LETHAL SPLASH: A PLAYFUL AND EFFECTIVE TOOL IN MICROBIOLOGY EDUCATION

RESPINGO LETAL: UMA FERRAMENTA LÚDICA E EFICAZ NO ENSINO DE MICROBIOLOGIA

ROCIADO LETAL: UNA HERRAMIENTA LÚDICA Y EFICAZ EN LA ENSEÑANZA DE MICROBIOLOGIA

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ABSTRACT: Active methodologies of teaching generate student engagement and promote lasting learning. In this context, games emerge as an option to foster interest and understanding of complex concepts, conveying information in a playful manner. Thus, we present the board game "*Respingo Letal*," developed by Biomedical Sciences undergraduates from ICB/USP. Focusing on the Mycobacterium genus allows participants to explore and understand the species Mycobacterium tuberculosis and general concepts of Microbiology. It was applied to elementary and high school students (n=216) in public schools in the state of São Paulo, and its effectiveness was evaluated through Likert scale-based questionnaires and word clouds. It was noted that students were interested in the dynamics of the game and reported learning gains, with more than 75% of favorable responses, which places "*Respingo Letal*" as an effective tool for Microbiology learning for basic education.

KEYWORDS: Active Methodologies. Games. Microbiology Teaching. Mycobacterium tuberculosis.

RESUMO: *Metodologias ativas de ensino geram engajamento dos alunos e promovem aprendizado duradouro. Nesse cenário, os jogos surgem como opção para propiciar o interesse e a compreensão de conceitos complexos, transmitindo informações de forma lúdica. Assim, apresentamos o jogo de tabuleiro "Respingo Letal", desenvolvido por graduandos de Ciências Biomédicas do ICB/USP. Centrado no gênero Mycobacterium, ele permite aos participantes explorar e compreender a espécie Mycobacterium tuberculosis e conceitos gerais de Microbiologia. Ele foi aplicado em alunos do ensino fundamental e médio (n=216) em escolas públicas do estado de São Paulo e a eficácia foi avaliada por meio de questionários baseados na Escala de Likert e nuvens de palavras. Nota-se o interesse dos alunos pela dinâmica do jogo e declaração de ganho no aprendizado, ambos com mais de 75% de respostas favoráveis, colocando o "Respingo Letal" como uma ferramenta eficaz para o aprendizado em Microbiologia para o ensino básico.*

PALAVRAS-CHAVE: *Metodologias Ativas. Jogos. Ensino de Microbiologia. Mycobacterium tuberculosis.*

RESUMEN*: Las metodologías activas de enseñanza generan el compromiso estudiantil y promueven un aprendizaje duradero. Este contexto, juegos surgen como una opción para propiciar el interés y la comprensión de conceptos complejos, transmitiendo información de manera lúdica. Así, presentamos el juego de mesa "Respingo Letal", desarrollado por estudiantes de Ciencias Biomédicas del ICB/USP. Centrado en el género Mycobacterium, permite a los participantes explorar y comprender la especie Mycobacterium tuberculosis y conceptos generales de Microbiología. Se aplicó a estudiantes de primaria y secundaria (n=216) en escuelas públicas del estado de São Paulo, y su eficacia fue evaluada mediante cuestionarios basados en la Escala de Likert y nubes de palabras. Se notó el interés de los estudiantes por la dinámica del juego y el aumento en el aprendizaje, ambos con más del 75% de respuestas favorables, posicionando a "Respingo Letal" como herramienta eficaz para el aprendizaje de Microbiología en educación básica.*

PALABRAS CLAVE*:* Metodologías Activas. Juegos. Enseñanza de Microbiología. *Mycobacterium tuberculosis.*

Introduction

In Brazilian basic education, the teaching of microbiology is predominantly centered on the identification of the various groups of microorganisms and their respective diseases, covering only a few viruses, bacteria, and protozoa (Ministry of Education, 2018). Despite being part of the educational curriculum, students' understanding of this subject faces challenges related to the current pedagogical structure. A notorious example is the traditional teaching methodology, which is often questioned as to its actual effectiveness in assimilating specific concepts or content (Armellini, 2021).

In the context of the biological sciences, it has been pointed out that students have difficulty understanding, retaining, and applying the concepts taught in class, a situation that can be partly explained by the way in which this knowledge is transmitted to students. An analysis of teaching materials for introductory biology classes in higher education showed that the main focus is memorizing and understanding facts (Momsen *et al*., 2010). The traditional methodology of transmitting knowledge, focused only on the teacher as an expositor of the content and the student as a passive element who captures and memorizes information, generates superficial and limited learning in terms of the ability to retain concepts (Güneş, 2020). As a result, students tend to show a lack of interest in the specific subject (Vander, 1994).

In order to increase student interest and make the learning experience more attractive, active teaching methodologies have emerged. Based on the principles of student protagonism and teacher mediation, active methods begin in practice and only then move on to theory, in other words, they shift the focus from "teaching" to "learning" (Diesel; Baldez; Martins, 2017). By placing the student in the role of active constructor of their knowledge, the integration of new knowledge with their perceptions and external experiences makes learning more effective (Armellini, 2021). Among the theoretical currents, Vygotsky (Vygotsky, 1967) highlights the importance of socialization in the construction of knowledge, since he advocates that cognitive development, i.e. learning, occurs when the individual appropriates knowledge from other people, from books, from activities carried out and from solving problems in collaboration with peers (Diesel; Baldez; Martins, 2017).

This idea is also seen in the thinking of Freire, the author with whom Brazilian educators are most familiar (Suzuki; Fries, 2023), who defines teaching as a process based on the most diverse interactions between individuals, from actions to words (Freire, 2005; Diesel; Baldez;

Martins, 2017). In Brazil, although active methodological approaches can be observed in higher education, there is a lack of these methods in basic education (Suzuki; Fries, 2023).

In this context of student protagonism, educational games have emerged as allies in consolidating specific subjects, such as microbiology. Such resources offer students the opportunity to absorb new knowledge in a multi-sensory way, in a dynamic environment that requires active participation (Cheung; Ng, 2021), which keeps them engaged in the challenges proposed during the game's dynamics. In addition, it is also worth highlighting the immediate obtaining of results and feedback on answers, which eliminates the need to wait for corrections from teachers as occurs in conventional tests and assignments (Cheung; Ng, 2021), as well as social interaction, which allows for the construction of knowledge through the appropriation of knowledge discussed in groups and collaboration in the discussion of solutions, as discussed in Vygotsky's fundamentals. In fact, this approach with games is recognized as "more interesting, motivating, conducive to knowledge retention and capable of increasing attention" (Cheung; Ng, 2021, our translation).

With these characteristics of the acquisition of knowledge provided by games and the importance of literacy in microbiology in mind, the board game called "*Respingo Letal*" was developed by students of the Biomedical Sciences undergraduate course at the Institute of Biomedical Sciences of the University of São Paulo (ICB-USP), as an activity carried out in the "Adopt a Bacterium" Project of the Bacteriology discipline (Botte *et al*.2014; Piantola *et al*., 2018; Taschner *et al*., 2020). *Respingo Letal* is a board game whose aim is to answer questions about aspects ranging from morphology, metabolism, pathogenesis, and epidemiology centered on the genus *Mycobacterium*, allowing participants to explore and understand not only the species of *M. tuberculosis and M. leprae*, but also basic concepts about the Monera Kingdom.

To analyze the game as a tool for active learning in microbiology, two qualitative methods of analysis were used: a questionnaire with 9 statements that were evaluated using a Likert scale (Likert, 1932), and the assembly of word clouds from the answers used by the students (Armellini, 2021). The game was applied to three second and third-year high school classes and one ninth-year elementary school class in three public schools in the state of São Paulo (capital, Sorocaba, and Agudos). The results show that the game stimulated students' interest in a playful way, generated engagement, and facilitated the understanding of concepts in Microbiology. Our work is the first to provide concrete data on the impact of a game about *M. tuberculosis* on elementary school pupils.

Materials and methods

Respingo Letal " board game

The game was designed to be educational, dynamic, and, above all, simple to play, making it versatile and inexpensive compared to other board games. For this reason, the game's entire structure can be printed on an ordinary printer from A4-sized sheets. For some extras, the lack of which doesn't hinder the player's experience, you need containers and something to hit them with, both of which are easy to find. The pawns used to mark the players, cards, identifications, board, rules, and glossary are available in the printable file. If players have any doubts about certain jargon or technical terms, the game comes with a glossary that they can consult at any time, as well as an instruction manual that explains the dynamics of the game.

The board follows a single direction, with a start and finish line. The pawns move according to the stipulations on the question card. Easy and general questions give you the right to advance fewer places than more difficult and specific questions. If the player gets the answer to the question on the card right, they advance the number of squares and receive a "macrophage" card; if they get it wrong, they continue on their current square and receive a "bacterium" card. The "bacteria" and "macrophage" cards are there so that the game isn't just based on luck or that the order of the players gives some advantage to one of them. When someone reaches the final square, the game ends, and the score is based on the difference between each player's "macrophage" and "bacteria" cards. The more "macrophage" cards a player has compared to "bacteria", the more points they have. In this way, the game's score favors the number of correct answers throughout the game.

Houses and special cards have been added to the game to make the experience dynamic and competitive. Events" change the rules of the game and can swap players around the board, divide the "macrophage" and "bacteria" cards between them, and immunize them from the effects of other events. There are two extra events, one of which is a component of the expansion that contains questions about *Mycobacterium leprae*. The "Hit the Target" event brings the player closer to the antibiotics used in treatment and their functions. "Who is more likely" explores the similarities and differences between *Mycobacterium tuberculosis* and *Mycobacterium leprae*.

Student application

The game "*Respingo Letal*" was applied to students from public schools in the state of São Paulo in the 9th grade of Elementary School (EF) II and in the 2nd and 3rd grades. Year Secondary School (MS), as described in the table below (Table 1):

Table 1 - Relationship between the number of students in each grade and their school of origin

School	Date of application	Students' grades	Number of students
IFSP - Sorocaba, SP	June 23, 2023	2nd year of MS	32
EMEF Profa. Wanny Salgado Rocha - São Paulo, SP	September 27th, 2023	9th grade	66
EE Padre João Batista De Aquino - Agudos, SP	June 14th, 2024	2nd and 3rd year of MS	52
IFSP - Sorocaba, SP	June 18th, 2024	2nd year of MS	66
Total number of students = 216 MS: high school EF: primary education			

Source: Prepared by the authors.

Evaluation questionnaire

The qualitative methods used to analyze the game's effectiveness were: the Likert scale and the formation of word clouds generated from the answers given by the students. For the Likert scale, 9 statements were used about learning with the game and the influence of the playful dynamics that favored learning. The answers were given on a graded scale from 1 (strongly disagree) to 5 (strongly agree) according to each student's experience.

The statements were built on the work of Rocha, Bittencourt, and Isotani (Rocha; Bittencourt; Isotani, 2015), which analyzes the various aspects of a game by subdividing them into 4 categories: 1) User reaction to the simulation - related to the experience of the game and its verisimilitude; 2) User reaction to learning with the game - related to the player's perception of knowledge acquisition; 3) User reaction to the game - related to satisfaction and engagement during the game; 4) User reaction to learning during the phases - related to the perception of learning in each phase of the game's progress.

Due to the fact that "*Respingo Letal* " is a single-stage game in which random questions are overcoming, category 4 was not included in the evaluation. The questions, as well as the category evaluated, are shown in Table 2.

Table 2 - Statements present in the questionnaire, which should be answered according to the precepts defined by the Likert scale (Likert, 1932) as well as the evaluation category that each one represents (Rocha; Bittencourt; Isotani, 2015)

NO.	Affirmation	Category
1.	The game allowed me to learn through the experience of answering questions;	User reaction to the simulation
2.	I believe that this game has contributed a lot to adding new knowledge to me;	User reaction to learning with the game
3.	I can relate what I've learned from the game to reality;	User reaction to the simulation
4.	The game added new knowledge and allowed me to keep it thanks to the playful experience;	User reaction to the simulation
5.	I gained more knowledge about *M. tuberculosis* during the game;	User reaction to learning with the game
6.	The dynamics of the game helped me to keep my attention and motivation on the subject;	User reaction to the game
7.	The content of the game is relevant to learning about *M. tuberculosis*;	User reaction to learning with the game
8.	It was easy to use the game as learning material;	User reaction to the game
9.	I enjoyed the game and didn't feel anxious or bored by it.	User reaction to the game

Source: Prepared by the authors.

The word clouds were assembled from answers to an essay question ("Do you have any criticisms or suggestions for improving the game?"), in which the students were able to express their opinions, suggestions, and criticisms about the experience of playing "*Respingo Letal*". The word clouds were generated using the program *Word Cloud Generator by Jason Davie*[6]*s.*

Ethics

The game and questionnaires were administered to students from the 9th year of elementary school to the 3rd year of secondary school. Before distributing the questionnaires,

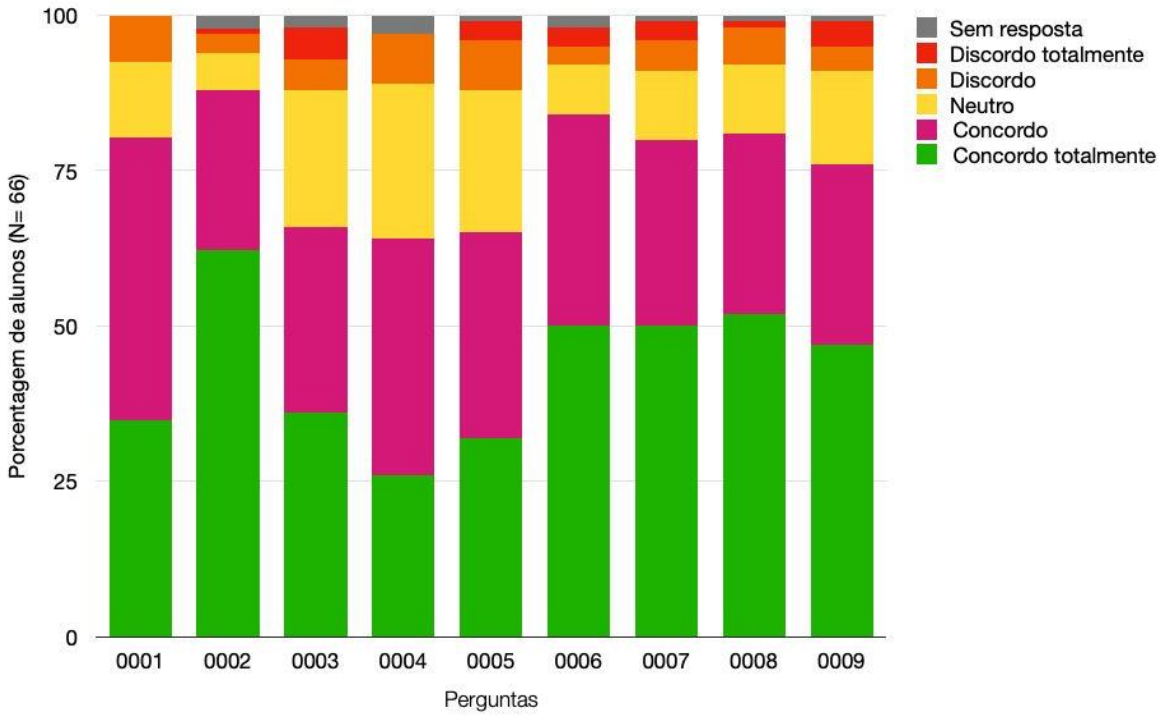
[6] Available at: https://www.jasondavies.com/wordcloud/.

students were told that participation was optional, anonymous, and non-evaluative. The study was approved by the ethics committee of *Plataforma Brasil* (CAAE: 51764021.0.0000.5467).

Results

For the construction of "*Respingo Letal*", the card game with board model was selected, because among the existing game mechanics, this variety has benefits for the learning process by allowing players to come into contact with microbiology content directly to advance in the game. As it is a physical game, it allows students to build their knowledge through social interactions with other students, which favors the consolidation of shared knowledge. By creating a competitive scenario, students are encouraged to concentrate on the activity, acquire information, and establish strategies to ensure their success, which combines learning with motivated engagement.

Figure 1 - Likert scale analysis of the game questionnaire, 9th grade - EMEF Profa. Wanny Salgado Rocha[7]



Source: Prepared by the authors.

Based on the data collected during the application of the game to 9th-grade students, a Likert scale was drawn up, as shown in Figure 1. Approximately 80% of the 9th graders agreed

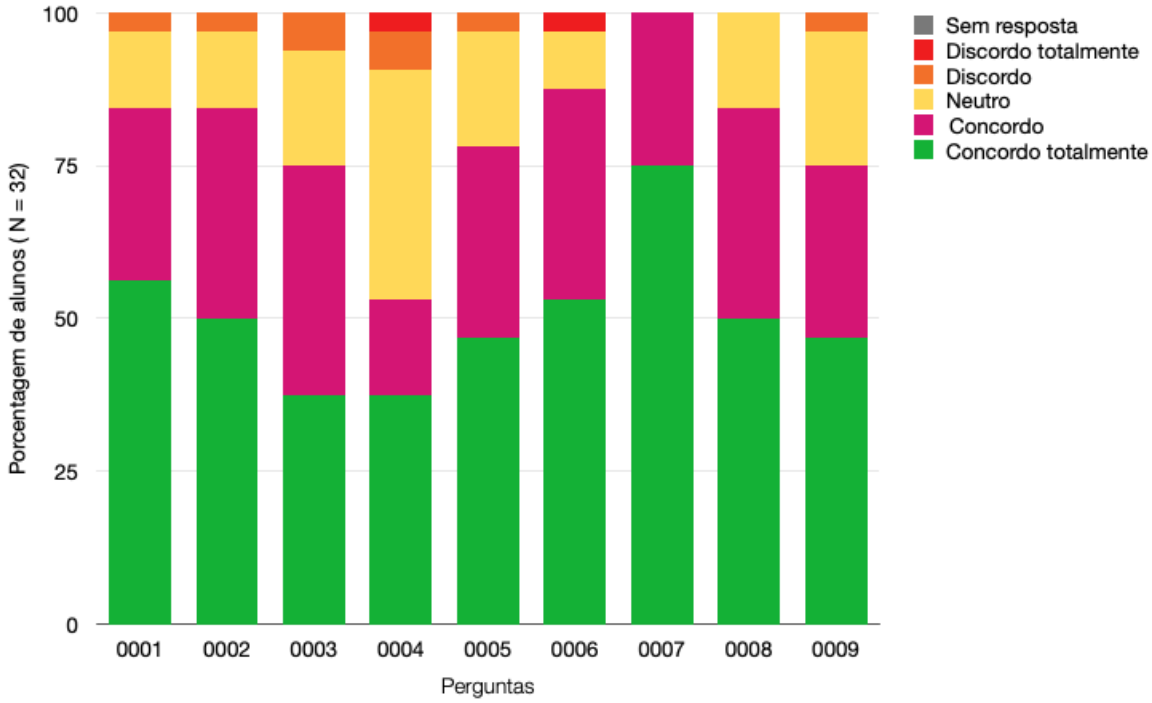
[7] Translation from top to bottom: No response; Strongly disagree; Disagree; Neutral; Agree; Strongly agree.

that the game helped to add new knowledge and that the dynamics helped to maintain attention and concentration. More than 75% agree that the response mechanism enabled learning, that the content is relevant to learning about M. tuberculosis, and that it was easy to use the material for this purpose. Based on the answers to the open question, a cloud of words used by the students was drawn up (Figure 2). Words like "interesting", "fun", "cool", "liked" and "great" were highlighted. The suggestion to make the game easier is inferred by the use of the term "difficult" by elementary school students.

Figure 2 - Word cloud formed from answers to the essay question asked by 9th grade students - EMEF Profa. Wanny Salgado Rocha

Source: Prepared by the authors.

Figure 3 - Likert scale analysis of answers to the questionnaire about the game, applied to 2nd year students of the MS - IFSP (2023)[8]



Source: Prepared by the authors.

With regard to the students at the Federal Institute of São Paulo, in Sorocaba, the results generated by the answers to the questionnaire about the game "*Respingo Letal*" are shown in Figure 3. All high school students agree that the content covered in *Legal Splash* is relevant to learning about *M. tuberculosis*, with more than 75% considering the game easy to use for learning (Figure 3).

In addition, more than 75% of the students agreed that the game's question mechanism helped them learn the microbiology concepts covered and that the playful dynamics helped keep their attention and concentration on the topic. In the essay question, the most used descriptors were "fun", "interesting", "good", "I liked it", "I loved it" and "learning", showing that the students felt that using "*Respingo Letal* " allowed them to learn in a relaxed way (Figure 4).

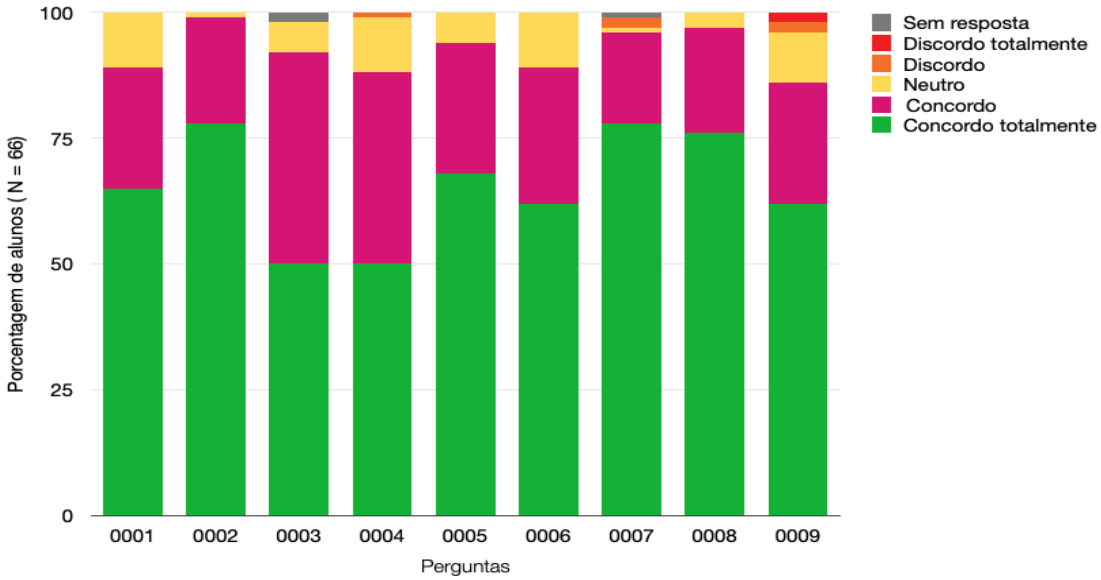
[8] Translation from top to bottom: No response; Strongly disagree; Disagree; Neutral; Agree; Strongly agree.

Figure 4 - Word cloud formed from the answers to the essay question asked by 2nd year students at the IFSP in 2023

Source: Prepared by the authors.

A similar response pattern was observed in the evaluations made among IFSP students in 2024 (Figure 5), with positive evaluations of all the questions asked in the questionnaire, with the percentage of "agree" being over 80% of the answers to the 9 questions. As for the word cloud made from the answers given by the students in the respective year (Figure 6), there was a positive evaluation, with the use of the terms "I liked it", "I loved it", "fun", "creative" and similar.

Figure 5 - Likert scale analysis of answers to the questionnaire about the game, applied to students in the 2nd year of primary school - IFSP, year 2024[9]



Source: Prepared by the authors.

Figure 6 - Word cloud of the game's questionnaire based on the answers given by students from the 2nd year of primary school - IFSP, in the year 2024[10]

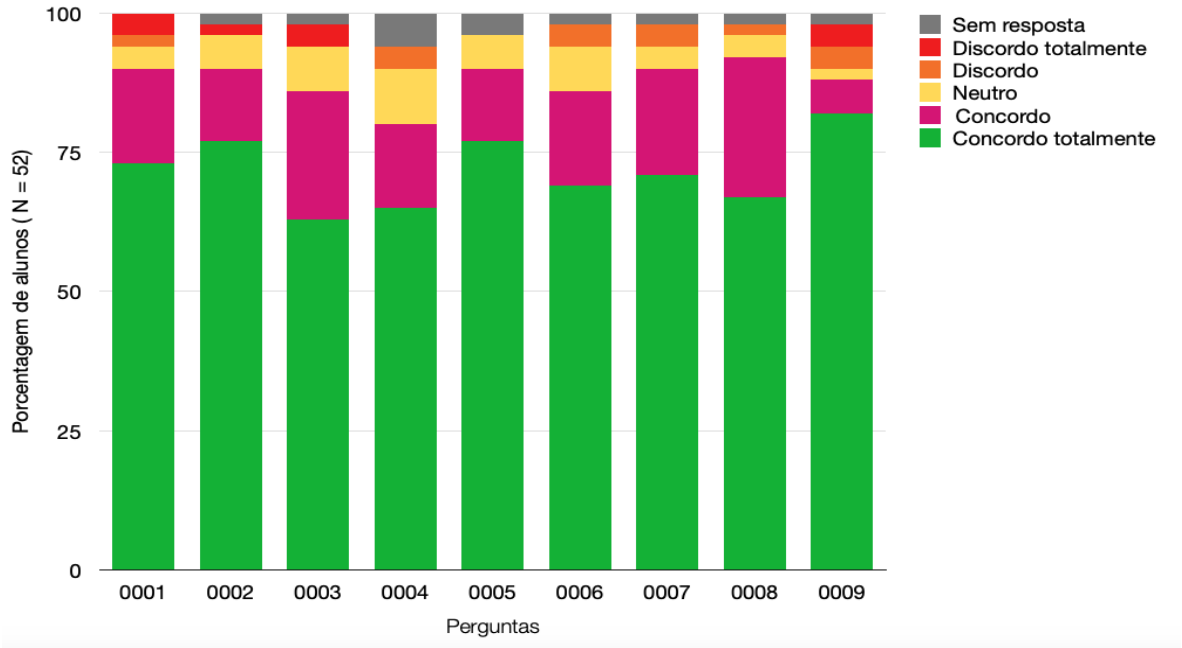
Source: Prepared by the authors.

Finally, we analyzed the responses of the 2nd and 3rd-year students at the Padre João Batista De Aquino School (Figure 7), which also shows that more than 80% of the students responded positively to all the questions about the relevance of the game as playful teaching

[9] Translation from top to bottom: No response; Strongly disagree; Disagree; Neutral; Agree; Strongly agree.
[10] Translation from top to bottom: No response; Strongly disagree; Disagree; Neutral; Agree; Strongly agree.

material. However, there is a more significant amount of disagreement, mainly due to the presence of "totally disagree" answers, in greater numbers than when compared to the other applications for high school classes. Despite this, the percentage of positive reviews for the game was over 80%. The word cloud assembled from the school students' answers to the essay question (Figure 8) shows the same pattern as previously observed, with the words "perfect", "very good", "I liked it" and "very interesting" gaining prominence.

Figure 7 - Likert scale analysis of the answers to the questionnaire about the game, applied to students in the 2nd and 3rd years of the MS at the Padre João Batista De Aquino School[11]



Source: Prepared by the authors.

[11] Translation from top to bottom: No response; Strongly disagree; Disagree; Neutral; Agree; Strongly agree.

Figure 8 - Word cloud from the game's questionnaire based on the answers given by students in the 2nd and 3rd years of primary school - E. E. Padre João Batista De Aquino

Source: Prepared by the authors.

In general, the results indicate that the game is a fun and effective tool for learning Microbiology among elementary school students, but the content covered was more appropriate for secondary school students, although elementary school students were also able to follow the dynamics and acquire new concepts. In both groups, applying the game increased the students' curiosity about microbiology.

Discussion

The "*Respingo Letal*" is about two mycobacteria of public interest: *Mycobacterium tuberculosis* (which causes tuberculosis) and *Mycobacterium leprae* (which causes leprosy). According to data from the 2024 tuberculosis epidemiological bulletin (Ministry of Health, 2024), although the incidence rate of tuberculosis in Brazil decreased from 2022 (38 cases per 100,000 inhabitants) to 2023 (37.0 cases per 100,000 inhabitants), the incidence of tuberculosis in children under 15 has been increasing since 2020, reaching 3.6% in 2023. Of this total in children under 15, 36.6% are between 0 and 4 years old.

The game draws attention to these public health problems in the national context through questions that cover not only information about *Mycobacterium* but also curiosities and general microbiology topics. In this sense, "*Respingo Letal*" aims to encourage players to learn without necessarily requiring a previous lesson on the subject, giving them autonomy to acquire knowledge. In addition, through questions that provide a snapshot of the social epidemiological panorama, the game also instigates the curiosity and critical sense of the participants. Our work

stands out from others on tuberculosis by evaluating a tool that doesn't require previous lessons, providing data on players' opinions, and comparing possible age groups of the material produced.

The distribution of "totally disagree" answers when the game was applied in 9th grade was present in 7 out of 9 statements, while in high school, there were only 4 out of 9. The only ones in which they didn't appear were "The game allowed me to learn through the experience of answering questions" and "The game added new knowledge and allowed me to keep it thanks to the playful experience", both questions in the "user reaction to the simulation" category, i.e. related to the experience of the game and its verisimilitude. The ones with the highest rates of disagreement were 3 ("I can relate what I learned from the game to reality") and 9 ("I enjoyed the game and didn't feel anxious or bored because of it"). The responses resulting from the word cloud made it clear that the students found the game difficult, which may have contributed to a feeling of anxiety and boredom as they were unable to fully engage with the dynamics and relate the material to their life experiences.

Despite this, the proportion of positive responses ("totally agree" and "agree") is notable in questions 1, 2, 6, 7, 8, and 9, all equal to or greater than 75%. Those with a lower proportion of positive responses (around 60%) were "I can relate what I learned from the game to reality", "The game added new knowledge and allowed me to keep it thanks to the fun experience" and "I acquired more knowledge about *M. tuberculosis* during the game".

Looking at the IFSP, in 2023 the statements that had "totally disagree" answers were "The game added new knowledge and allowed me to keep it thanks to the playful experience" and "The dynamics brought by the game helped me to keep my attention and motivation on the subject". The first was also the one that received the fewest positive responses, with just over 50%. All the others, however, were equal to or higher than 75%, with 7 ("The content of the game is relevant to learning about *M. tuberculosis*") achieving 100% approval. This may indicate that, although the students felt that the game was able to allow them to add new knowledge and that the mechanism of answering questions allowed them to learn, the experience of the game was not the main factor. However, this panorama changes for the year 2024, in which the only statement with "totally disagree" was "I enjoyed the game and didn't feel anxious or bored because of it", and even then, all the statements, including this one, received more than 75% positive responses, with the majority (6 out of 9) not receiving any negative opinion ("disagree" or "totally disagree"). The clouds reinforced that, overall, the

response to the game was positive, with the 2024 questionnaire showing that the students found the language of the game easy.

For E. E. Padre João Batista De Aquino, there were "totally disagree" responses to statements 1 ("The game allowed me to learn through the experience of answering questions"), 2 ("I believe that this game contributed a lot to adding new knowledge to me"), 3 ("I can relate what I learned from the game to reality") and 9 ("I enjoyed the game and didn't feel anxious or bored because of it"). However, the scale showed a positive response of over 75% in all questions, and the highest proportion of "totally agree" to "agree" among all applications, with the word cloud also reflecting the positive reception to the game.

Considering the high proportion of positive responses to most of the statements during the high school applications, as well as the lower prevalence of negative responses and the word cloud showing appreciation for the game, compared to the positive reactions to the game in 9th grade, with a higher prevalence of negative responses and the word cloud indicating the game was more complex, we consider high school to be the ideal age group for applying the game. However, despite the higher prevalence, it is notable that the negative responses from 9th graders were very low, and that the participants reported having enjoyed and had fun during the dynamics, saying they found the game interesting. Thus, although the ideal range is high school students, younger students also report learning gains from the game. In this sense, one of the limitations of our work arises, since we didn't use quantitative methods to measure students' knowledge, only self-declaration.

Of all the statements, the one that tended to receive the fewest positive responses in all the questionnaires was #4: "The game added new knowledge and allowed me to keep it thanks to the playful experience." Considering that statements 1 and 2 received more than 75% positive responses in all applications ("The game allowed me to learn through the experience of answering questions" and "I believe that this game contributed a lot to adding new knowledge to me"), which relate to both learning and the game's playful dynamics, this result seems to indicate that the students don't feel that they have retained the content learned during the game or that they have, but not because of the playful experience.

It is difficult to assume either explanation, given that no tests have been carried out on the acquisition of knowledge and its long-term maintenance. However, it is known that building and solidifying knowledge requires remembering the information, understanding it, and applying it (Ferraz; Belhot, 2010), a process that is made more difficult when the game is used only once. Despite this, the "totally disagree" responses to this statement were not very high,

with positive and neutral responses prevailing. All of this indicates that, when faced with new knowledge, it is essential to consider ways of continuing to work on the acquired content so that it sticks, such as, for example, making multiple applications of the game or working on the content in class.

Final considerations

With the internet's widespread use and the rapid development of hardware and electronic components that make cell phones and computers increasingly agile, electronic and digital games have become widely prevalent among children and adolescents. Choosing a physical game, however, has advantages, such as promoting social interaction and interpersonal relationships, allowing players to interact and learn from each other. What's more, a physical game eliminates dependence on internet quality and the need for electronic devices, and can be reused for several years after printing.

The "*Respingo Letal*" addresses *Mycobacterium tuberculosis* and *Mycobacterium leprae*. In Brazil, the growing incidence of tuberculosis among children under 15 highlights the importance of disseminating information about tuberculosis in schools. The game draws attention to these serious public health issues within the national context, often overlooked by the general population, through epidemiological questions that encourage students to reflect on the most vulnerable populations to tuberculosis, the continents and Brazilian states most affected by the disease, as well as information on transmission, treatment, and general aspects of mycobacteria and microbiology. The objective is not only to convey relevant content about tuberculosis but also to spark curiosity and critical thinking among students. The responses from high school and elementary school students in public schools in São Paulo revealed that the "Lethal Splash" successfully evoked such reactions.

In high school, the vast majority of students agreed that the game provided relevant information about *M. tuberculosis*. In addition, the game managed to keep the students motivated, thanks to its dynamics. In this way, it can be seen that the learning tool has fulfilled its role of transmitting knowledge, ensuring that the student remains motivated and does not become discouraged by the subject of Microbiology. In relation to elementary school, even with the difference in content, the pattern of results remains, and the students showed that the game was important for learning about the disease and the infectious agent.

Educational board games have already been described for viruses (Wanyama *et al.,* 2012) (Lennon; Coombs, 2007), microbiota (Coil; Ettinger; Eisen, 2017) and even *M. tuberculosis* (Silva *et al.*, 2024), among others. Despite this, this is the first paper to present data resulting from the application of a game focusing on *M. tuberculosis* to students, demonstrating, through the results of the Likert scale and word cloud, the students' opinion on "*Respingo Leta*". In addition, the study sought to evaluate the age group with which the game is best suited, analyzing both elementary and high school students, which resulted in relevant information about the insertion of this tool in basic education.

Furthermore, the development and application of the game had a positive impact on the undergraduate students involved, not only in terms of their academic performance, considering the extensive research and learning work involved in developing a scientific game, but also in terms of their professional training. This experience allowed the students to be in contact with scientific dissemination initiatives for the community through academic extension activities. Direct contact with primary education also promoted the development of the undergraduates' critical and social vision by challenging them to convey complex content in a simple, fun, and accessible way.

It is therefore clear that the fact that the #Adote Project encourages and provides tools for the creation of science communication materials, based on the "Adopt a Bacteria" active teaching methodology, plays a significant role in training professionals interested in disseminating microbiology content in society and organizing academic extension activities.

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