

PLAYFULNESS THROUGH THE EDUCATIONAL GAME HERBALMED* TEACHING BIOLOGY WITH THE THEME OF MEDICINAL PLANTS

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ABSTRACT

Active methodologies stand out in the teaching–learning process of curricular content; in this study we highlight gamification, which integrates concepts such as playability, learner rewards, teamwork, among other aspects. Knowledge about medicinal plants is relevant for students, since their use is common among the general population. This work sought to develop, apply, and evaluate the educational game HerbalMed, which was administered to 28 high school students at a public school in the state of Rio de Janeiro and evaluated via a mixed printed questionnaire. The results revealed everyday use of medicinal plants and students' misinformation regarding their uses and efficacies, allowing the acquisition of new knowledge—especially in the discursive questions that addressed appreciation and application. We understand the importance of active methodologies, such as gamification, in biology teaching, since they promote fun, learning, and application, connecting content to the student's reality.

Keywords: Educational game; Biology teaching; Active methodologies; Medicinal plants.



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1 INTRODUCTION

Popular knowledge about the use of medicinal plants for treating and relieving symptoms and illnesses is passed down from generation to generation. From this knowledge, the use, research, and development of drugs derived from medicinal plants have become increasingly relevant, contributing to the population's health in general (Araújo; Rodrigues; Moura, 2021). They are a fundamental part of Brazil's great biodiversity and, beyond being used as home remedies in traditional communities, they also serve as raw material for the manufacture of industrialized medicines (Leão; Ferreira; Jardim, 2007).

Given the importance and indiscriminate use of medicinal plants, it became necessary to develop and implement public policies that regulate their uses and preparations, in addition to making these resources available through the Unified Health System (SUS). Accordingly, Ordinance No. 971 of May 3, 2006, of the Ministry of Health was drafted, which approved the National Policy of Integrative and Complementary Practices (PNPIC). Among its directives, this public policy included the preparation of the National List of Medicinal Plants and Phytotherapeutics, as well as the provision of access for SUS users (Brazil, 2016) to medicinal plants and phytotherapy.

With the aim of regulating the use of medicinal plants, the Brazilian Health Regulatory Agency (ANVISA) provides, free and online, a guidance booklet on the use of phytotherapeutics and medicinal plants, containing important information for correct consumption and identification of phytotherapeutics in Brazil. It warns that plants may undergo changes that prevent them from producing the target active principle or may modify their composition; the same plant that benefits a consumer may be toxic and cause undesired reactions. Such modifications may be due to biotic factors—such as insects, fungi, and other plants that present competitive relationships—or abiotic factors such as air humidity, soil composition, pesticides, pollution, and heavy metals, which can be harmful to human health (Brazil, 2022).

This work presents the theoretical framework on medicinal plants and their uses in biology teaching, the application of educational games aimed at learning, details of the application with high school students and their questionnaire responses for learning assessment, the obtained results, future perspectives, and a brief conclusion regarding

the applicability of didactic games as a tool for the teaching–learning process.

2 THEORETICAL FRAMEWORK

2.1 MEDICINAL PLANTS AND THE TEACHING OF BIOLOGY

Biology teaching in Brazil, besides encouraging knowledge of nature itself—rich in biodiversity—also involves recognizing the environment in which living and non-living beings live and their relationships, their natural habitats, and how humans can relate to nature (Borba, 2013).

Important advances marked the 1990s with the enactment of the Law of Guidelines and Bases of National Education (LDB). Another advance was the National Curricular Guidelines (DCN) for Elementary and Secondary Education, formalized in 1998, which organized Secondary Education into three areas of knowledge: Natural Sciences; Mathematics and its technologies; Language and Codes and their technologies; and Human Sciences and their technologies (Longhini, 2012).

In 1999, the National Curriculum Parameters for Secondary Education (PCNs) were published, bringing the perspective that Secondary Education should aim to address knowledge areas in an interdisciplinary manner to solve contemporary life problems, and that such knowledge should contribute to a new worldview (Brazil, 2006).

The document titled “Curricular Parameters + Secondary Education” or “PCN+” was published in the 2000s and aimed to promote dialogue between teachers and schools. Oliveira et al. (2013, p. 6) state that “The PCN+ came to supply the teachers' need to learn new methodologies or new ways of approaching content from analyses and reflections on the document.” Thus, PCN+ were essential for proposing a re-signification of methods and approaches to the content taught in Biology.

In December 2018, the National Common Curricular Base (BNCC) for Secondary Education was homologated (Brazil, 2018). The BNCC guides and directs the essential learnings students must acquire throughout basic education, comprising Early Childhood Education, Elementary School, and Secondary School (Brazil, 2018). For Secondary Education, the formative itineraries are organized as: Languages and their technologies; Mathematics and its technologies; Natural Sciences and their

technologies; and Human and Social Applied Sciences. In the area of Natural Sciences, specific competences to be acquired during secondary school are outlined, for example:

1. Analyze natural phenomena and technological processes based on interactions between matter and energy to propose individual and collective actions that improve productive processes, minimize socio-environmental impacts, and improve living conditions locally, regionally and globally. 2. Analyze and use interpretations about the dynamics of life, the Earth and the Cosmos to elaborate arguments, make predictions about the functioning and evolution of living beings and the Universe, and ground and defend ethical and responsible decisions. 3. Investigate problem-situations and evaluate applications of scientific and technological knowledge and their implications in the world, using Natural Science procedures and languages to propose solutions that consider local, regional, and/or global demands and communicate findings to varied audiences using different media and digital information and communication technologies (TDIC) (Brasil, 2018, p. 553).

Given these competences, the interdisciplinarity among Natural Science subjects becomes evident. This fosters solutions for environmental and everyday problems faced by students, aiming to provide better quality of life both individually and collectively within Brazilian society.

Because of the relevance and possibilities that teaching botany presents in secondary biology curricula, the PNPMF suggests including the theme of medicinal plants in this curriculum segment (Brazil, 2006). It is therefore up to schools, the Ministry of Education (MEC), teachers, and pedagogical coordinators to propose interdisciplinary, contextualized and playful approaches so learning is meaningful and brings the content of medicinal plants closer to students' everyday lives, since the topic is part of learners' reality (Moitinho; Marisco, 2015). Teaching in Brazil should be associated with qualitative development of content rather than quantitative aspects, integrating interdisciplinary content from biology and chemistry, for example, and re-signifying content in a way that relates to students' prior knowledge.

The topic of medicinal plants fits into interdisciplinarity, as plants contain a range of chemical substances—many still unknown—that assist public health in particular regions by presenting biological activities (geography). Thus, students are linked to everyday knowledge learned from their ancestors (history), such as customs like taking an herbal tea for a symptom or to improve sleep quality, integrating this information and increasingly involving the student in class (De Souza, 2012).

2.2 MEANINGFUL LEARNING WITH EDUCATIONAL GAMES: ACTIVE

METHODOLOGIES IN BIOLOGY TEACHING

Playful activities have been known since ancient civilizations; games originally developed for entertainment became tools for learning centuries Before Christ (Barros; Miranda; Costa, 2019). As we can see

Aristotle suggested for early childhood education, the use of games that imitate serious activities or adult occupations serves to prepare for future life; at that time, there was still no discussion of employing games as a resource for teaching reading and arithmetic (Kishimoto, 1995, p. 39).

And as we can also infer from philosophical thought that

[...] to provide these children with basic instruction in all necessary subjects; for example, teaching a carpenter's apprentice, through toys, how to use a ruler and tape measure; teaching a soldier how to ride a horse and other relevant things. And thus, through their toys and games, we would strive to direct the tastes and desires of children toward the object that constitutes their main goal in relation to adulthood (Platão, 1999, p. 92).

Although it is not easy to define exactly what a game is, researchers agree on its importance for the learning process (Santos, 2014; Miranda et al., 2016; Costa, 2017). As Santos (2014, p. 32) highlights, “[...] playful activities can significantly contribute to the child’s knowledge construction process.” According to Miranda (2002), didactic games can achieve several objectives: (1) development of intelligence and personality; (2) development of sensitivity, esteem, and friendship; (3) expansion of social contacts; (4) increased motivation; and (5) stimulation of creativity.

Active methodologies position the student as protagonist of their learning process and the teacher as mediator, where students take an active role in constructing knowledge in class (Lovato, 2018). Teachers are tasked with encouraging students to learn autonomously and participatively (Pereira, 2012).

Active methodologies are valuable tools that teachers can employ to foster autonomy, creativity, responsibility, collaborative learning, and critical thinking (Lovato, 2018). These tools are applicable during adolescence. Examples of active methodologies include problem-based learning, project-based learning, and gamification (Mattar; Aguiar, 2018).

The term “gamification” was coined by British programmer Nick Pelling in 2002, who noted the advantage of working on academic content through games. Professionals have since incorporated game principles into areas such as health,

education, public policy, sports, and productivity (Vianna et al., 2013). Gamification involves bringing game elements—such as rewards, competition, fun, and interaction—into school content with the aim of creating the same motivation and engagement found in games (Fardo, 2013).

Biology teaching encompasses systematic learning with names and processes that can be complex and abstract, potentially hindering learning. Therefore, teachers use playful activities, including games, to facilitate the continuous teaching–learning process and increase students’ interest and motivation. Consequently, alternatives that increase student engagement—such as playful activities—are necessary, since classroom games can be another teaching tool; the teacher’s role is to mediate and ensure the playfulness of playing and gaming within the content context (Sousa, 2022).

By definition, gamification uses mechanics, dynamics, and aesthetics of games in external contexts (Sousa, 2022). The resource chosen and used as the teaching–learning methodology in this research was gamification as a strategy for botany teaching, with medicinal plants as the thematic focus.

The BNCC (Brazil, 2017) mentioned in the previous section contains ten general competences to be developed across all stages of basic education. Among them, general competence two relates to this work by proposing an active methodology for learning biology content

2. To cultivate intellectual curiosity and employ the scientific approach, including research, reflection, critical analysis, imagination, and creativity, to investigate causes, develop and test hypotheses, formulate and solve problems, and create solutions (including technological ones) based on knowledge from different fields. (p. 9).

Using games in everyday classroom activities can promote a more horizontal teacher–student and student–student relationship that traverses the participants of the teaching–learning process and encourages the acquisition of new content in non-traditional ways. Authors such as Kishimoto (2001) and Miorim & Fiorentini (1990) present advantages of using games as a teaching methodology.

Based on the above, this study aimed to develop and apply the card didactic game HerbalMed on medicinal plants for high school students as a gamified strategy; to qualitatively evaluate student perceptions via questionnaire after the game; to identify knowledge mobilized and consolidation of new knowledge; to understand students’ positions on the use of medicinal plants in their daily lives; and to evaluate

the HerbalMed didactic game through student feedback.

3 METHODOLOGY FOR THE DEVELOPMENT OF THE HERBALMED GAME AND ITS APPLICATION

The didactic game called HerbalMed was developed as a didactic-pedagogical tool to contribute to the teaching–learning process of botany within the Biology curriculum for Secondary Education.

HerbalMed is an adaptation of the card game “Top Trumps” (Super Trunfo), produced by Grow®, which consists of acquiring all other players’ cards by selecting characteristics. Modifications were necessary so that HerbalMed could be applied to a 3rd-year high school class, contextualized within the curricular content “Life, Earth and Cosmos – diversity of living beings and their relationship with the environment” according to BNCC (Brazil, 2018).

HerbalMed was developed with the primary objective of disseminating knowledge about medicinal plants and contributing to more meaningful learning as a playful didactic tool.

This research obtained approval from the Research Ethics Committee of the State University of Rio de Janeiro (UERJ) in August 2023 and is registered on Plataforma Brasil under opinion number: 6.263.056. The game’s layout was created using the free online platform Canva. Funding was provided by the researchers themselves. Some examples of the game cards are shown below (Figure 1).

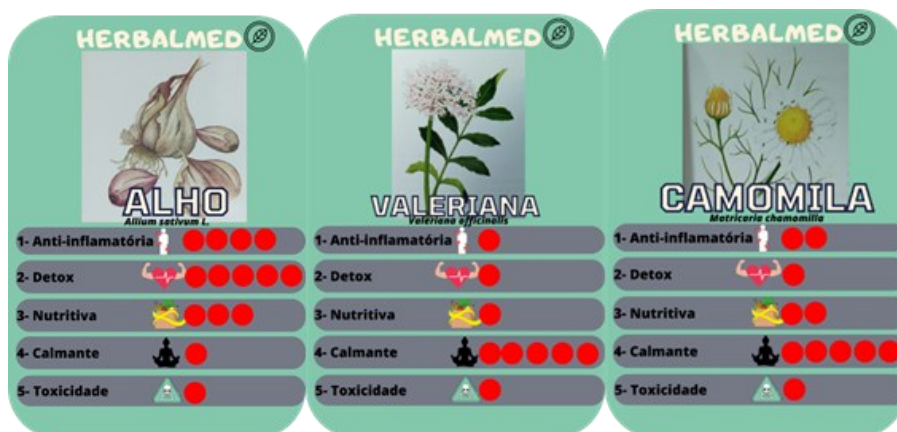
Information on the cards—such as plant images, common and scientific names, and pharmacological activities of each medicinal plant—was consulted from the book *Introdução à Fitoterapia: Utilizando Adequadamente as Plantas Medicinais*, 2nd edition, Colombo: Herbarium Lab. Bot. Ltda, 2011.

3.1 DESCRIPTION AND DEVELOPMENT OF THE HERBALMED GAME

The materials required for the activity are a set of 25 cards and a script. The objective of the game is to win as many cards as possible. Card description: each HerbalMed card features an illustration of the medicinal plant; its common name; scientific name; and a set of ratings for five representative medicinal properties (anti-

inflammatory, detoxifying, nutritive, calming, and toxicity). Additionally, a number of red circles—ranging from 1 to 5—was assigned to each property, corresponding to the property's strength in the plant; the greater the number of circles for a given property, the higher the plant's potential (Figure 1).

Figura 1: Examples of 3 cards from the HerbalMed didactic game.



Source: The authors, 2023.

HerbalMed begins with one player shuffling all cards. Five cards are then randomly dealt to each of the five participants. Each player keeps their stack face down.

A round starts when a player selects a card from their stack (without revealing it to others) and chooses the medicinal property to compete with. The player's remaining cards remain face down. After the property is announced, the other players perform the same action.

All participants reveal their cards simultaneously. The chosen property is compared across all cards, and the round's winner is the player whose card has the highest value—indicated by the greater number of red circles in that property. The winner collects all cards played in the round and adds them to their pile.

In case of a tie (two or more cards with the same value for the chosen property), only the tied players continue the dispute. One is drawn to choose a new property from the same card, and the tied cards are compared again. The player with the highest value in the new property wins the tiebreaker and collects all cards on the table.

The game proceeds through successive rounds until a player wins all the cards or until a pre-defined end (by time or number of rounds). The match winner is the player who has accumulated the most cards at the end.

If there is a tie in the total number of cards, tied players sum the red circles across all cards in their piles. The winner is the player with the highest total number of

circles, regardless of the number of cards. In the conducted session, no tie occurred in any round, and a single winner was identified at the end of play.

3.2 APPLICATION CONTEXT

HerbalMed was applied at a state public school located in the Vila Isabel neighborhood of Rio de Janeiro, near UERJ, in September 2023, with the participation of 28 third-year high school students, previously authorized by guardians through the Free and Informed Consent Term (TCLE). The biology class teacher and the researcher-author were present.

The initial explanation of the game lasted approximately 10 minutes. The questionnaire completion also required about 10 minutes. The complete session—including theoretical introduction, game development, and questionnaire—lasted 50 minutes. The class teacher briefly presented the proposal and organized group formation; the research author conducted the rest of the activity.

3.3 DATA COLLECTION INSTRUMENT

A printed questionnaire was administered to the 28 students after the game, composed of 5 open questions and 2 closed questions, thus a mixed questionnaire (Nogueira, 2002), as shown in Table 1.

Table 1: Questionnaire applied to students after the didactic game and the objective of each question.

Question	Objective
1. Do you or your family use medicinal plants at home? For example, drinking chamomile tea to calm down? () YES () NO	Assess students' perceptions about the use of medicinal plants in their daily lives and among family members.
2. Do you think that ALL plants should be consumed without restriction? () YES () NO	Investigate students' positions on the use of medicinal plants in everyday life.
3. Do you think medical or other professional guidance is necessary to consume medicinal plants? () YES () NO	Check students' mobilized knowledge.
4. Are there toxic plants that are harmful to health and should be consumed with care and medical guidance? () YES () NO	Encourage consolidation of new knowledge acquired after the game.
5. Did you learn new content about medicinal plants with the game <i>HerbalMed</i> ? () YES () NO	Assess content learned by students after the didactic game and their evaluation of <i>HerbalMed</i> .
6. If you answered "yes" to question 5, which contents were learned with the game? Comment. If you answered "no," justify your response.	Evaluation of <i>HerbalMed</i> by students.
7. What did you think about using the didactic game to learn school content?	Investigate the use of educational games in the student's teaching-learning process.

Source: The authors, 2023.

4 RESULTS AND DISCUSSION OF DATA COLLECTED DURING THE GAME ACTIVITY

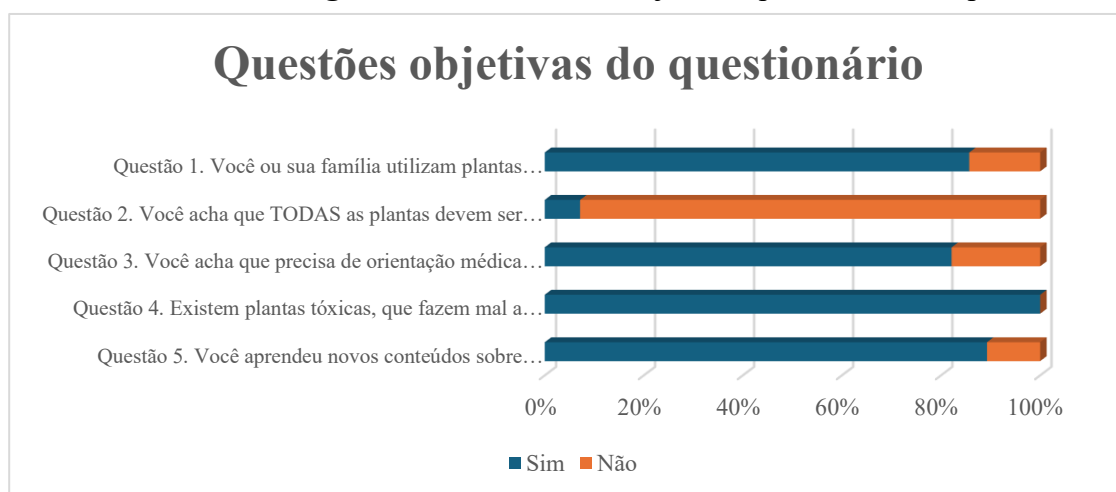
4.1 QUANTITATIVE ANALYSIS OF DATA

Results showed that the majority of students—approximately 86% (n = 25)—reported using medicinal plants at home or witnessing such practices among family members, for example using chamomile tea as a calming remedy. These data corroborate Trindade (2017), who identified chamomile as the primary plant known, used, and studied among students. It was also observed that many participants already had prior knowledge about medicinal plants.

After the game, when asked about unrestricted consumption of medicinal plants, most students (93%, n = 26) stated that plants should not be used indiscriminately or excessively (Figure 2). Additionally, 83% (n = 23) of students affirmed that consultation with a health professional is necessary before consuming them at home (Figure 2).

Although these plants are easily accessible, there is still limited knowledge about their correct use and proper control, which contributes to their use without appropriate guidance or prescription by qualified professionals. This scenario is illustrated by study data showing that 18% (n = 5) of students did not consider professional guidance necessary for using medicinal plants (Figure 2).

Figure 2: Distribution of objective questionnaire responses.



Source: the authors, 2023.

Before the game, a theoretical exposition on medicinal plants and the HerbalMed game proposal was given (Figure 3). During this introduction, students reported lacking knowledge about potential toxicity associated with plant use, which

can cause various adverse health effects. Among complications mentioned were allergic reactions affecting skin and mucous membranes, as well as cardiovascular, respiratory, metabolic, gastrointestinal, and neurological disturbances, and in cases of overdose, death when used indiscriminately.

Trindade (2017) and Mera (2018) found that students are aware of what medicinal plants are but that this information is not systematized or explored scientifically and broadly in schools. According to Trindade (2017), students access knowledge about medicinal plants from parents and grandparents, i.e., popular knowledge transmitted generationally, but with little systematic understanding of preparation and dosing. Mera (2018) observed that students from rural schools showed greater knowledge of medicinal plants than urban students, reflecting that the locality where a student lives influences their knowledge about medicinal plants and classroom learning.

After the activity, a significant change was observed in students' perception regarding the risks of inappropriate use of medicinal plants. All participants (100%, n = 28) (Figure 2) recognized that certain species are toxic and that their consumption should occur with restrictions and professional guidance, aligning with findings by Firmo (2012), Trindade (2017), and Stavski (2018).

Corroborating these data, Morais et al. (2021) found that most students had heard about medicinal plants and their use in treating illnesses. Regarding gamification in Biology teaching, Braz (2022) identified, via literature review, 14 works developed between 2013 and 2022 that addressed this methodological approach, demonstrating increasing interest in treating biological content through active methodologies.

In the present study, 89% of students (n = 25) reported having acquired new knowledge through HerbalMed (Figure 2). This finding is consistent with Santos (2022), who applied a didactic game about the "Super Trunfo dos Campos Sulinos," using medicinal plants as a pedagogical resource. Additionally, 100% of participants in this study declared they appreciated using games in class, expressed interest in deepening knowledge on the subject, and reported that the experience significantly contributed to the teaching–learning process. These results reinforce this study's aim to integrate knowledge about medicinal plants into the school context in a playful and meaningful way, applicable both to academic formation and student daily life. The main innovative contribution of this work is the integration of Biology curriculum content,

traditional/popular knowledge (use of medicinal plants), and a customized gamified tool.

4.2 QUALITATIVE ANALYSIS OF DATA

In the final stage, to evaluate participants' perception of the didactic resource's relevance, open-ended questions were applied..

Students' responses to: "If you answered 'yes' to question 5, which contents were learned with the game? Comment; if you answered 'no' justify your response," highlighted knowledge directly related to botany and medicinal plants, showing they could relate scientific content through HerbalMed. Excerpts from some replies include:

- "Discovering new plants and their peculiar and unique characteristics that I didn't know." (Student 1)

- "Yes, that plants can be good as medicines, but being natural can be positive or at the same time very toxic." (Student 2)

Figure 3: Application of the *HerbalMed* game at school. Public school students participating in the *HerbalMed* activity. A) Game demonstration; B) introductory presentation about the project and the game; C) students handling the cards; D) students playing *HerbalMed*.



Source: the authors, 2023.

•“I learned that guaraná (*Paullinia cupana*) is very nutritious, horse chestnut has a high toxicity potential, and cat’s claw (*Uncaria tomentosa*) is anti-inflammatory.” (Student 3)

•“Many plants I didn’t know and didn’t know they could be used medicinally.” (Student 4)

Students were also asked: “What did you think about using the didactic game to learn school content?” Selected responses:

•“I thought it was a different and interesting way to teach students.” (Student 1)

•“An interesting approach, because it breaks the standard routine, and with games teaching becomes more fun.” (Student 2)

•“I thought it was wonderful, because it got us away from the boring routine of the board all the time.” (Student 3)

According to Campos et al. (2003), didactic games contribute to understanding content in a fun and motivating way, which was evidenced in several comments from the students, such as “I thought it was wonderful, because it got us away from the boring board routine,” reported by Student 16.

Most open responses converged on discoveries about pharmacological properties and toxicity of medicinal plants, significantly contributing to continuous learning on the topic and safe use of such plants, as demonstrated by Gonçalves (2022), who performed an ethnobotanical and ethnopharmacological survey in a rural area of southern Brazil. That study found over 50% of individuals did not report medicinal plant use to health professionals; 80.65% associated plants with other medications; 58.33% of identified species had possible risks, contraindications or toxicity; and 35.83% showed possible interactions with continuous-use drugs—representing high health risk. For example, *Echinodorus macrophyllus* (“Chapéu de couro”), if used in doses higher than recommended, can cause renal problems and is sold in capsules in natural product stores without adequate safety, potentially causing toxicity and health damage (Gonçalves, 2022).

Miranda (2002) and Trindade (2017) note that didactic games are valuable tools that increase student participation, generating greater engagement. They present numerous advantages, such as stimulating enjoyment, changing students’ views on traditional classes (which may sometimes lose meaning), contributing to student autonomy, promoting decision-making, social interaction among students, cooperation

in group activities, and motivating development of intelligence, personality, sensitivity, esteem, friendship, motivation, and creativity. This was observable in game dynamics: students were engaged, attentive to explanations, and committed to the competitive aspects of the game.

The game activity motivated healthy competition and curiosity and stimulated social interaction among classmates, as described by Adams (2018). Students were surprised when informed that some plants common in their daily lives are considered medicinal—such as açaí—reinforcing the relevance of exploring the topic in basic education, as shown in Trindade (2017) and Mera (2018): students have knowledge of medicinal plants but this information is not systematized nor explored scientifically in schools.

Indiscriminate and excessive use of medicinal plants can cause a range of problems—from skin and mucous membrane allergies to cardiovascular, respiratory, metabolic, gastrointestinal, and neurological disturbances, and in overdoses, death. However, medicinal plants are easily found in commerce and households, and little is known about their use and control. Their use often occurs without medical attention or health professional guidance, marketed under the label “natural” and perceived as risk-free though often lacking proven quality, creating an alarming scenario regarding their misuse and potential toxicity or undesired effects (Firmo, 2012; Trindade, 2017; Stavski, 2018). After the toxicology explanation and game application, students responded unanimously (100%) that some plants are toxic and should be consumed under medical guidance, indicating an objective and consolidated learning outcome. Furthermore, more than 89.29% reported learning new knowledge and content after playing HerbalMed.

Cesar et al. (2013) observed that 99% of students had heard of medicinal plants and their use in disease treatment. Braz (2022), reviewing gamification in Biology teaching, found 14 studies on the topic between 2013 and 2022, indicating interest in addressing Biology topics through active methodology strategies.

Santos (2022) reported applying a didactic game, “Super Trunfo dos Campos Sulinos,” involving forms of consuming medicinal plants as a pedagogical tool; 87% of students already had general knowledge of medicinal plants, and 100% enjoyed classroom games and were interested in further knowledge. The game contributed significantly to the students’ teaching–learning process, aligning with the present

study's aims of associating and engaging knowledge of medicinal plants relevant to students' schooling and daily lives.

Didactic materials are fundamental because they provide teachers new ways of introducing resources beyond theoretical content into the classroom, facilitating more dynamic and motivating learning. "The game has a vital function for the individual, not for relaxation and discharge of energy, but mainly as a way of assimilating reality" (Campos et al., 2003, p. 597), often translating into more efficient and meaningful learning. Only one student among the 28 participants did not understand the game's functionality, confirming the didactic resource's applicability/playability for the intended target audience: high school students.

4.3 LIMITATIONS OF THE RESEARCH AND FUTURE PERSPECTIVES

Although results from the HerbalMed application were broadly positive—especially regarding student engagement and assimilation of content about medicinal plants—some limitations were identified. The activity was applied in a specific context: a single 3rd-year high school class, limiting generalization to other education levels and different school realities.

Accessibility is another relevant aspect. Because the game is predominantly visual and textual, requiring reading and analysis of properties described on cards, participation by students with visual impairments, cognitive difficulties, or reading limitations may be compromised. This highlights the need for material adaptations to make it more accessible and inclusive. Resources like Braille cards, digital versions with automatic reading, simplified language, or tactile elements could be effective alternatives to broaden the proposal's reach.

As future perspectives, it is recommended to apply the game across different educational levels, including final years of elementary school and Adult Education (EJA) groups. Expanding the game to digital versions, integrating technological and interactive elements, may further strengthen innovative, inclusive and contextualized pedagogical practices, making the game dynamic even more innovative.

5 FINAL CONSIDERATIONS

Tools such as videos, mind maps, and summaries are important allies for teaching and learning, bringing the sciences closer to students and their daily lives, and encouraging motivation and acquisition of new knowledge. As active methodologies—including gamification—they structure classes with dynamic strategies that develop competences such as critical thinking, communication, and teamwork. Gamification introduces playability into school content, promoting active student participation and appropriation of knowledge.

In this study, gamification was applied to Biology teaching specifically on medicinal plants, resulting in greater content retention and curiosity among students. Their active participation in all stages, including reading rules and answering questionnaires, expanded their knowledge on the subject and promoted conscious use of medicinal plants, as inferred from questionnaire results.

Students expressed satisfaction with the methodology, emphasizing that the playful approach made learning more interesting and fun. Thus, gamification proved valuable in Biology teaching, increasing student interest and motivation through HerbalMed, facilitating construction of more relevant and everyday-centered knowledge, and promoting social interaction and curiosity.

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