APPLICATION OF GAMING AS STRATEGY FOR TEACHING ORGANIC NOMENCLATURE IN A BRAZILIAN PUBLIC SCHOOL

APLICACIÓN DEL JUEGO COMO ESTRATEGIA PARA LA ENSEÑANZA DE LA NOMENCLATURA ORGÁNICA EN UNA ESCUELA PÚBLICA BRASILEÑA

APLICAÇÃO DE UM JOGO COMO ESTRATÉGIA PARA O ENSINO DE NOMENCLATURA ORGÂNICA EM UMA ESCOLA PÚBLICA BRASILEIRA

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ABSTRACT
Specific topics in chemistry, such as organic nomenclature, are often considered key subjects for understanding organic chemistry in high school. Several research types have already demonstrated that most high school students and even university students have great difficulty in this topic. In general, the problems come from the approach used to present these contents, sometimes superficial or without the use of interactive methodologies. This work aims to help the teaching & learning chemistry process by applying a game’s applying, which consisted of building organic molecules using jelly beans and toothpicks, the previously published "Fastest Fingers." In the present work, we analyzed the positive impact that gaming can bring for the learning process and knowledge assimilation of this article's topic. This method mainly shows its importance when applied in a state that faces many issues in its education system, like Alagoas-Brazil. It was possible to notice that students’ interaction and perception of the game, and molecules representation occurred more efficiently, thus favoring the learning and the interaction improvement between teachers and students.

Keywords: Alagoas, Brazil, didactic game, organic nomenclature, organic chemistry, public school

Resumen
Los temas específicos de la química, como la nomenclatura orgánica, a menudo se consideran materias clave para comprender la química orgánica en la escuela secundaria. Varios tipos de investigación ya han demostrado que la mayoría de los estudiantes de secundaria e incluso universitarios tienen grandes dificultades en este tema. En general, los problemas provienen del enfoque utilizado para presentar estos contenidos, a veces superficial o sin el uso de metodologías interactivas. Este trabajo tiene como objetivo ayudar al proceso de enseñanza y aprendizaje de la química mediante la aplicación de un juego, que consistió en construir moléculas orgánicas utilizando gominolas y palillos de dientes, los "Dedos más rápidos" publicados anteriormente. En el presente trabajo analizamos el impacto positivo que puede traer el juego para el proceso de aprendizaje y asimilación de conocimientos del tema de este artículo. Este método muestra su importancia principalmente cuando se aplica en un estado que enfrenta muchos problemas en su sistema educativo, como Alagoas-Brasil. Se pudo notar que la interacción y percepción de los estudiantes sobre el juego y la representación de las moléculas ocurrieron de manera más eficiente, favoreciendo así el aprendizaje y la mejora de la interacción entre profesores y estudiantes.

Palabras clave: Alagoas, Brasil, juego didáctico, nomenclatura orgánica, química orgánica, escuela pública.

RESUMO
Tópicos específicos em química, como nomenclatura orgânica, são frequentemente considerados assuntos essenciais para a compreensão da química orgânica no ensino médio. Diversos tipos de pesquisas já demonstraram que grande parte dos alunos do ensino médio e até mesmo universitários apresentam grande dificuldade neste tópico. Em geral, os problemas advêm da abordagem utilizada para apresentar este conteúdo, por vezes superficiais ou sem acesso a metodologias interativas. Este trabalho visa auxiliar o processo de ensino e aprendizagem de química por meio da aplicação de um jogo, que consiste na construção de moléculas orgânicas a partir de jujubas e palitos de dente, o jogo “Fastest Fingers”, previamente publicado. No presente trabalho, analisamos o impacto positivo que o jogo pode trazer para o processo de aprendizagem e assimilação do conhecimento do assunto tema deste artigo. Esse método mostra sua importância principalmente quando aplicado em um estado que enfrenta muitos
problems in its teaching system, such as Alagoas-Brasil. It was possible to perceive that the interaction and perception of the game by students and the representation of molecules occur in a more efficient way, favoring learning and the improvement of interaction between professors and students.

**Keywords**: Alagoas, Brazil, didactical game, organic nomenclature, organic chemistry, public school.

**INTRODUCTION**

Many authors describe playful activities in the literature as attractive methodologies for the teaching and learning processes. According to Teixeira (1995), the game is a highly relevant didactic factor. It is considered an indispensable element for the teaching-learning process for those teachers who intend to motivate their students to learn. Also, Friedmann (1996) states that the game can be used to encourage human development in its different aspects: linguistic, moral, cognitive, affective, and physical-motor.

Concerning chemistry teaching, didactic games act as essential activities for the critical-reflexive development of students and an incentive to participate in the processes of daily issues investigation (DE MELLO E SOARES, 2019; ANTUNES et al., 2012). On the other hand, a common practice in science teaching is the simple reproduction of the content, having no concerns about motivating the listener to the knowledge; this practice creates gaps in the learning process, discouraging students. Thus, when dealing with chemistry, it is observed that students often consider it as an abstract and even dull content. As the school must be a place of learning, having amusement in this environment can be advantageous for knowledge acquisition (DO NASCIMENTO, 2019). From this perspective, it is crucial to introduce new methodologies to teach and evaluate students.

By comparing data amongst Brazilian states, Alagoas presents one of the worst benchmarks in IDEB, Basic Education Development Index (INEP, 2020). These results show the importance of introducing different and better teaching methodologies.

Therefore, it is essential to rethink chemistry teaching, aiming to provide alternatives for the traditional teaching approach and allow the student to learn effectively. It is crucial to develop the sense that the student can master the learning process by walking side by side to the teacher, exchanging knowledge, not in an authoritarian way, but by sharing ideas that convince and not just elect a winner (DURO, 2020). Regarding didactic games, it acts as an effective strategy since it provides a motivational atmosphere that stimulates the student to learn (DE MELO E DE OLIVEIRA). Games can also be exciting and challenging activities, balancing anxiety caused by the game difficulty and the excitement for the victory (PRIETO et al, 2005). Given the significance of this approach, the process must be spontaneous and focused [191]
on the student, who, at the end of high school, should understand chemical concepts and become a citizen who has a good interaction in society (MALDANER, 1999).

According to Rezende et al. (2019), understanding an addressed topic is essential for the chemical teaching concepts since it works as the basis of a good part of chemistry. In this sense, it is crucial to use different teaching strategies that help students to learn. Therefore, it is justified by using the educational game as a practical methodology to understand concepts that present themselves as obstacles to the student’s performance.

This work intends to approach an intervention within this context, using a didactic game entitled: "Fastest Fingers" for 3rd-year high school students in a partner school of the extension program ProCCaExt (Programa Círculos Comunitários de Atividades Extensionistas), located in the city of Maceió-AL. We proposed to analyze students' affinity and perception in chemistry subject and their opinion about game components, such as clarity of rules, difficulty, and how the game contributed to the assimilation of the concepts of the discipline. Finally, we evaluated the game as an instrument to consolidate the student's knowledge in "organic nomenclature," an important topic taught in the 3rd year of high school, and also in university. It was done by comparing the student's answers to the questions applied before and after the game application.

**METHODOLOGY**

The research took place in the State School Irene Garrido, situated in Maceió city – Alagoas state – in the Northeast region of Brazil (figure 1). The research was done with two high school classrooms participation, being 37 students in one classroom and 36 in other, with a total of 73 students.

Questionnaires, observation and recording were used as research instruments with students. This is justified, according to Gil (1999, p.128), "as the investigation technique composed of several questions presented in writing to people, aiming at the knowledge of opinions, interests, expectations, situations experienced, etc.". Mentioning this, the methodological basis of this work is referred to as qualitative and quantitative research.
During the experiment steps, the intervention processes started with chemistry classes, including a list of organic nomenclature exercises, using a chemistry textbook as a resource (MORTIMER E MACHADO, 2003). Some supplies were also useful: an image projector, jelly beans, and toothpicks to build the molecules. Eastwood’s game was the main base for the slide’s construction (EASTWOOD, 2013).

For each classroom, four classes were needed in order to apply the activities, two visits for chemistry classes, and two visits for the game. After the chemistry classes, the students answered the questionnaires pre-game, and then, after the gaming round, the questionnaires were also answered. At this moment, the research has focused on the students’ interactions, as well as the teacher’s resourcefulness during the activity.

For the project development and the game rules, molecules were made in PowerPoint, and on each slide, the students would have the script of which structure they should build. They would have to observe the teacher’s instructions and follow the guidelines according to the established rules - the slides were the guide.

Thus, the slide should show what molecule and what atom's color needed to build the whole and correct structure. A sample video is available on YouTube to explain how the game works. The game idea was developed by Professor Michael Eastwood (2013, "Fastest fingers - a molecule building game).

https://www.youtube.com/watch?v=vVTy1clF0TA

**Game's instructions and rules (details):**

1. In each round, a molecule's name was projected; the goal was to build it, wholly and throughout. For that, the students utilized the jelly beans plus the toothpicks. Those students
who built the molecules faster and correctly would get the highest score.

2. Each team member would get a score by the letters "A" to "E." Only a few members (2 or 3) would be able to build in each round, but all of them are allowed to help.

3. The first team to correctly build the molecule and give the sign would score 5 points; the second team would receive 4 points, and so on. The last-placed group would not receive any score.

4. Correct answers can give 5 (five) points. Despite that, students can lose points on each error in the general building of the molecule; the most points scored in a round are 10 points.

The game also specifies what colors the students should take for a given atom, as figure 1 shows. Figures 2 and 3 show the slides indicating which participants should build a molecule in that round and which molecule they should make, respectively.

Game's slides (sample)

RESULTS AND DISCUSSION

Chemistry classes and Pre-game questionnaire

After the explanatory classes of organic nomenclature, object of this research, a list of exercises was applied to the students to evaluate the extent of their learning through the
traditional class. In order to better analyze the content assimilation quantitatively, the results were separated by class and are shown in table 3 (vide infra).

Besides, a pre-game questionnaire with four questions was answered by the students, and the data are presented in table 1.

<table>
<thead>
<tr>
<th>Table 1 – Pre-game questionnaire</th>
<th>Total students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question</td>
<td>Yes</td>
</tr>
<tr>
<td>Do you like chemistry?</td>
<td>40</td>
</tr>
<tr>
<td>Do you think chemistry is important in your life?</td>
<td>49</td>
</tr>
<tr>
<td>Do you think studying chemistry is important?</td>
<td>45</td>
</tr>
<tr>
<td>Have you had contact with some chemistry professionals?</td>
<td>16</td>
</tr>
</tbody>
</table>

Analyzing the results obtained through the answers, we have found the following points:

1. Overall, students do like chemistry; more than half of them (40 of 73 individuals) showed to be interested in chemistry. Even though they have little knowledge about the subject of this research, they have studied chemistry in the previous two years, and we believe it's a motivating result, given the content's complexity and difficulties of the education system;

2. Students understand that chemistry is important in their lives, and this could be seen in the second question in which 49 students answered "yes, (I do like chemistry)" to the question;

3. 45 students think that study chemistry is important. Some students stated not to like chemistry, but they understand that it is a necessary subject for the comprehension of bases that are used in different areas of the labor market and life as a whole. Thus, by analyzing the answers for the third question, it was showed that the students could relate chemistry contents and daily life;

4. Generally, students have had little contact with chemistry professionals (only 16 of 73). In this way, projects and actions in this area should be encouraged in order to provide the experiences for the students with chemistry professionals. It could be technical visits, as well as the organization of lectures that can be given by specialists.

Second questionnaire and results obtained after game

For the second questionnaire, we analyzed the student's conceptions of the game during and after playing. The performed questions and the student's answers are summarized in table 2.
Table 2 – After game questionnaire

<table>
<thead>
<tr>
<th>Question</th>
<th>Total students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did you think the game's rules were clear?</td>
<td>Yes 57</td>
</tr>
<tr>
<td></td>
<td>No 16</td>
</tr>
<tr>
<td>Did you think it was difficult to play the game?</td>
<td>Yes 26</td>
</tr>
<tr>
<td></td>
<td>No 47</td>
</tr>
<tr>
<td>Did the game help you to learn organic nomenclature?</td>
<td>Yes 55</td>
</tr>
<tr>
<td></td>
<td>No 18</td>
</tr>
<tr>
<td>Would you recommend the game to your colleagues?</td>
<td>Yes 60</td>
</tr>
<tr>
<td></td>
<td>No 13</td>
</tr>
</tbody>
</table>

In the first question of table 2, the rule's clarity was assessed. 57 students were satisfied with the game and rules development, and, only 16 students said they didn't understand very well the game's rules.

The second question refers to the game's difficulty. 47 students (almost half of the classroom) demonstrated no problem in understanding the game and its proposal. This information suggests that the majority of the students have classified the game as useful to understand the organic nomenclature.

The third question is related to content learning by students throughout the game. According to this, 55 interviewees considered the game effective in learning organic nomenclature. On the other hand, 18 students demonstrated that, even after a teacher's class, the game was not efficient to help them absorb the content.

Finally, of the 73 students, 60 would recommend the game to their colleagues. In addition to the results shown in table 2, we also observed that during the game application, the students were focused and motivated; dedicated to solving the problems and building the molecules as proposed (figure 2). They also displayed the ability to work in groups and competitiveness, in line with other games applied before (REZENDE, 2019; OLIVEIRA E SOARES, 2015; SOUZA, 2012; HWANG, 2017).

Figure 2 – Game application in classroom
In order to verify the efficiency of the game in learning organic nomenclature, we applied some exercises. A total of 10 organic names were randomly chosen and presented to students so that they could assemble the structures. The same activity was done before and after the application of the game. After the game, the available compounds were different from the previous ones, but taking care to maintain the same level of difficulty. The results are shown in table 3. It is important to note that, despite being a game for learning mainly of organic nomenclature, when assembling the compounds, using jelly beans and toothpicks, students also interacted with other important organic chemistry concepts such as functional groups, molecular geometry, and hybridization. We were glad to observe that the average percentage of molecules drawn correctly by class improved significantly after the application of the game, with 40.4% and 39.7% for classes 1 and 2, respectively, before the game, and 63% and 62.5% for the same classes after the game (table 1). By the results obtained, we strongly recommend the "Fastest Fingers" game as a supporting activity for teaching organic chemistry, specifically for organic nomenclature contents.

### Table 3 – Knowledge assimilation by game application

<table>
<thead>
<tr>
<th>Compound</th>
<th>Before Game</th>
<th>After Game</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Classroom 1 (%)</td>
<td>Classroom 2 (%)</td>
</tr>
<tr>
<td>1</td>
<td>39</td>
<td>37</td>
</tr>
<tr>
<td>2</td>
<td>38</td>
<td>38</td>
</tr>
<tr>
<td>3</td>
<td>47</td>
<td>45</td>
</tr>
<tr>
<td>4</td>
<td>35</td>
<td>37</td>
</tr>
<tr>
<td>5</td>
<td>44</td>
<td>40</td>
</tr>
<tr>
<td>6</td>
<td>41</td>
<td>39</td>
</tr>
<tr>
<td>7</td>
<td>42</td>
<td>42</td>
</tr>
</tbody>
</table>

[197]
FINAL CONSIDERATIONS

The present work reinforces that changing alternative methodologies are essential for organic chemistry learning, specifically in this paper, organic nomenclature. The use of games allows students to understand the content in a motivating way, aiming to make knowledge more attractive, instead of only focusing on traditional teaching methods.

In this regard, the research sought to evaluate and demonstrate the importance of using ludic games as an effective teaching strategy for understanding organic chemistry concepts, considering that the students showed better assimilation of the content after the entertaining activities.

During the activity, it was noticed that the action promoted student's motivation by the results obtained with the questionnaires. It is favorable for the construction of their knowledge. So, by the game, students and teachers could achieve their goals positively, avoiding demotivation development. It can be one of the significant factors for indiscipline and learning gaps.

Finally, the game's application proved to be an effective teaching methodology, since it improved the educational aspect, as initially proposed. With this, after the assessment analysis, it was noticed that the gaming participants had better results in exercises related to organic nomenclature.

ACKNOWLEDGMENTS

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