



EVALUATION OF THE GAME *COMBATE À DENGUE* AS AN EDUCATIONAL TOOL: PERCEPTION OF STUDENTS AND ENDEMIC DISEASE CONTROL AGENTS

AVALIAÇÃO DO JOGO COMBATE À DENGUE COMO FERRAMENTA EDUCACIONAL: PERCEPÇÃO DE ESTUDANTES E AGENTES DE COMBATE A ENDEMIAS

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*Brenda Dalla Costa Rossato*¹

*Alana Ames*²

*Marcelo Monteiro*³

*Eduardo Marschal Schabarum*⁴

*Adriano Franceschi*⁵

*Samara Cristina Mazon*⁶

*Junir Antônio Lutinski*⁷

*Maria Assunta Busato*⁸

1 Undergraduate student in Biomedicine - Community University of the Chapecó Region (Unochapecó).

2 Undergraduate student in Biomedicine - Community University of the Chapecó Region (Unochapecó).

3 Graduated Student of the Postgraduate Program in Health Sciences - Community University of the Chapecó Region (Unochapecó).

4 Undergraduate student in Biological Sciences - Community University of the Chapecó Region (Unochapecó).

5 Undergraduate student in Biological Sciences - Community University of the Chapecó Region (Unochapecó).

6 PhD in Environmental Sciences - Community University of the Chapecó Region (Unochapecó).

7 Professor in the Postgraduate Program in Health Sciences - Community University of the Chapecó Region (Unochapecó).

8 Professor in the Postgraduate Program in Health Sciences - Community University of the Chapecó Region (Unochapecó).

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ABSTRACT

This study assessed the effectiveness of the digital game *Combate à Dengue* as a health education tool. A total of 24 elementary school students and 69 Endemic Disease Control Agents (EDCAs) from Chapecó, Santa Catarina, participated. Qualitative and quantitative questionnaires were administered after participants played the game, either alone or in groups, using smartphones or tablets provided by the researchers. Among the EDCAs, 94.1% viewed the game as an innovative way to reinforce knowledge, and 76.8% said it increases the perceived value of the agent's role within the community. Among students, 91.7% already correctly identified *Aedes aegypti* breeding sites, showing engagement and offering suggestions for improvement, such as adding new scenarios and stages. The findings support gamification as an effective and promising strategy for public health efforts, learning, and dengue prevention.

Keywords: *Aedes aegypti*, Gamification in education, Dengue, Public health.

RESUMO

Este estudo avaliou a eficácia do jogo digital *Combate à Dengue* como uma ferramenta de educação em saúde. Participaram 24 estudantes do ensino fundamental e 69 Agentes de Combate a Endemias (ACEs) de Chapecó, Santa Catarina. Questionários qualitativos e quantitativos foram aplicados após os participantes jogarem, individualmente ou em grupos, utilizando smartphones ou tablets fornecidos pelos pesquisadores. Entre os ACEs, 94,1% consideraram o jogo uma maneira inovadora de reforçar o conhecimento e 76,8% disseram que ele aumenta a importância do papel do agente na comunidade. Entre os estudantes, 91,7% já identificavam corretamente os locais de reprodução do *Aedes aegypti*, mostrando engajamento e oferecendo sugestões de melhoria, como a adição de novos cenários e fases. Os resultados aprovam a gamificação como uma estratégia eficaz e promissora para os esforços de saúde pública, aprendizado e prevenção da dengue.

Palavras-chave: *Aedes aegypti*, Gamificação na educação, Dengue, Saúde pública.

1. INTRODUCTION

Dengue is an arboviral disease caused by the dengue virus (DENV; genus *Flavivirus*, family *Flaviviridae*), which comprises four antigenically distinct serotypes (DENV-1, DENV-2, DENV-3, and DENV-4). Infection occurs through the bite of a female *Aedes aegypti* (Linnaeus, 1762) mosquito during its blood meal. It represents a significant public health

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concern due to the geographic expansion of the vector, population growth, and persistent limitations in vector control strategies (Andrioli, Busato, Lutinski *et al.*, 2020; OPAS, 2024).

Preventing dengue relies on effective public policies for vector control, community participation, and improved health education programs. In this context, educational digital games have emerged as innovative tools that support surveillance and health promotion efforts (Silva, Mallman, Vasconcelos., 2015; Silva *et al.*, 2008). Specifically in health education related to dengue vector control, gamification involves elements of interaction, challenge, and reward that increase cognitive engagement, facilitate learning, and encourage the adoption of preventive behaviors (Goulart, Silveira, Moreira, 2019; Alves *et al.*, 2022).

Games offer a playful yet effective way to promote health. When grounded in educational theory, they not only spark interest in the topic but also encourage learning and skill-building through interactivity by mimicking real-world situations (Tang *et al.*, 2021; De Carvalho *et al.*, 2025). In this way, educational games focused on dengue prevention stand out from traditional methods by making learning more accessible and engaging. They also support the efforts of Endemic Disease Control Agents (EDCAs) and help educate elementary and high school students about civic responsibility.

EDCAs are public health professionals within Brazil's Unified Health System (SUS) who play a frontline role in preventing and controlling vector-borne diseases. Their responsibilities include inspecting residential and commercial premises to identify and eliminate mosquito breeding sites, educating the public on preventive measures, applying larvicides and insecticides, and collecting data to support public health planning (Ministério da Saúde, 2025).

By incorporating playful elements and meaningful challenges into teaching and learning, gamification encourages cooperation, critical thinking, and social responsibility, all key to citizenship development among children and adolescents. Using gamified educational methods boosts students' active participation and sense of belonging within their communities. Additionally, gamification supports holistic education by fostering ethical

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behavior, empathy, and collaboration — skills vital for creating a democratic and participatory culture in schools (Alves, Bianchin, 2024) — with measurable benefits for public health.

This study aimed to assess students' and EDCAs' perceptions of the educational potential of the digital game *Combate à Dengue*, considering its use as a pedagogical and innovative tool to improve health education efforts and reduce the impacts of the dengue vector.

2. METHODOLOGY

2.1 Study design and setting

This study was descriptive and exploratory, with an applied and evaluative focus, and used a mixed-methods approach combining quantitative and qualitative components. Field research involved direct data collection from participants. This design was chosen to facilitate a participatory understanding of perceptions and experiences related to using gamified tools in health education, integrating both objective and subjective data (Bardin, 2016), specifically focusing on dengue.

The research took place in the municipality of Chapecó, located in the western region of the state of Santa Catarina, southern Brazil. Chapecó has a population of 275,959 inhabitants distributed over an area of 624.673 km², with a population density of 407.76 inhabitants per km². The predominant biome is the Atlantic Forest, and the urbanized area covers approximately 66.00 km² (Ministério da Saúde, 2013).





2.2 Participants

The study included Endemic Disease Control Agents (EDCAs) involved in municipal surveillance and control activities targeting *Ae. aegypti*, along with eighth and ninth grade elementary school students from a private school. Sampling was intentional and non-probabilistic, considering the direct involvement of EDCAs in public health actions and the strategic role of students as multipliers of good health practices.

2.3 Game Description

Combate à Dengue is a cross-platform mobile app available for Android and iOS. To access it, find the app in your phone's store. The game was created as a gamified health education tool designed to promote learning through interactive engagement. In the game, the player assumes the role of an Endemic Disease Control Agent who visits homes and backyards to identify and eliminate *Ae. aegypti* breeding sites.

Throughout gameplay, users interact with non-playable characters (NPCs) who provide information on preventive measures, symptoms, and best practices for dengue prevention (Figure 1). One of the main interactive elements is the use of an electric racket to eliminate visible mosquitoes in the game environment, promoting engaging, interactive awareness of vector control (Figure 2).





Figure 1. NPCs who provide information on preventive measures



Source: Compiled by the author himself

Figure 2. Electric racket to eliminate visible mosquitoes



Source: Compiled by the author himself

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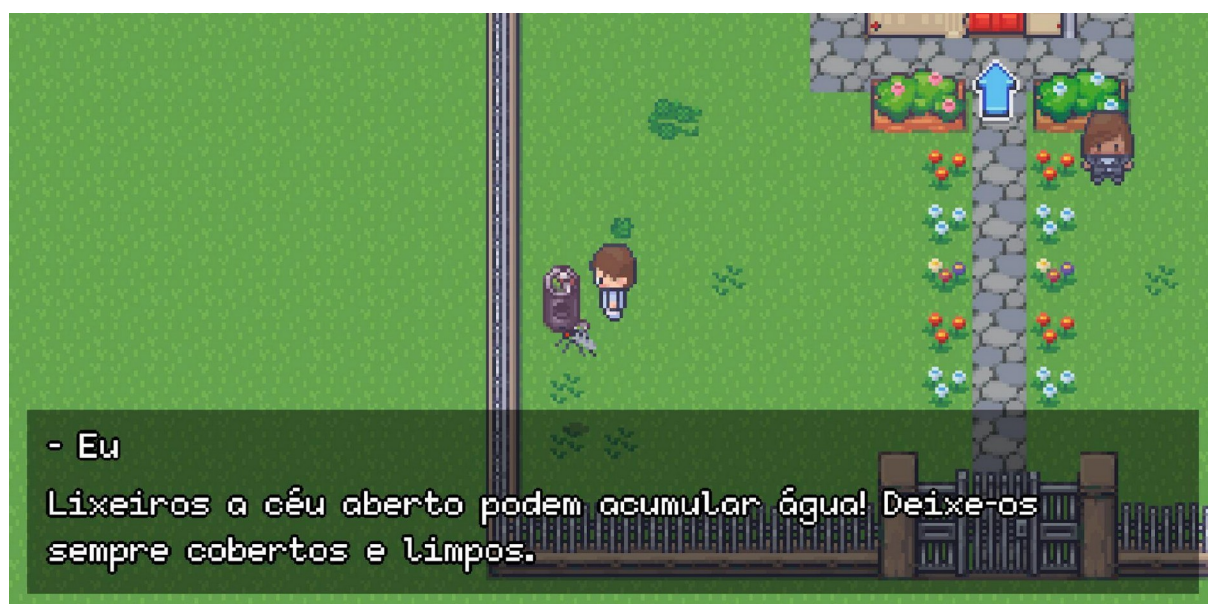
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The main goal of the game is to locate and eliminate all mosquito breeding sites, interact with all NPCs, and remove mosquitoes present in the scenario, combining entertainment with meaningful learning through the simulation of real-world situations (Figure 3). The game was developed by a startup in collaboration with the authors of this research and currently includes two stages: one in a residential environment and the other in a school environment.

Figure 3. Simulation of real-world



Source: Compiled by the author himself

2.4 Data Collection and Analysis

Endemic Disease Control Agents (EDCAs) were gathered in an auditorium where the *Combate à Dengue* game was presented and the activity's procedures were explained. All participants tested the game either on their own mobile phones, where the application had been pre-installed, or on tablets provided by the researchers. The activity was conducted both

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individually and in groups to assess the game's effectiveness and to collect suggestions for potential improvements.

The same activity was conducted with elementary school students in a university classroom setting. After the gameplay session, participants completed a structured questionnaire comprising both open- and closed-ended questions, organized into four thematic sections: participant profile, game experience and usability, educational impact, and suggestions for improving the interface and functionality.

Responses were recorded using the Google Forms platform. Quantitative data were analyzed through descriptive statistics, while qualitative data were examined using Bardin's (2016) (Ministério da Saúde, 2016) content analysis method to identify perception patterns and emerging categories.

Ethical considerations: The study adhered to all ethical guidelines set by Resolutions No. 466/2012 and No. 510/2016 of the Brazilian National Health Council (Bruno, Carvalho, Monteiro, 2022; Chavez *et al.*, 2024). The Research Ethics Committee approved the research protocol under approval number 7.601.865. All participants were fully informed about the study's objectives and procedures and provided written informed consent before participating.

3. RESULTS

3.1 Endemic Disease Control Agents

The study included 69 Endemic Disease Control Agents (EDCAs) from the municipality of Chapecó, Santa Catarina, aged 21 to 62 years, with the majority aged 23 to 48 years (mean age: 30 years). The group presented a homogeneous profile regarding their experience with the topic, as all participants were professionals actively engaged in surveillance and control activities targeting *Ae. aegypti*.

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The results revealed a highly positive assessment of the digital game *Combate à Dengue* as a supportive tool for health education. Most participants (94.1%) reported that the game reinforced their knowledge of dengue and its prevention innovatively and interactively, while 76.8% recognized its contribution to strengthening EDCAs' work within the community. Participants emphasized that the game could complement existing educational activities and enhance communication between agents and the general population.

Regarding applicability, 73.9% recommended using the game in schools and activities involving children and adolescents, 15.9% suggested its use during household visits, and 18.7% proposed including it in community campaigns and lectures. These results demonstrate an increased understanding of the game's pedagogical potential.

The main suggestions for improvement centered on adding new challenges and educational missions (53.6%), followed by ideas to enhance accessibility (18.8%) and to include more detailed information (11.6%). A smaller segment (8.8%) felt the game is sufficient in its current form. Qualitative feedback showed a desire to boost realism and interactivity by introducing new scenarios (e.g., cemeteries and vegetated areas), features that direct residents to gutters and hard-to-reach areas, and interface updates to accommodate different user profiles, including left-handed players.

Content analysis following Bardin's (2016) (Ministério da Saúde, 2016) framework organized responses into four thematic categories: educational effectiveness and learning potential, engagement and practical applicability, limitations and suggestions for improvement, and professional appreciation and strengthening of the EDCA's role.

In the *educational effectiveness and learning potential* category, participants identified the game as an effective tool for transmitting and reinforcing knowledge about vectors and dengue prevention, highlighting its playfulness as a facilitator of learning. The *engagement and practical applicability* category underscored the interest and motivation generated by the activity, especially in school contexts, with participants viewing the game as a resource that





connects technical knowledge to social reality and broadens the reach of prevention campaigns.

The *limitations and suggestions for improvement* category gathered technical and pedagogical recommendations, evidencing the agents' critical and collaborative involvement in the evaluation process. Finally, the *professional appreciation and strengthening of the EDCA's role* category emphasized the symbolic impact of the game, which was recognized as a tool that enhances the visibility of the agents' importance in arbovirus prevention and reinforces their professional identity.

Overall, the findings show that EDCAs see *Combate à Dengue* as an innovative, interactive, and supplementary educational tool that supports epidemiological surveillance, enhances community involvement, encourages meaningful learning, and helps recognize the roles of agents in health promotion.

3.2 Students

The study involved 24 elementary school students aged 13 to 15 years (average age: 14), enrolled in the 8th and 9th grades at a private school in the municipality of Chapecó, Santa Catarina. The group exhibited a consistent profile in terms of age and educational level, making them an ideal target audience for health promotion educational programs.

Most students (66.7%) reported receiving information about dengue in the school environment, indicating prior exposure to the topic. Regarding specific knowledge of the vector, 91.7% of participants correctly identified the behavior of *Ae. aegypti* in laying eggs in containers with stagnant water and other favorable breeding sites such as tires, uncovered water tanks, and clogged gutters.

Regarding perceived learning, 75% of students considered it very important to know how to identify and eliminate mosquito breeding sites. In comparison, 33.3% emphasized raising awareness among others about the disease, reflecting collective consciousness and a

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sense of social responsibility. A total of 25% rated all aspects addressed by the game, including vector identification, prevention methods, and control measures, as equally relevant, whereas 8.3% highlighted learning how to avoid mosquito bites as the most significant aspect.

The use of the digital game *Combate à Dengue* proved effective in enhancing understanding of preventive concepts and practices. Following the activity, 79.2% of students stated they felt capable of adopting dengue prevention measures in their homes and communities, 16.7% indicated they would still require adult assistance, and only 4.1% reported minor doubts about the correct preventive actions. These findings demonstrate effective knowledge assimilation and a positive influence on participants' autonomy in adopting preventive behaviors.

Based on students' responses, three thematic categories were identified: learning and knowledge retention, engagement and social awareness, and autonomy and co-responsibility. The first category highlighted the game as a supportive learning tool that helps retain information about the mosquito vector and the importance of environmental control. The second emphasized the motivating and interactive role of gamification in fostering curiosity and encouraging both emotional and cognitive engagement. The third underscored the internalization of preventive attitudes, shown in students' willingness to apply and share what they learned within their family and community settings.

4. DISCUSSION

Controlling *Ae. aegypti*, the mosquito vector responsible for transmitting dengue, Zika, and chikungunya viruses, remains a public health priority. Raising community awareness through educational initiatives can significantly contribute to reducing disease incidence. In the context of science communication, playful and interactive strategies have gained prominence as effective tools for bridging the gap between the public and the complex issues

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surrounding arboviruses, the mosquito vector's life cycle, and preventive practices (IBGE, 2023).

The educational game was well received by both Endemic Disease Control Agents (EDCAs) and students. This perception suggests that the game holds considerable potential as a complementary tool to existing dengue control initiatives, reinforcing the importance of integrating playful technologies into health education strategies.

Most EDCAs (76.8%) regarded the tool as effective for health education activities in schools and the broader community. This finding indicates that the game is not merely a technological novelty but a practical, applicable resource, validated by professionals on the front lines of *Ae. aegypti* control. The perception that the game reinforces knowledge innovatively and interactively aligns with current trends in health gamification, which, according to Soares Neto et al. (2016) (Soares Neto *et al.*, 2016) and Miguel and Sarinho (2019) (Miguel, Sarinho, 2019), aim to increase engagement and knowledge retention compared with traditional awareness methods such as the distribution of informational leaflets.

The evaluation also revealed an additional benefit: the enhancement of professional self-worth among EDCAs. In a context where their work is often undervalued or misunderstood by the public, a tool that helps communicate the importance of their role carries both social and professional significance.

Among students, it was notable that most already possessed some prior knowledge about dengue. This does not diminish the educational value of the game but rather positions it as a reinforcement and extension tool. Active learning through interactivity enables students to apply theoretical concepts in simulated scenarios, consolidating their understanding of mosquito breeding sites, as evidenced by the high rate of correct answers in specific questions. The students' own suggestion to introduce the game in more schools reinforces its potential as an educational resource to be integrated into local health departments' portfolios of initiatives (Silva, Soares, 2023).

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The findings demonstrate that gamification applied to health education represents a promising strategy to support the work of health professionals, particularly Endemic Disease Control Agents, by promoting knowledge renewal and strengthening social participation in health promotion and disease prevention. The interactive digital tool *Combate à Dengue* can enhance communication with the public, transforming dengue prevention awareness into a participatory and context-based experience. In continuing education, gamification also fosters socioemotional skills, such as empathy and community engagement, which are crucial to the success of surveillance and vector control activities (Bardin, 2016; Soares Neto *et al.*, 2016). Integrating digital games into health education strategies can therefore enhance interdisciplinary collaboration and foster proactive engagement among agents in creating healthier environments.

The use of digital games also proved valuable for civic education by linking scientific knowledge with collective responsibility. Through playfulness and problem-solving dynamics, gamification stimulates curiosity, critical thinking, and co-responsibility, transforming students into lifelong multipliers of good health practices. This process contributes to the internalization of values such as solidarity and community participation, connecting school content with real-world experiences (Alves, Bianchin, 2024, De Carvalho *et al.*, 2025). Thus, *Combate à Dengue* proved to be an effective social technology that connects education, citizenship, and public health, fostering the development of a preventive and participatory culture essential to addressing arboviruses such as dengue.

Participants' suggestions for improvement also enhance the game's effectiveness. Requests for additional levels and more complex scenarios indicate a desire for a more challenging and realistic experience that better reflects the environments where EDCAs work. Similarly, suggestions for including more detailed information on the mosquito's life cycle and clearer guidance on potential breeding sites demonstrate a genuine interest in deepening understanding, turning players into prevention agents within their own homes.

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Overall, the results indicate that *Combate à Dengue* is an innovative and effective pedagogical tool for children and adolescents, capable of promoting meaningful learning, social engagement, and the empowerment of students as active participants in dengue and arbovirus prevention efforts.

5. CONCLUSION

The perceptions of students and Endemic Disease Control Agents regarding the game indicate that adopting new technologies, such as *Combate à Dengue*, represents a promising educational strategy for strengthening arbovirus prevention and controlling *Ae. aegypti* mosquito.

The use of this game complements Endemic Disease Control Agents activities and serves as an innovative pedagogical tool that reinforces health education initiatives and mitigates the impacts of *Ae. aegypti* vector.

Implementing the improvements suggested by participants should be prioritized to enhance user experience and maximize the game's educational potential. Future studies are encouraged to expand this research to other regions and populations, including a broader age range.

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