Exploring elements: Playfulness as an ally in teaching the Periodic Table

https://doi.org/10.56238/sevened2024.009-013

Thainar Lopes Lobo[1], Tainara Campos Vieira[2], Charles Alberto Brito Negrão[3], Waleria Magno Rodrigues[4], Vitória Caroline de Souza Martins[5], João Pedro dos Reis Lima[6], Marcos William Leão de Araújo[7], Samantha Siqueira Pantoja[8], Silvia Helena da Silva e Souza[9], Ewerton Carvalho de Souza[10] and Antonio dos Santos Silva[11]

ABSTRACT

Chemistry teaching is often seen as difficult and unattractive to students, mainly because it deals with many abstract concepts that are worked through traditional teaching methodologies that do not place students as subjects of their learning. This work explores the potential transformation of the learning environment and increasing the quality of education by incorporating playfulness, through educational games and interactive simulations in the teaching of Chemistry, especially the Periodic Table. The approach promotes practical and contextualized understanding, connecting abstract concepts to everyday situations and makes learning enjoyable. This pedagogical change contributes to training students with a scientific and curious mindset. This work presents the game entitled "Elementar: War of the Atomic Clans", which is a card game inspired by RPG, designed to familiarize students with chemical elements using the Periodic Table. The careful elaboration of the letters, using low-cost materials and computational resources, highlights the importance of creativity and interdisciplinary collaboration in education, contributing to a more solid and meaningful education.

Keywords: Teaching Methods, Didactic Games, Teaching-Learning.

[1] Pharmacy graduate
Federal University of Pará
[2] Pharmacy graduate
Federal University of Pará
[3] Doctor in Chemistry
Federal University of Pará
[4] Pharmacy graduate
Federal University of Pará
[5] Pharmacy graduate
Federal University of Pará
[6] Pharmacy graduate
Federal University of Pará
[7] Pharmacy graduate
Federal University of Pará
[8] Doctor in Chemistry
Federal University of Pará
[9] Master of Teaching in Science and Mathematics Education
State Department of Education of Pará
[10] Doctor in Chemistry
Federal Rural University of the Amazon
[11] Doctor in Chemistry
Federal University of Pará

INTRODUCTION

The teaching of chemistry in schools plays a crucial role in the academic training and construction of students' scientific knowledge. However, it faces significant challenges that can impact the quality of learning. Difficulties are often related to the complexity of the discipline, the lack of adequate resources, insufficient teacher training and the traditional approach used in many institutions. The difficulty is also perceived in the lack of connection between the abstract concepts of chemistry and the students' everyday reality. [1]

One of the main difficulties is the negative perception that students have of chemistry, often associated with a difficult subject. Excessive theoretical approach and lack of practical experimentation can contribute to a lack of interest and understanding on the part of students. [2] Furthermore, the lack of well-equipped laboratories and the scarcity of innovative teaching materials limit more dynamic and participatory learning opportunities. [3]

The traditional approach, often marked by expository classes and dense content, can distance students from understanding chemical principles. [4] By introducing playful elements, such as educational games, interactive simulations and practical activities, it is possible to transform the learning environment, making it more engaging and accessible. [5]

Play provides opportunities to illustrate these relationships in a tangible and stimulating way, allowing students to visualize and experience chemical principles in a more tangible way. Games that explore compound formation and hands-on classroom experiments can spark student interest and promote a deeper understanding of concepts. [6]

Educators can transform the classroom into a dynamic environment where students become active participants in the learning process. This develops skills such as teamwork, critical thinking and problem solving. Playfulness breaks the monotony of conventional classes, and creates a space conducive to exploration, discovery and curiosity, fundamental to the development of a scientific mindset. [5]

In short, by recognizing the potential of play as a facilitating tool in chemistry teaching, we can transform not only the way students absorb knowledge, but also the way they perceive and relate to the discipline. Incorporating playfulness is more than a pedagogical strategy; is an invitation for students to discover the fascinating journey of chemistry in an engaging, interactive and, above all, fun way. [7]

Considering the above, it was proposed to create a didactic game aimed at teaching Chemistry, focusing on concepts related to chemical elements and the periodic table. The conception of this game took place through the use of accessible, low-cost materials and computational resources to design the game pieces.

FUN AND TEACHING THE PERIODIC TABLE

The word “ludic” has its origins in the Latin term *ludus* which means game, [8] but, in educational terms, it is necessary to be careful with the pure and simple meaning of the word, as, in its original conception, it refers only to the act of playing, when playing, when moving spontaneously, however, one must seek to go far beyond this original concept of playfulness, and thinking that the game, in educational terms, is a voluntary practice or occupation, carried out within certain and determined limits, following rules that were freely agreed upon, but of a mandatory nature, with a purpose that is accompanied by tension and joy, in addition to being different from what happens on a daily basis. [8,9] However, it is necessary to highlight that “drawing a definition for a game is difficult, and we can say that there is no closed definition on the subject.” [10]

The use of play as a didactic strategy in teaching the periodic table represents an innovative and effective approach to engaging students in a more active and participatory way in the learning process. The game, which involves games, practical activities and interactive dynamics, provides an environment conducive to the absorption of complex concepts, such as chemical elements and their properties, in a more relaxed and accessible way. [4]

By incorporating educational games such as puzzles, [11] chemistry bingo, [12] roulette [13] or even themed board or card games, [14] educators can turn assimilating the periodic table into a fun and challenging experience. Likewise, assigning fictional personalities to the elements and creating stories that explore their interactions can humanize the Periodic Table. [15] These approaches not only make learning more enjoyable and memorable, but also encourage understanding of the properties and relationships between elements, and collaboration among students, promoting teamwork and the exchange of knowledge. [12]

The games allow for a more practical and contextualized understanding of chemical elements, as students can associate the abstract concepts of the periodic table with everyday situations. This connection between theory and practice facilitates knowledge retention, as students are able to visualize the real application of the elements in their lives. [16]

Another benefit of the playful approach is the intrinsic motivation it provides. By transforming learning into a pleasurable activity, students become more engaged and interested in the content, developing a proactive attitude towards chemistry studies. This pedagogical approach contributes to the formation of more critical and autonomous students, preparing them to face scientific challenges with a curious mindset. [17]

This didactic strategy for teaching the periodic table represents a valuable alternative to overcoming traditional learning barriers. By making education more dynamic, interactive and contextualized, educators can not only facilitate the understanding of chemical concepts, but also awaken students' lasting interest in science, contributing to a more solid and meaningful education. [15]

There are four criteria to be followed when choosing a game to be applied in class, so that such playful activity can guarantee the essence of the game and the educational process. [8, 18] Such criteria are:

I) Experimental value, which leads the student to explore and manipulate, and in this way, teaches chemical concepts through the manipulation of some type of toy, space or action;

II) Structuring value, which corresponds to freedom of action following specific rules, which supports the structuring of personality that appears in strategies developed by the student and in the way of playing;

III) Relationship value, which corresponds to the ways of relating to the environment and other human beings (social interaction);

IV) Playful value, which assesses whether the objectives have the qualities that encourage the appearance of playful action.

Another point to be considered when considering using educational games in class is that four very important precautions must be observed, the first of which is the prior testing of the teaching resource to avoid unpleasant surprises when implementing it in class. The second precaution to take is to carry out a brief summary of the content to be worked on through the playful activity, as this content must have already been worked on and must be reviewed before applying the activity, to make better use of the resource used. Thirdly, the need to check the rules with students stands out, so that they can clearly understand the activity. And finally, the fourth precaution would be the development of subsequent pedagogical activities related to the activity to investigate the value of the playful activity as a teaching tool, that is, evaluation of the activity developed. [19]

METHODOLOGY

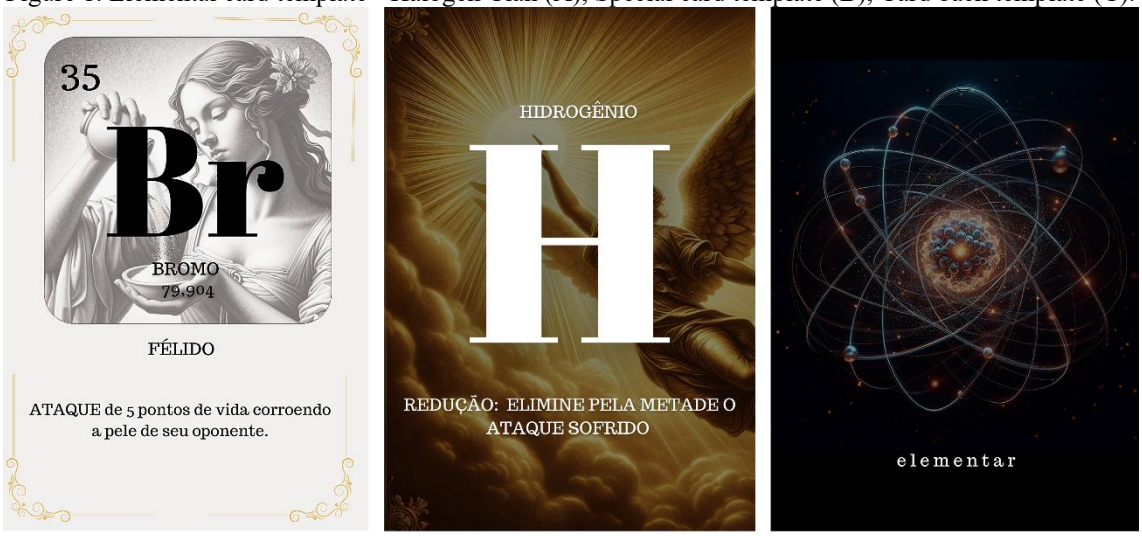
The game "Elementary: War of the Atomic Clans" was designed as a card game inspired by the RPG style, using the Periodic Table to familiarize players with the chemical elements, their names, symbols and families to which they belong. The preparation of the letters involved several steps and specific materials (photographic paper sheets; paper glue; scissors; printer; transparent adhesive paper).

The aforementioned didactic game was created by a team of students from an introductory chemistry discipline, belonging to the curricular matrix of the bachelor's degree course in pharmacy, at the Federal University of Pará (UFPA), located in the North of Brazil, in the Amazon, as a mechanism for review of content related to high school, more specifically, the periodic table, chemical elements, symbols and properties, with all work supervised by the subject teachers.

PREPARATION OF LETTERS

The cards were designed using the Canva program to create the model for the Clan cards (Figure 1), which were sized with a length of 9.5 cm and a width of 7.0 cm, using use simple scissors for your cutting.

Figure 1. Elemental card template - Halogen Clan (A), Special card template (B), Card back template (C).



(A) (B) (C)

Each of the clan cards created represents a different chemical element (Figure 1A), so 118 cards were created. Some information was included in these cards: name of the element, chemical symbol, atomic mass, atomic number, game name related to etymology, characteristic or history. Furthermore, each card was assigned a role in the game, among the following four: attack; defense; rare; restoration (Table 1). These functions will be described in the game rules.

Table 1 . Cards and their functions within the game

Type of Letter	Function or Game Action
Attack	Causes damage to the opponent.
Defense	Eliminate half or total of the attack suffered.
Restorations	They restore a specific amount of lost points.
Rare	You can assign the card any function you want, as long as this function is one of the functions of the specific card's clan.

A color code was also created for each clan to which the card belongs, according to the family of the chemical element (Table 2).

Table 2 . Game card color coding

Clan	Color	Elements belonging to the clan
Boro family	Dark green	Boron (B); Aluminum (Al); Gallium (Ga); Indian (In); Thallium (Tl) and Nohônio (Nh)
Carbon Family	Purple	Carbon (C); Silicon (Si); Germanium (Ge); Tin (Sb); Bismuth (Bi); Lead (Pb) and Flerovium (Fl)
Alkali Metals	Red	Lithium (Li); Sodium (Na); Potassium (K); Rubidium (Rb); Cesium (Cs); Francium (Fr) and Hydrogen (H).
Alkaline Earth Metals	Gray	Barium (Ba); Calcium (Ca); Magnesium (Mg); Strontium (Sr); Beryllium (Be) and Radium (Ra)
Noble Gas	Orange	Helium (He); Neon (Ne); Xenon (Xe); Argon (Ar); Radon (Rn); Tenesso (Ts) and Krypton (Kr)
Transition Metals	Blue	Chromium (Cr); Zinc (Zn); Iron (Fe); Manganese (Mn); Copper (Cu); Nickel (Ni); Silver (Ag); Platinum (Pt); Gold (Au); Mercury (Hg); Cobalt (Co); Molybdenum (Mo); Titanium (Ti) etc.
Halogens	White	Fluorine (F); Bromine (Br); Chlorine (Cl); Astatine (At) and Iodine (I)
Chalcogens	Black	Oxygen (O); Sulfur (S); Selenium (Se); Polonium (Po); Livermorium (Lv) and Tellurium (Te)

A background image for each of the cards was generated by AI Bing, with this image referring to the characteristics of the Periodic Table family for each clan. As for the special cards, a different model was created for them, including the name of the element, chemical symbol, function and a representative background image (Figure 1B). The back of the card also received an illustrative figure (Figure 1C).

In Figures 2, 3, 4 and 5 other examples of created cards are presented.

Figure 2 . Examples of letters of elements belonging to the Chalcogen family (16)

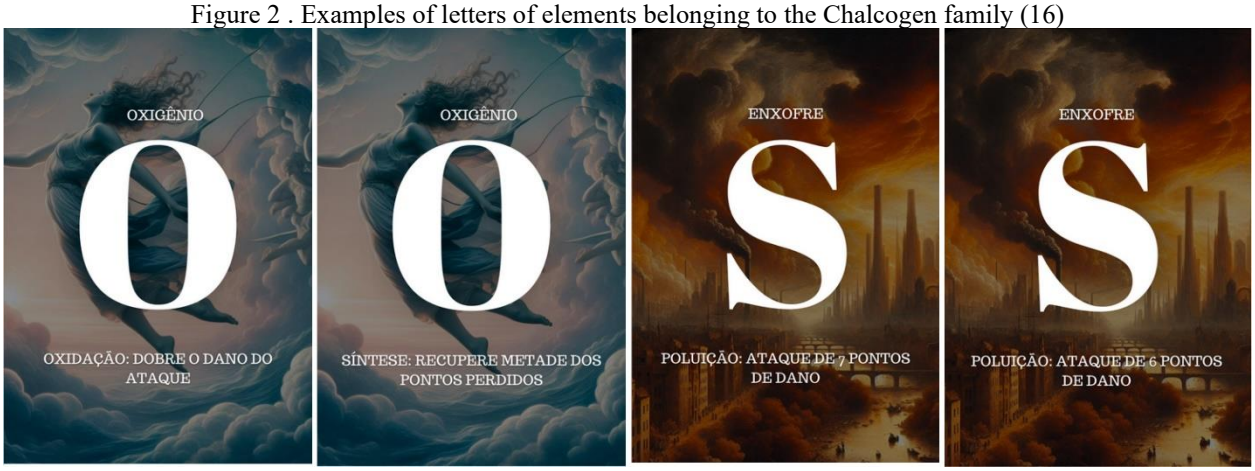
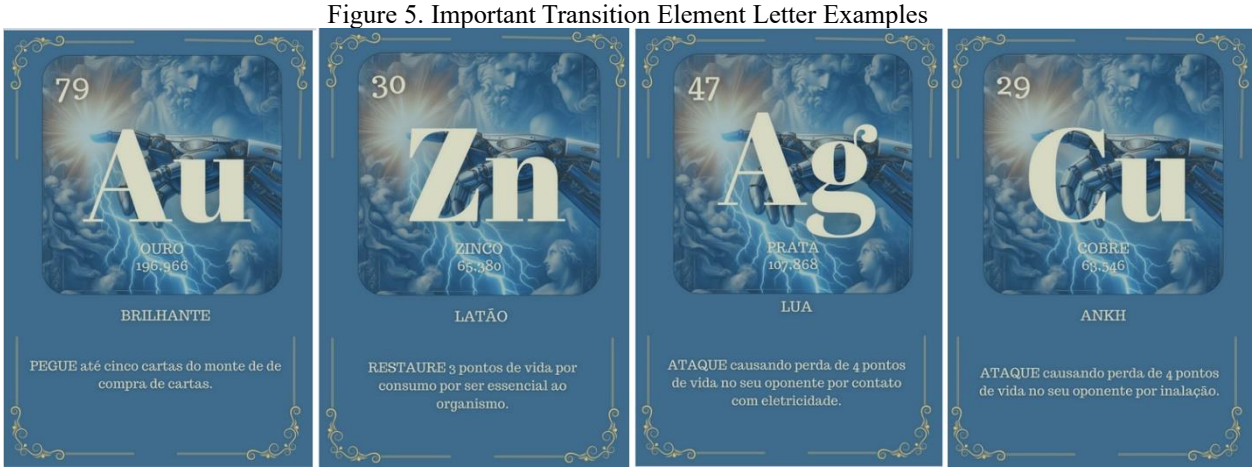


Figure 3. Examples of letters of elements belonging to the Halogen family (17)

Figure 4. Examples of charts of elements belonging to the Noble Gas family (18)

Figure 5. Important Transition Element Letter Examples



After making all the letters, they were printed on A4 size sheets of photographic paper, cut and then glued onto cardboard to make the pieces harder, and then covered with transparent adhesive paper, to ensure greater durability of the pieces.

A personalized box to store the letters was built with cardboard, with the following dimensions: height of 9.5 cm, width of 7.5 cm and length of 15.0 cm (Figure 6). Where it says “glue” means that this area is used to glue the sides of the box and where it says “do not glue” it means that they are flaps on the sides of the box and should not be glued. The box, after being properly

assembled, was decorated with images created using the Canva program and covered with transparent adhesive paper (Figure 7).

Figure 6 . Game box planning

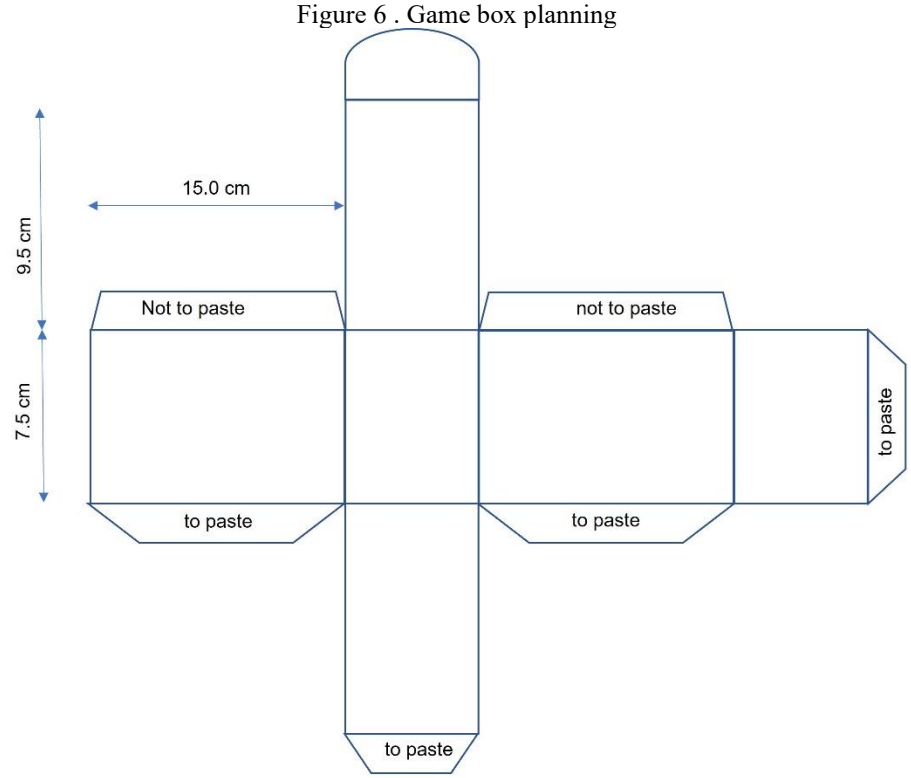
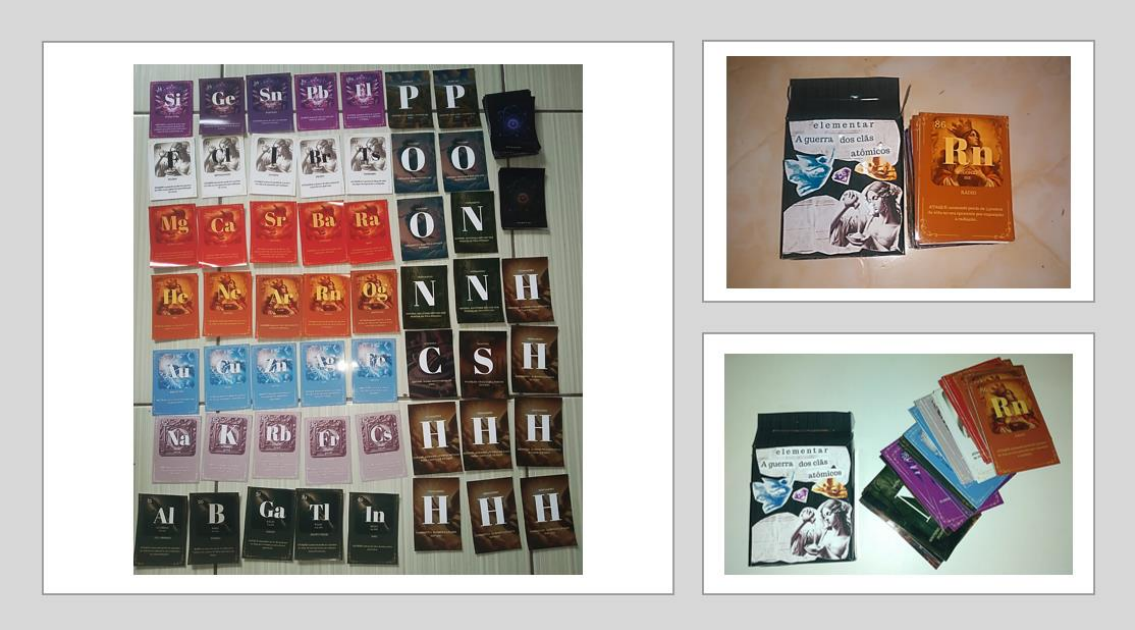


Figure 7. Completed cards and box for the game "Elementary: War of the Atomic Clans"



The entire process of preparing the game (pieces and rules) was led by students from an undergraduate Pharmacy class at the Federal University of Pará (UFPA), as the careful elaboration of the cards and other elements of the game not only integrates the fun of the game with learning

chemical elements, but also highlights the importance of creativity and interdisciplinarity in the educational process.

GAME RULES

The didactic game Elementary: The War of the Atomic Clans was designed to be played by two to four players, accompanied by a mediator, who could be the teacher, a class monitor, or a student, and in the case of four players, the The game must be played in pairs. There is the possibility of being played by teams, but always with the election of one representative per team.

The mediator is responsible for conducting the game, shuffling cards, drawing special cards for both players and keeping track of the players' points.

Initially, each player receives a set of five cards from their clan and two special cards, as well as twenty points (or twenty lives). Each player can freely choose the clan they will “defend” (Table 1) and their special cards (two) are drawn by the mediator.

The cards not drawn by the Moderator are stacked with the element's information face down, forming the card draw “pile”.

The game begins when both players agree on who will start, at which point the chosen player plays their first card. This can be done by direct agreement between the players or through some type of draw, such as rolling a common dice.

Each round, the participant plays a card in the discard pile and draws a new card from the draw pile, with the function of the discarded card announced by the Mediator.

The cards on the battlefield (round) can attack the opponent with the aim of removing energy, defending themselves, preventing the attack or restoring energy according to functions created from the properties of the chemical elements of each clan. Each of the game's cards has a certain number of attack points (representing the damage caused) and defense points (protection against damage). For example, the Bromine (Br) card, shown in Figure 1A, has 5 attack points, while the hydrogen (H) card, shown in Figure 1B, can halve the damage suffered in an attack.

If a player does not have an elemental attack card on their turn, they can draw a card, but give up playing that round, passing the turn to the opponent.

The Mediator records life point gains, losses, and restorations on a sheet with the players' names, adding and subtracting the corresponding points.

If a player resets his points, he has the right to play a card to recover points.

The one who removes all of his opponent's life points first wins the game. But in special situations, such as the end of available class time, the winner can be determined by the player with the most life points.

GAME TESTING

After its elaboration and creation, the game was tested by the team members, and was later tested with all students in the class of the game's team (Figure 8), fulfilling one of the essential points in a proposal for an educational game, which It's your preliminary test. [19]

Figure 8 . Game testing moment

FINAL CONSIDERATIONS

The work highlights the challenges faced in teaching chemistry in classrooms, whether in schools or often in universities, focusing on students' negative perception of the subject and the limitations of the traditional approach. The lack of connection between abstract concepts and everyday reality, combined with the scarcity of practical resources, contributes to learning difficulties. [20]

By adopting playful approaches, such as educational games and practical activities, [21] the work suggests that it is possible to transform the learning environment, making it more engaging and accessible. The use of the proposed game aims not only to illustrate the concepts of the periodic table, but also to promote the active participation of students and other participants (teachers and monitors).

The methodology for creating the game highlights interdisciplinarity and the importance of creativity in the educational process. The "Elementar" game not only seeks to make learning about chemical elements more enjoyable and memorable, but also aims to stimulate understanding of the properties and relationships between the elements, providing a practical and contextualized connection.

After the testing carried out with the class, it was noticed that the rules of the game and its didactic purposes were very clear to the participants of the game, in addition to that there was good acceptance of the dynamics created by the team and developed in the class, with spontaneous reports such as: “ I learned without realizing I was studying” (student 1), or “I learned while having a lot of fun. I never thought Chemistry could be something really fun.” Such reports are in line with several existing works in the literature, which present spontaneous reports of content similar to those recorded in the present work. [22]

Another point to be considered was the motivation of the team when developing the game, which agrees with what Soares (2015) says when reporting that some recreational manufacturing and construction activities in teams of students, in which it can be observed that the interest caused through the possibilities of creation, changes and adaptations, it provides student involvement. Board games, in particular, promote interaction with the game through the manipulation of pieces. Another interaction that is important to mention is teacher-student and student-student, strengthening bonds of friendship, trust, cooperativeness and/or competitiveness. [23]

REFERENCES

1. De Lima, José Ossian Gadelha. (2012). Perspectivas de novas metodologias no Ensino de Química.

2. Veiga, M. S. M.; Quenenhenn, A.; Cargnin, C.. (2012). O ensino de química: algumas reflexões. Jornada de Didática, v. 1, p. 189-198.

3. Bueno, L. et al. (2008). O ensino de química por meio de atividades experimentais: a realidade do ensino nas escolas. Universidade Estadual Paulista "Júlio de Mesquita Filho" Faculdade de Ciências e Tecnologia, Presidente Prudente, p. 34.

4. Souza, E. C. et al. (2018). O lúdico como estratégia didática para o ensino de química no 1º Ano do Ensino Médio. Revista Virtual de Química, Belém, v. 10, n. 3, p. 449-458.

5. Lima, E. C. et al. (2011). Uso de jogos lúdicos como auxílio para o ensino de química. Revista Eletrônica Educação em Foco, v. 3, p. 1-15.

6. Neto, H. da S. M.; De Moradillo, E. F.. (2016). O lúdico no ensino de química: considerações a partir da psicologia histórico-cultural. Química nova na escola.

7. Felício, C. M.; Soares, M. H. F. B. (2018). Da intencionalidade à responsabilidade lúdica: novos termos para uma reflexão sobre o uso de jogos no ensino de química. Química nova na escola, v. 40, n. 3, p. 160-168.

8. Souza, E. C.; et al. (2017). O Lúdico como Estratégia Didática para o Ensino de Química no 1º Ano do Ensino Médio. Rev. Virtual Quim. V.10, n.3, p.449-458. DOI: 10.21577/1984-6835.20180033.

9. Lisboa, M.; (2013). Jogos: Para uma aprendizagem significativa, 1ª ed., Wak: Rio de Janeiro.

10. Santos, V. R. (org.); (2014). Jogos na Escola: Os jogos com ferramenta pedagógica, 1ª ed., Vozes: Petrópolis.

11. Dos Santos Araújo, Á. C.; Leão, M. F.. (2021). Elaboração e avaliação de um jogo didático do tipo quebra-cabeças para ensinar Tabela Periódica no 1º ano do Ensino Médio. REAMEC-Rede Amazônica de Educação em Ciências e Matemática, v. 9, n. 1, p. e21010-e21010.

12. Rodrigues, P. H.; Amauro, N. Q.; Teodoro, P. V.. (2022). Bingo Atômico: uma interlocução didática para o ensino de tabela periódica. Research, Society and Development, v. 11, n. 15, p. e263111535545-e263111535545.

13. Dos Santos, T. P. A.; Araújo, Y. R. S.; Souza, E. C.; Silva, A. S.. (2024). ROLETA QUÍMICA: O USO DE ATIVIDADES LÚDICAS PARA O ENSINO DA TABELA PERIÓDICA. Revista Multidisciplinar do Nordeste Mineiro, v. 3, n. 3. DOI: 10.61164/rmnm.v3i3.2214. Disponível em: https://revista.unipacto.com.br/index.php/multidisciplinar/article/view/2214.

14. Romano, C. G. et al. (2017). Perfil químico: um jogo para o ensino da tabela periódica. Revista Virtual de Química, v. 9, n. 3, p. 1235-1244.

15. Piccoli, F.; Lopes, C.. (2013). Episódios da história da tabela periódica e dos elementos químicos para o ensino de química. Enseñanza de las ciencias: revista de investigación y experiencias didácticas, n. Extra, p. 2791-2794.

16. Wartha, E. J.; Silva, E. L. da; Bejarano, N. R. R.. (2013). Cotidiano e contextualização no ensino de química. Química nova na escola, v. 35, n. 2, p. 84-91.

17. Santos, J. L. et al. (2022). A avaliação da utilização de jogos lúdicos no ensino de química geral.

18. Campagne, F.. (1989). Le jouet, l´enfant, l´éducateur – roles de l´objet dans lê développement de l´enfant et lê travail pédagogique, 1ª ed., Privat: Paris.

19. Lozza, R.; Rinaldi, G. P. (2017). O USO DOS JOGOS PARA A APRENDIZAGEM NO ENSINO SUPERIOR. Caderno PAIC, v. 18, n. 1, p. 575–592. Disponível em: https://cadernopaic.fae.edu/cadernopaic/article/view/264.

20. De Mello, R. M. Q.; Micaroni, L.; Da Cunha, M. M.. (2018). Química na Prática: divulgando a química nas escolas. Extensão em Foco, n. 17.

21. Da Cruz Junior, F. M. et al. (2017). Uso de jogos lúdicos no processo de ensino-aprendizagem nas aulas de Química. Estação Científica (UNIFAP), v. 7, n. 2, p. 149-157.

22. Petizeiro Dionízio , T. (2022). “La Casa de Química”: relato da aplicação de um jogo didático para promover aprendizagem e diversão aos alunos de ensino médio. Journal of Education Science and Health, v. 2, n. 4. DOI: 10.52832/jesh.v2i4.169. Disponível em: https://bio10publicacao.com.br/jesh/article/view/169.

23. Soares, M. H. F. B.. (2015). Jogos e Atividades Lúdicas para o Ensino de Química. 2. ed.. Goiânia: Kelps.