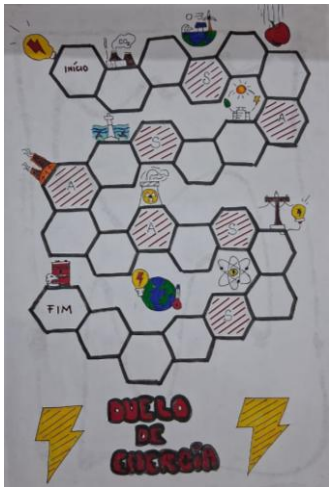
Figure 1

Game board Duel of Energies



Source: Authors (2025).

The so-called lucky squares, four in number, are distributed along the board and give the player who lands on them the benefit of advancing one square beyond the value obtained on the dice. The houses of chance, on the other hand, in number of three, impose on the pair the penalty of remaining a round without playing, which increases the degree of challenge of the match.

In addition to the board, 24 cards were made with cardboard paper in the dimension of 5.00 cm by 9.00 cm, and play an essential role in the development of the game, being divided into two sets: the "challenge" cards present the name of all the forms of energy addressed — mechanical, elastic potential, gravitational potential, nuclear, solar, wind, tidal, hydroelectric, fossil fuels, electric and geothermal — and require the pair to explain the operation and definition of each of them. The "dribble" cards, on the other hand, have a lower degree of difficulty, bringing questions related to general characteristics or everyday applications of different forms of energy. Figures 2 and 3 illustrate these sets of cards.

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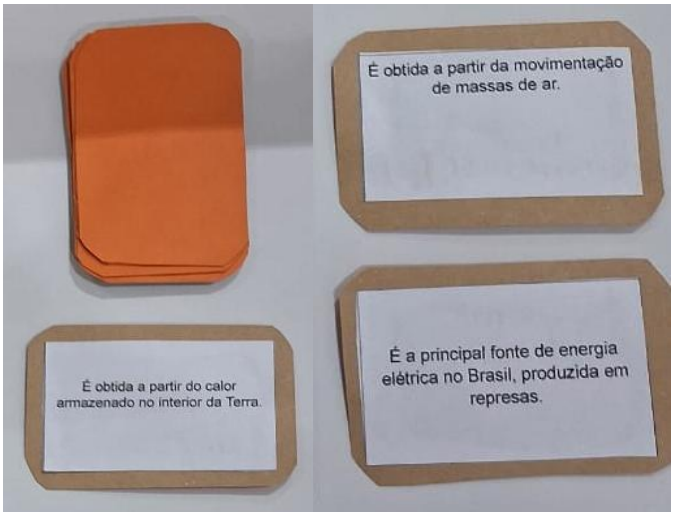
Figure 2

Dribbling cards



Source: Authors (2025).

Figure 3

"Challenge" type cards

Source: Authors (2025).

Table 1 presents examples of questions and answers to the challenge cards.

Table 1

Example of questions and answers of the challenge type cards

Kinetic Energy Track 1: It is directly related to the mass and velocity of a body. Clue 2: Appears whenever there is movement of an object. Track 3: It is the energy present in moving things, such as cars, kicked balls or downhill bicycles. **Answer:** Kinetic Energy	**Nuclear energy** Clue 1: It is released in fission or fusion reactions that involve the nucleus of atoms. Track 2: Used in power plants that produce electricity from uranium. Runway 3: It can generate a lot of energy, but it is also linked to accidents such as Chernobyl and Fukushima. **Answer:** Nuclear Energy	**Wind power** Track 1: It is obtained from the movement of air masses. Track 2: Uses wind turbines to generate electricity. Lane 3: It is the energy produced by the wind. **Answer:** Wind Energy
Gravitational Potential Energy Clue 1: It depends on the height of a body relative to a reference point and its mass. Clue 2: It is a type of stored energy that can be transformed into movement. Clue 3: An object at the top of a shelf or a stone about to fall has this type of energy. **Answer:** Gravitational Potential Energy	**Solar energy** Lane 1: It can be converted into electricity or heat through specific technologies. Track 2: Uses photovoltaic panels or thermal collectors for its use. Clue 3: It is the energy obtained from sunlight. **Answer:** Solar Energy	**Tidal Energy** Track 1: It is generated from the periodic variation of the water level in the oceans. Clue 2: It depends on the gravitational influence of the Moon and the Sun on the Earth. Lane 3: It is the energy obtained by the movement of the tides. **Answer:** Tidal Energy
Hydroelectric Power Track 1: Uses the potential energy of water stored in large reservoirs. Clue 2: The movement of water makes turbines that generate electricity rotate. Runway 3: It is the main source of electricity in Brazil, produced in dams. **Answer:** Hydroelectric Power	**Elastic Potential Energy** Clue 1: It is associated with the deformation capacity of certain materials. Clue 2: Arises when an object is stretched or compressed, accumulating energy. Clue 3: Common examples are the compressed spring and the sling pulled before releasing. **Answer:** Elastic Potential Energy	**Geothermal energy** Clue 1: It is obtained from the heat stored inside the Earth. Runway 2: Used to generate electricity and also for heating buildings or swimming pools. Track 3: It is present in regions with volcanoes, hot springs and geysers. **Answer:** Geothermal Energy

Source: Authors (2025).

Finally, the eleven (11) "pins" (Figure 4) are representative of the different forms of energy, which were elaborated using modeling clay that was later dried to ensure its

resistance. Given this, the pins served as markers of the powers and strategic elements during the match.

Figure 4

Game Pins

Source: Authors (2025).

2.2 GAME RULES

The game is played in a duel between two pairs, who take turns throwing the dice and moving around the board, and the first pair to play can be chosen by consensus by the players or by odd or even method.

Throughout the game, depending on the square on which the players land, the pair must first choose between answering a challenge or dribbling card and if they answer correctly the card they can move the pin (pin). It is important to note that the hit on a challenge card allows you to advance the total number of squares indicated by the die, while the hit on a dribbling card allows you to advance only half of the value obtained, and if the players do not get it right, they do not advance on the board.

Regarding the movement, after dribbling cards, if the dice indicate an odd number, the number of squares to be covered will always be the smallest in relation to half, for example, the dice indicate number 5, half is 2.5, the value is rounded to the smallest, that is, number 2.

Regarding the choice of challenge or dribble, if the pair rolls the number 1 when rolling the dice, the duel requires that the chosen card be the challenge, because being a small number prevents the dribbling movement.

For every two hits on challenge cards, the pair receives a pin, and there are 11 pins in all, which are representative of each form of energy and can be chosen by the duo considering that every two hits the options are the energies of the cards answered by the players. Furthermore, pins can be used strategically at any time of the match and their

respective "powers" were creatively designed according to each energy, as this can confer benefits to the pair or harm to the opponent, as described below.

In the dynamics of the game, the pins were organized into two main categories: **Benefits** and **Harms** and creatively named according to their respective energy.

In the first category, which contains six (6) pins, the following stand out:

a) **Kinetic Energy** – "Lightning Speed", which allows the pair to advance 2 additional squares;

b) **Elastic Potential Energy** – "Total Propulsion", which makes it possible to jump directly to the next lucky square;

c) **Solar Energy** – "Guiding light", whose effect is to visualize the next challenge in advance;

d) **Hydroelectric Power** – "Water Force", which grants the pair the opportunity to roll the dice twice in a row;

e) **Tidal Energy** – "Current exchange", which authorizes the exchange of position with the opposing pair on the board;

f) **Geothermal Energy** – "Internal Heat", which allows the recovery of a power already used.

In the Losses category, with five (5) pins, there are:

a) **Electrical Energy** – "Paralyzing Shock", which causes the opponent to lose his turn;

b) **Gravitational Energy** – "Extra Weight", which restricts the opponent's advance to only half of the value obtained on the die in the next turn;

c) **Nuclear Energy** – "Radioactive", which forces the disposal of a conquered power;

d) **Fossil Fuel Energy** – "Dense Smoke", which forces the opponent to go back the number of squares indicated on the dice;

e) **Wind Energy** – "Windstorm", which imposes on the opponent the retreat of 3 squares on the board. Given this, it should be noted that each pin can be used only once, so it is considered crucial that the duo strategically chooses these moments.

The power of the pin requires that it be followed completely regardless of the choice of challenge or dribble (considering the rule of moving the total number or half of the value defined by the result of the die). In addition, the pair must inform the moment they will use loss pins before the opponents roll the dice.

If the pair does not answer the challenge chosen by them, the card must be returned to the pile, and can be reused at another time.

The pair that reaches the last square on the board first wins.

2.3 PEDAGOGICAL APPLICATION

The game was designed as a playful resource to support the teaching of Science and Physics, especially in the study of forms of energy. Its application is planned for elementary and high school classes, in collective activities that encourage participation, group cooperation and active learning, since, according to Silva (2018), didactic games favor motivation and enable more meaningful learning through playfulness.

During the application, students will be divided into pairs, and the teacher's mediation will be essential to conduct the rounds, clarify doubts and reinforce the concepts covered in the cards.

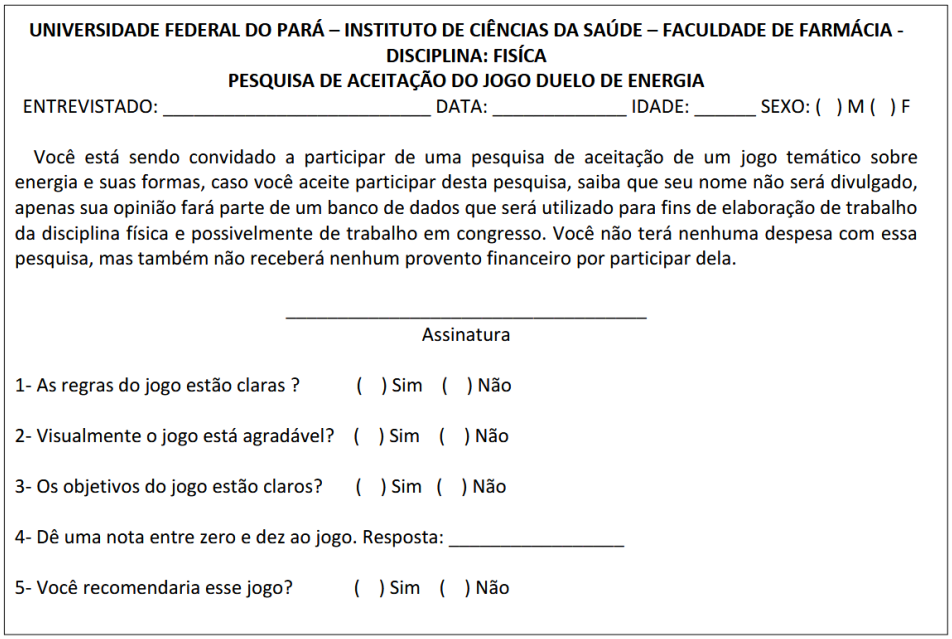
The observation of student participation, performance in the answers and involvement during the game will serve as qualitative indicators of the pedagogical effectiveness of the game. In addition to observation, it is recommended to use complementary evaluative instruments, such as perception questionnaires or conversation circles, in order to verify the contribution of the game to the fixation of the content and the motivation of the students.

2.4 GAME ACCEPTANCE ASSESSMENT

In order to evaluate the acceptance of the Energy Duel game by the students, a practical application was carried out and after participating in a game, the students answered a form prepared for this purpose, containing characterization questions (name, age and gender) and specific questions about the game (Figure 5).

Figure 5

Match evaluation sheet



UNIVERSIDADE FEDERAL DO PARÁ – INSTITUTO DE CIÊNCIAS DA SAÚDE – FACULDADE DE FARMÁCIA - DISCIPLINA: FISÍCA

PESQUISA DE ACEITAÇÃO DO JOGO DUELO DE ENERGIA

ENTREVISTADO: _____ DATA: _____ IDADE: _____ SEXO: ( ) M ( ) F

Você está sendo convidado a participar de uma pesquisa de aceitação de um jogo temático sobre energia e suas formas, caso você aceite participar desta pesquisa, saiba que seu nome não será divulgado, apenas sua opinião fará parte de um banco de dados que será utilizado para fins de elaboração de trabalho da disciplina física e possivelmente de trabalho em congresso. Você não terá nenhuma despesa com essa pesquisa, mas também não receberá nenhum provento financeiro por participar dela.

_____

Assinatura

1- As regras do jogo estão claras ? ( ) Sim ( ) Não

2- Visualmente o jogo está agradável? ( ) Sim ( ) Não

3- Os objetivos do jogo estão claros? ( ) Sim ( ) Não

4- Dê uma nota entre zero e dez ao jogo. Resposta: _____

5- Você recomendaria esse jogo? ( ) Sim ( ) Não

Source: Authors (2025).

The instrument sought to verify the clarity of the rules, visual attractiveness, perception of the objectives, willingness to recommend the game, in addition to a general evaluation on a scale of 0 to 10. In all, 30 participants answered the form, allowing quantitative and qualitative data to be obtained about the acceptance of the didactic material.

3 RESULTS AND DISCUSSION

According to Zabala (1998), educational practice should be supported by diversified methodologies that promote the active construction of knowledge by students, going beyond the simple transmission of content. In this sense, the didactic game was developed as a pedagogical resource for teaching the forms of energy, enabling participation, interaction and meaningful learning.

In addition, the author Prado (2018) states that the use of modern board games as a pedagogical resource favors meaningful and engaging learning. Considering that they stimulate pleasure, interest and self-confidence, facilitating the retention of knowledge and promoting the development of cognitive and socio-emotional skills, such as strategic reasoning, decision-making, communication and teamwork. In this way, games offer a safe environment for experimentation and error, value strategic thinking over luck, and

allow you to explore complex concepts in a playful way. In addition, they constitute a flexible and contextualized tool for teaching, as long as the teacher's mediation is intentional, guiding the selection of the game, the organization of the space and the construction of concepts (Prado, 2018).

The application of the Duel of Energies game, illustrated in Figure 6, evidenced a high level of interaction and engagement on the part of the participants. According to Santos dos Santos and Menezes (2024), the pair format encourages cooperation and the exchange of ideas, making the dynamics more collaborative and favoring the development of social skills, such as dialogue, respect for colleagues' strategies, and teamwork.

Figure 6

Moment of application of the game in the test class

Source: Authors (2025).

Torres and Pereira (2024) observed that questions related to forms of energy that are more present in everyday life, such as electrical, solar, mechanical, kinetic, and hydroelectric, were answered more easily by students, which demonstrates familiarity with concepts linked to practical situations, often addressed in the school curriculum and in personal experiences.

On the other hand, Silva and Pereira (2020) highlight that questions that address less common energies in everyday life or of greater theoretical complexity, such as nuclear, geothermal, gravitational potential, tidal potential, and fossil fuels, are more difficult to answer. This result suggests the need for greater conceptual depth of these contents, which, although relevant, usually receive less emphasis in traditional classes.

In addition, Silva and Pereira (2020) and also Torres and Pereira (2024) point out that the use of the "challenge" and "dribble" cards contributed to balancing the level of difficulty of the questions, allowing students to move between simple and complex questions. Energy pins, on the other hand, by introducing elements of strategy and surprise, increased the involvement and motivation of the participants, who showed enthusiasm in applying the advantages and disadvantages throughout the game.

Regarding the evaluation carried out by the thirty evaluators of the game, 20 (66.67 %) were female, aged between 18 and 53 years, with a mean age of 23.4 years and age profile given in Table 2.

Table 2

Age profile of the evaluators

Age group (year)	Frequency	Percentage
18–22	20	66,67
23–27	5	16,67
28–32	2	6,67
33–37	2	6,67
38–42	0	0,00
43–47	0	0,00
48–53	1	3,33
Total	**30**	**100,00**

Source: Authors (2025).

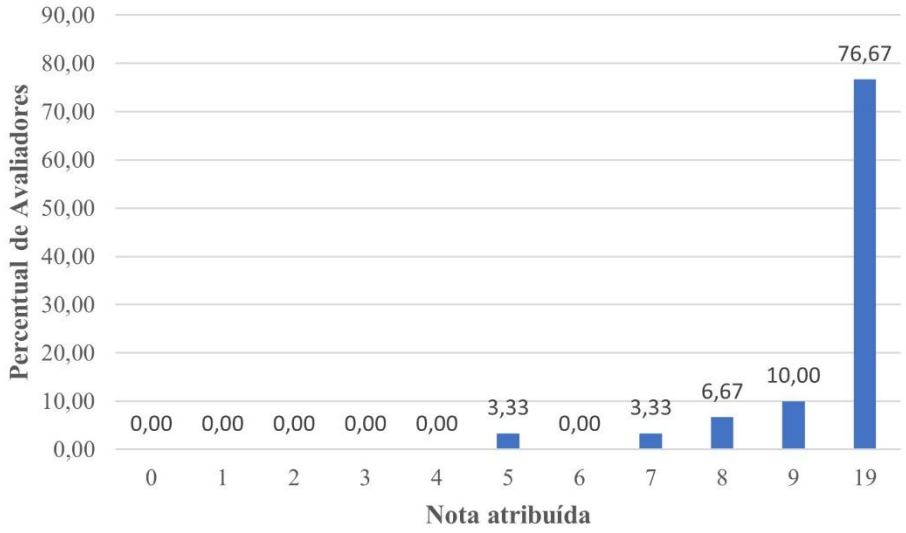
All thirty (30) evaluators answered that yes, the rules of the game are clear and that yes, the objectives of the game are clear. In this way, the game can be considered as easy to understand and execute, which is very important for a didactic game, because the lack of understanding of its rules and objectives can lead to problems in the classroom, during the application of this didactic resource, compromising its pedagogical validity.

In terms of the visual aspect of the game, all the reviewers considered that the game presents a good visual aspect and as to whether they would recommend the game to anyone, they all stated that they would.

When asked to assign a score for the playful activity (game) developed, the evaluators assigned scores between five (5) and ten (10), with an average of 9.5, and the grade profile is shown in Figure 7.

Figure 7

Grade Distribution Profile



Source: Authors (2025).

This result shows the high acceptance of the proposal and reinforces the perception that the methodology used is attractive, engaging and effective for educational purposes, a result similar to that found by das Dores *et al*. (2025), which elaborates a didactic game for teaching Analytical Chemistry in a Pharmaceutical Analysis class, and by Coelho *et al.* (2025) that developed a didactic game about energy to be applied in an introductory discipline of Physics in a class of pharmacy students.

In general, Santos dos Santos and Menezes (2024) confirm that the playful character of the board, combined with the competitive-collaborative format, enhances active learning. The game promotes not only the fixation of scientific concepts, but also the development of cognitive skills, such as logical reasoning, critical thinking and decision-making, evidencing its effectiveness as an innovative didactic resource, capable of bringing theory and practice together in a dynamic and meaningful way.

4 CONCLUSION

This study demonstrated the effectiveness of the didactic game **"**Duel of Energies**"** as an innovative tool for teaching Physics. By facing the challenges of abstraction and demotivation of students, the work proposed an approach aligned with active methodologies, aligning playfulness as a potential catalyst for meaningful learning.

The results of the application of the game showed that, in addition to promoting the fixation of scientific concepts, the collaborative and competitive dynamics of the "Duel of Energies" contributes to the development of social cognitive skills. The ability to think logically, make strategic decisions and teamwork are improved in a playful and safe environment during the games played.

In short, this work reinforces the importance of rethinking teaching methodologies, showing that the integration of playful and interactive resources can transform the classroom into a more engaging and productive space. The "Duel of Energies" presents itself as a pedagogical model in which, according to the evaluation criterion, it obtains a high level of acceptance from the participants. In addition, it illustrates how theory and practice can come together to form students who are more critical, autonomous, and motivated to learn.

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