Instructional Digital Game for Prevention of COVID-19 Contagion

Stéphanie Gomes[1], Izack Costa[1], Juliana Silva[1], Ana Carvalho[1], Jose Ricardo da Silva Junior[1]

[1]Instituto Federal do Rio de Janeiro (IFRJ)
21.710-240 – Realengo – RJ – Brazil

stephanie.raposo@hotmail.com, izackcosta97@gmail.com,
{juliana.silva, ana.azevedo, jose.junior}@ifrj.edu.br

Abstract. Introduction*: During the COVID-19 pandemic, several educational strategies were developed to raise awareness about preventive measures. Among these, digital games emerged as accessible and interactive tools capable of reaching diverse audiences and promoting meaningful learning.* ***Objective****: To develop and evaluate the digital game Linha de Frente as an educational tool to illustrate how user behavior influences the spread of COVID-19.* ***Methodology****: The game was designed as a puzzle for mobile platforms to ensure broad accessibility. Its narrative follows a young nurse working in a hospital during the pandemic. The gameplay consists of scenarios in which users must apply biosafety measures, simulating real-life infection-prevention situations. User testing was conducted to assess comprehension and the game's educational impact.* ***Results****: The results demonstrated a positive impact on knowledge acquisition, helping to demystify aspects of virus transmission, including among healthcare professionals. Furthermore, the game gained widespread acceptance as a learning method, even among individuals not accustomed to playing digital games.*

Keywords *Serious games, Game-based learning, Public health education, Games on health.*

1. Introduction

In March 2020, the World Health Organization declared a global pandemic caused by the new coronavirus, SARS-CoV-2, which became one of the major challenges for the global population, leading to significant economic and social repercussions. This pathogen is related to a kind of pneumonia linked to severe acute respiratory syndrome. The main clinical symptoms include cough, fever, and fatigue. This virus is highly contagious, and its primary hosts are infected patients and wild animals. The transmission occurs through respiratory dropletsm [Ochani et al. 2021, Shi et al. 2020].

Uncertainties and significant misinformation characterized this period, as fake news proliferated, primarily focusing on treatment methods and reporting cases. The discussion of strategies to mitigate health-related misinformation, particularly regarding contamination and hygiene habits, requires a critical evaluation of the medium through which information is delivered. Traditionally, public health campaigns have leaned heavily on mass media channels such as television and newspapers to disseminate corrective information. While these platforms possess significant reach, their fundamental architecture is rooted in a passive communication model. In this paradigm, the audience

serves as a mere recipient of prepackaged content, which often fails to foster the deep cognitive processing necessary to override ingrained biases or counter the viral nature of fake news [Roozenbeek e van der Linden 2019]. Furthermore, the static nature of print and broadcast media creates a temporal lag; by the time a newspaper publishes a debunking article or a news segment airs a correction, the misinformation has often already achieved a “first-mover advantage", anchoring itself in the public consciousness. Lewandowsky et al.[Lewandowsky et al. 2017] identify the “continued influence effect", explaining how misinformation persists in a consumer’s mind even after a passive correction is issued. They argue that traditional media lacks the cognitive engagement required to overwrite initial impressions, a gap that interactive environments are designed to bridge. This passivity is a significant barrier to behavior change, as it lacks the mechanisms to challenge the viewer’s existing heuristics or provide the immediate feedback required to refine complex habits.

To combat misinformation and scientific denialism, we believe a more ludic approach to presenting this information would be more effective. The theoretical advantage of video games in this context is grounded in Inoculation Theory, as explored by McGuire [McGuire 1964]. This framework suggests that exposing individuals to a “weakened dose” of misinformation or a simulated risk can help them build cognitive defenses. Roozenbeek and van der Linden [Roozenbeek e van der Linden 2019] operationalized this theory through “prebunking” games, demonstrating that players who actively engage with manipulation techniques—such as identifying fake news—become significantly more resistant to actual misinformation than those who receive passive warnings.

In recent years, serious games and gamification have been employed in rehabilitation, phobia treatment, education, and other areas, demonstrating the ability to achieve better results than traditional approaches [Bonnechère et al. 2016, Vard et al. 2018, Gee 2003]. Video games represent an active, participatory approach that shifts the individual from a consumer to an agent within a simulated environment. Unlike a television viewer who simply hears about the dangers of contamination, a player in a game-based simulation must navigate choices, manage risks, and experience the immediate consequences of their actions. This experiential learning loop fosters higher engagement and retention, as the “active"nature of gameplay requires the constant application of critical thinking and procedural knowledge[Gee 2003]. By requiring players to identify and counteract fake news or unhygienic shortcuts to succeed in the game, these tools transform abstract health guidelines into lived experiences. Consequently, while traditional media may inform, video games possess the unique capacity to"train, making them a significantly more robust tool for fostering the resilient, evidence-based habits necessary to combat modern infodemics[Csikszentmihalyi 1991]. In this sense, we aim to enable users to become active agents in health promotion through an educational digital game [De Matos 2020, Pollard et al. 2020] that helps them understand how their actions affect their risk of contracting COVID-19.

A digital game is a formal, closed system explicitly designed to manipulate resource exchanges between the virtual world and the player. Such resource manipulation is known as the game’s economy, or, more broadly, as a dynamic system. Therefore, the user becomes the primary agent responsible for the dynamism and outcome of their

success or failure in this type of system [Luenberger 1979, Hunicke 2005, Schell 2008]. Intrinsically, it can offer the player an opportunity to promote qualitative innovation, in which transformation and modification are inherent to the learning process. Consequently, this system allows the genesis of new behavioral patterns. Furthermore, digital gaming media possesses undeniable strengths in engagement, dynamism, and dissemination. Hence, it can combine a variety of content in different formats (text, images, animations, audio, video), organized within a structure governed by the rules that underpin the game and motivate players [Juul 2011]. So, integrating digital technology into science classes is increasingly urgent given its flexibility, appeal, and motivational value [Campos e Ramos 2020]. Lima et al. [Lima et al. 2023] showed that the use of didactic games in science classes is a viable alternative, as they motivate students to learn scientific content, make students protagonists rather than just receivers, foster autonomy, and aid knowledge acquisition.

In this paper, we propose a digital game that offers a view of viral propagation patterns, highlighting the attitudes that guide the countless individual decisions that positively impact the virus's spread. We evaluated our proposal with 244 participants, both in terms of the game itself as an object of study and its impact on the instructional process, compared with traditional information dissemination media. According to our results, 96% of participants reported learning at least one new aspect of COVID-19 prevention after playing the game.

Additionally, it is important to note that COVID-19 is a form of pneumonia, so the proposed approach could be used to raise awareness of other pathogens, including those other than SARS-CoV-2. The approach, design, and game mechanics presented in this paper can be extended to promote education on other virus-related diseases beyond SARS-CoV-2, as they typically share the same prevention protocols.

The paper is structured as follows: Section 2 presents the related work, while Section 3 presents the methodology used. In Section 4 we present the proposed approach, and in Section 5 we present the design evaluation. Section 6 shows the results, while Section 7 discusses some of the findings. Finally, Section 8 concludes the work and discusses future work.

2. Related Work

The mitigation of health-related misinformation and the promotion of biosafety habits are increasingly viewed through the lens of active versus passive learning. In healthcare education, the transition from theory to procedural habit is facilitated by what Gee [Gee 2003] defines as the "cycle of expertise". Games require players to act, receive immediate feedback, and iterate on their performance, which is essential for mastering the high-stakes protocols of biosafety. This state of "optimal experience" or "Flow" as described by Csikszentmihalyi [Csikszentmihalyi 1991], ensures that learners remain motivated while navigating complex procedures, such as chemical cleaning or PPE sequencing, which might otherwise be perceived as tedious or overly abstract in a classroom setting.

Empirical studies specifically targeting hygiene and contamination support these interactive models. Arbianingsih et al. [Arbianingsih et al. 2018] used a simulation-based game to improve hand hygiene knowledge, demonstrating that virtual environments

enable the safe exploration of "contamination consequences" that would be impossible to demonstrate in a real-world setting. Furthermore, Gentry et al. [Gentry et al. 2019] provide a comprehensive review of serious gaming in health professions, noting that gamified simulations are particularly effective for teaching "step-by-step" procedural tasks—such as donning and doffing PPE—because they allow for repetitive practice without the consumption of physical resources or the risk of actual infection.

Consequently, the scenarios described in this paper—from the respiratory impact of SARS-CoV-2 to the chemical management of surface disinfection—leverage these established pedagogical advantages. By replacing the passive observation of traditional media with an active "contamination bar" feedback system, the game transforms biosafety protocols from a set of rules into a lived, survival-based experience.

According to the reviewed literature, Ribeiro et al. concluded in their systematic review that the main themes addressed in the 18 educational games about COVID-19 are: personal hygiene, control measures, signs and symptoms, and transmission means—all themes addressed in the game Linha de Frente [Ribeiro et al. 2022]. 'De volta ao lar' (Back home) [1] is aimed at children, demonstrating the main ways of contamination and prevention of COVID-19. According to the developers, the game was designed to raise awareness during the peak of the pandemic, aligning with Linha de Frente's objectives. Meanwhile, 'Jacaré Covid-19' (COVID-19 alligator)[2] tells the story of an alligator that follows sanitary measures and goes to the basic health unit to get vaccinated. There are also other educational game projects, such as the MultiRio initiative – Municipal Media Company, linked to the Municipal Education Secretariat of Rio de Janeiro's City Hall, with the product 'Quiz Rio Contra o Corona' (Rio's quiz against Corona) [MultiRio 2020b] and 'Pode ou Não Pode?' (Can or cannot?) [MultiRio 2020a].

3. Methodology

To evaluate our proposal, we began with descriptive and conceptual research to design a game that incorporates the most important aspects of COVID-19 transmission and prevention. To identify the most important aspects of COVID-19 to represent in the game, descriptive and conceptual research on COVID-19 transmission and prevention has been conducted. The methodology comprises three stages, as shown in Figure 1.

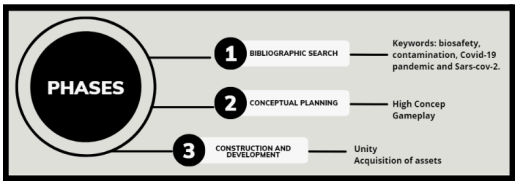


Figura 1. Methodology phases.

Initially, we conducted a broad bibliographic review using communication portals from the Brazilian government, such as the National Health Surveillance Agency

[1] https://www.ifsudestemg.edu.br/noticias/cataguases/extensao/campus-cataguases-publica-na-google-play-jogo-educativo-para-a-prevencao-do-covid-19

[2] https://portal.ifrn.edu.br/campus/natalcentrohistorico/noticias/projeto-de-extensao-lanca-jogo-com-tematica-de-conscientizacao-contra-a-covid-19/

(ANVISA) and Fiocruz, with the following keywords: biosafety, contamination, COVID-19 pandemic, and SARS-CoV-2. Collecting and analyzing papers and articles on COVID-19 in the previous step facilitates the identification of real-world scenarios that contribute to the spread of the virus. Based on these findings, mechanics and different environments were designed to inform the user of the most appropriate biosafety protocol to follow during phases 2 and 3 of the game.

Given its informative nature, the game is designed to prevent the spread of COVID-19 by incorporating scenarios that require users to follow biosafety protocols. The main topics covered during the game are biosafety measures, main signs and symptoms, and modes of transmission. These themes were chosen to address the main concerns or doubts of the population, as well as those identified in guidance letters prepared by Brazilian health agencies.

4. Proposed Approach

4.1. Game Design

Linha de Frente is a digital game developed during the COVID-19 pandemic to illustrate how user behavior affects the spread of the virus. To be accessible and cater to a large number of users, it is conceived as a puzzle game designed for mobile platforms. The game tells the story of a young male nurse who works in a hospital during the COVID-19 pandemic. During the game, quizzes and interactive mini-games address one or more aspects of biosafety protocol.

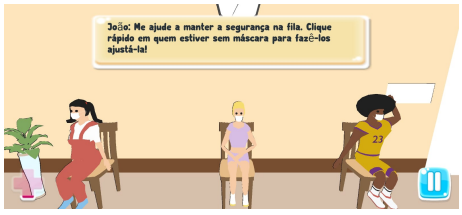
The game's main character is João, an 18-year-old nursing student who is doing an internship at a hospital during the pandemic. He lives with his elderly grandparents, José, 75, and Ana, 72. In his daily work routine, he directly cares for infected patients and must follow all biosafety measures, use personal protective equipment (PPE) correctly, and maintain social distancing. To penalize users who do not adopt the correct protocol, we introduced a gauge bar that indicates the probability of COVID-19 contamination. We believe this mechanism motivates users to follow the correct protocol and, at the same time, provides a measurement of viral contamination. Most educational games lack a fun experience, and players sometimes simply leave the game, thereby compromising learning. Linha de Frente, on the other hand, employs such a level of contamination mechanics to motivate the user to adopt the correct protocols in each scenario to win the game and, at the same time, to absorb knowledge about virus transmission[Shute e Rahimi 2021]. Ultimately, the main objective of the game is to avoid contracting COVID-19, as indicated by a contagious meter that increases when the user does not follow the correct protocol in the scenarios. The game takes place in various COVID-19-related settings, such as homes and hospitals, where the main character is controlled by the user in third-person view, as shown in Figure 2.

In the game, the user is the protagonist of the environment, observing the direct impact of their actions in containing the transmission or spread of the COVID-19 virus. These concepts are also presented playfully through mechanics that demonstrate the importance of adopting appropriate attitudes to prevent contagion, such as the proper use and handling of PPE. To win the game, the player must reach the end of the day without being contaminated. The fewer contamination points he has, the greater his chance of winning.

(a) A scenario in the Linha de Frente introducing the game's narrative.

(b) Scenario for practising safest distance.

(c) Demonstration of correct use of PPE.



(d) Scenario showing the importance of the mask.

(e) Scenario for introducing the chemical aspect of decontamination.

Figura 2. Some of the biosafety active problem-solving scenarios in Linha de Frente.

4.2. Scenarios and Biosafety Contributions

During the game, various themes are explored through each scenario. One of them is about the correct use of the mask. It is already known that its positioning influences the level of transmission protection against the virus. Furthermore, proper handwashing and social distancing practices influence the incidence of new COVID-19 cases [Lee et al. 2020, Talic et al. 2021]. Linha de Frente also employs scenarios and game mechanics to inform users about how social distancing and handwashing can affect the virus's spread.

The game's architecture comprises seven distinct scenarios, each designed to translate abstract biosafety guidelines into procedural knowledge through active problem-solving. In the first scenario, **players take a diagnostic quiz focusing on SARS-CoV-2, its causative agent, and its primary physiological effects on the human respiratory system**. This stage establishes the biological rationale for all subsequent actions; by identifying how the virus attacks lung tissue, the player internalizes the high stakes of barrier protection, transforming a simple "rule"into a logical necessity for survival.

The second and fifth scenarios focus on the **correct positioning of masks**. In the second, the player must select the correct orientation, while the fifth requires them to identify "non-compliant"characters in a crowd (Figure 2(d)). These scenarios contribute

to biosafety learning by developing “visual literacy"regarding PPE. Instead of passively hearing that a mask must cover the nose, the player must actively scan for errors. This reinforces the concept of the “seal"as a primary defense mechanism against aerosolized droplets.

The third and fourth scenarios introduce procedural **sequencing for hand hygiene and the donning of Personal Protective Equipment** (Figure 2(c)). The player must enumerate the four phases of hand washing and the specific order for outfitting gear (e.g., gown, then mask, then eye protection, then gloves). In biosafety, the order of operations is as critical as the action itself to prevent cross-contamination. By requiring the player to reconstruct these sequences, the game builds “muscle memory"and emphasizes that a break in the chain of protocol—such as putting on gloves before a gown—compromises the entire sterile field.

Environmental risk assessment is explored in the hospital cafeteria scenario and in the bus (Figure 2(b)). Here, the player must evaluate spatial dynamics to choose the safest place to sit and the table at which to eat. This teaches the player to recognize “high-risk zones” where PPE is removed, emphasizing that biosafety is not just about equipment, but also about social distancing and airflow awareness. The sixth scenario complements this by focusing on **undressing (doffing) protocols**. This is often the most dangerous phase in a clinical setting, as improper removal can lead to self-contamination. By requiring the player to indicate the correct order of removal, the game teaches the “clean-to-dirty” biosafety principle.

Finally, the last scenario addresses the **chemical aspect of decontamination** by requiring the player to select the appropriate chemical combination for surface cleaning (Figure 2(e)). This contributes to learning by clarifying the efficacy of different agents (e.g., 70% alcohol vs. detergents) and the hazards of mixing incompatible substances. Throughout all scenarios, the game provides immediate, high-stakes feedback. For each error, the player receives a visual representation of their “viral load” reinforcing the idea that biosafety is a cumulative effort, in which small mistakes can lead to systematic failure.

5. Evaluation

Evaluation of the proposed approach has been done considering two dimensions: a) user satisfaction and the overall usability of the game, and b) the impact of the game to address missing information regarding contagious diseases. For this, we employed an anonymous questionnaire (self-completed), without synchronous interaction between the researcher and participant. The target audience for this evaluation was undergraduate students and technicians from one of our institution’s campuses, selected at random based on their availability and interest. The research was disseminated through the educational institution’s groups and in-person approaches during the 40-day collection period. All participants were asked to complete the consent form before the experiment. Participants in the experiment may or may not have experience with digital games to verify that the proposed game content and mechanics are adequate. Participants did not receive any training on the game before participating in the experiment, and the experiment imposed no time or session limits before they completed the questionnaires.

Google Forms was chosen to collect participants’ responses on the game’s

satisfaction and usability. Three groups of questions have been made: a) related to personal data; b) related to diagnosis, general knowledge, biosafety measures, risk groups, and places with greater risk of contamination and their relationship with the human body; and c) players' opinions about the game itself.

6. Results

The project was developed using the Unity game engine, enabling export to multiple heterogeneous platforms. Currently, the game is available for Android[3], and we plan to support iOS in the future.

In total, 244 people participated in the experiment and answered the form after playing the game. The majority of participants are from the physiotherapy course (127), the occupational therapy course (44), and the pharmacy (43) course.

Regarding the responses related to general knowledge about COVID-19, 201 (89.70%) students stated that a member of their family or themselves had been diagnosed, 188 (83.90%) believe they have good knowledge of the disease, 209 (93.90%) report knowing what biosafety measures are, and 213 (95.10%) are familiar with Personal Protective Equipment. In Figure 3, 184 (75.41%) say that the hospital has the highest risk of COVID-19 contamination compared to the supermarket and the park.

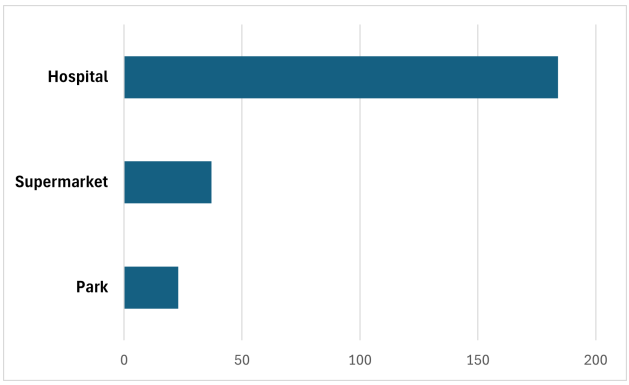


Figura 3. Highest risk of contamination places according to the participants.

Regarding user satisfaction with the game, 215 (96%) learned something from it, 216 (96.4%) would recommend it to a friend, 17 (7.6%) found it too long, and 31 (13.8%) did not like its design. Besides, 132 (58.9%) participants are not accustomed to playing games regularly. The majority of participants (69.2%) began playing games between ages 5 and 12.

7. Discussion

The field of user experience seeks to understand human-computer interaction in digital games, including its applications and metrics. Such experience tends to influence the construction of games. In the current scenario, with reduced budgets, it is rare for creative teams to have a dedicated professional to handle this area, so developers often use non-standardized methods to evaluate their games, making comparisons and the reliability of

[3]Linha de Frente: https://github.com/GSimCog/GameCovid

the results difficult to assess. Our strategy was then to use an evaluation form that the player completes after playing [Borges et al. 2019, Sánchez et al. 2012].

The form contained general-knowledge questions about COVID-19 and also asked about user satisfaction. Initially, questions about COVID-19 were crucial for assessing the user's knowledge of the disease, as they affected the user's performance during the game. After all, the game included mini-games with specific COVID-19-related questions.

A large proportion of participants (188; 83.9%) reported having a good understanding of COVID-19. This may be attributed to the significant role of social media in scientific dissemination and combating fake news during the pandemic's peak. Furthermore, during the pandemic, students participated in non-face-to-face pedagogical activities, and as a result, many attended courses that likely addressed this topic, such as Morphofunctional Bases I and II, Fundamentals of Microbiology and Immunology, and General Pathology and Semiology [De Souza et al. 2020].

In addition, the questions about the digital game were designed to assess its fluidity and gameplay. These items were also analyzed in another study published in 2019 with the participation of players of different age groups as well as in a game about spotted fever. In this game, they used such information to improve the organization of the gameplay. Still, according to Rodrigues et al., opinion polls are important for translating technical and scientific knowledge [Rodrigues et al. 2019].

The role of biosafety in reducing occupational health risks, both individual and collective, is described in numerous guidelines, protocols, and even technical notes from ANVISA. It is evident that these measures have saved countless lives and prevented potential contamination. Regarding responses, 209 (93.3%) report knowing what biosafety measures are; however, only 192 (85.7%) report knowing how to wash their hands according to ANVISA's recommendation. Interestingly, a larger number, 213 (95.1%), report knowing what PPEs are. This suggests that participants may not be clear about the main components of COVID-19-related safety measures [Ahmad et al. 2020].

Another interesting point is the increased risk of contamination in different exposure locations. In the form, there were three possible options: supermarket, park, and hospital. These locations were chosen based on Chang et al.'s study [Chang et al. 2020], which proposed an integrated model of COVID-19-related dynamic mobility. According to the responses, 37 (15.16%) individuals reported that the supermarket poses a higher risk of contamination than the hospital, which is incorrect, as noted by Chang et al. This number of responses might stem from the belief that, in hospitals, individuals are more protected due to the use of PPE and greater attention to hygiene, whereas in the market, the environment lacks control and enforcement of sanitary restrictions [Chang et al. 2020].

Regarding the validation of the digital game as an educational tool, its role in the development of the teaching-learning process and its contribution to student engagement in their learning process are well established. Additionally, games are inherently participatory, promoting active learning and encouraging audience dialogue [Dos Santos et al. 2017].

Finally, participants most frequently cited implementing 3D graphics, increasing the time to answer the minigames, and providing feedback on correct answers when the player selects the wrong option. Such functionalities could be implemented in a new

version of the game.

8. Conclusion

In the present study, we describe the development of a digital health game, from its theoretical foundation to its conception, narrative, and design. We believe that the digital game we created can serve as a powerful communication tool for scientific dissemination and health prevention regarding COVID-19. Expanding knowledge about the spread of the coronavirus and the proper use of PPE to prevent contamination and effectively stop its transmission can promote engagement with biosafety measures in a ludic way, which could be applied beyond COVID-19.

The methodology adopted for the design of Linha de Frente can be replicated to develop other educational digital games in healthcare, thereby enhancing the teaching–learning process. The accessibility and flexibility of such games allow students to learn autonomously, democratizing education and reaching populations in peripheral areas with limited access to traditional teaching. They also reduce costs associated with in-person classes, materials, and simulators, while enabling the simulation of real clinical scenarios in a safe environment. Immediate feedback supports error correction and continuous improvement, whereas personalized learning adapts challenges to the user's level, optimizing the pace of knowledge acquisition. Moreover, the playful approach enhances motivation and satisfaction, fostering a productive and effective learning environment.

The game aims to address the scarcity of materials and resources used in health education and to publicize the COVID-19 biosafety protocol through a playful approach. It is a product with good usability and safety, and it contributes to the culture of health in a simple, interactive way. Regarding user satisfaction with the game, 215 (96%) learned something from it, and 216 (96.4%) recommended it to a friend.

Furthermore, the software is registered with the National Institute of Industrial Property (BR512023001415-0) and is available for free download on Google Play. As a future direction, the version could be ported to iOS and converted into a 3D game. Therefore, in addition to serving as a potential instrument for innovation in the communication process, it can be used in playful, active ways to promote health. Finally, it is a potential facilitator of biosafety-related knowledge and is considered a promising form of scientific dissemination.

9. Acknowledgments

The authors would like to thank CAPES, CNPq, and FAPERJ for the financial support.

Referências

Ahmad, T. et al. (2020). Biosafety and biosecurity approaches to restrain/contain and counter sars-cov-2/covid-19 pandemic: A rapid-review. *Turkish Journal of Biology*, 44(7):132–145.

Arbianingsih, Utario, Y., Rustina, Y., Krianto, T., e Ayubi, D. (2018). Arbi care application increases preschool children's hand-washing self-efficacy among preschool children. *Enfermería Clínica*, 28:27–30.

Bonnechère, B., Jansen, B., Omelina, L., e Van Sint Jan, S. (2016). The use of commercial video games in rehabilitation: A systematic review. *International Journal of Rehabilitation Research*, 39(4):277–290.

Borges, B. et al. (2019). Experiência do usuário em jogos digitais: uma catalogação de instrumentos de avaliação. In *Anais do 1º Workshop on Interaction and User Research in Game Development*, pages 69–78. SBC.

Campos, T. R. e Ramos, D. K. (2020). O uso de jogos digitais no ensino de ciências naturais e biologia: uma revisão sistemática de literatura. *Revista Electrónica de Enseñanza de las Ciencias*, 19(2):450–473.

Chang, S., Pierson, E., Koh, P. W., Gerardin, J., Redbird, B., Grusky, D., e Leskovec, J. (2020). Mobility network models of covid-19 explain inequities and inform reopening. *Nature*, 589(7840):82–87.

Csikszentmihalyi, M. (1991). *Flow: The Psychology of Optimal Experience*. Harper Perennial, New York, NY.

De Matos, R. C. (2020). Fake news frente a pandemia de covid-19. *Vigilância Sanitária em Debate: Sociedade, Ciência e Tecnologia*, 8(3):78–85.

De Souza, T. S. et al. (2020). Mídias sociais e educação em saúde: o combate às fake news na pandemia da covid-19. *Enfermagem em Foco*, 11(1).

Dos Santos, C. A. et al. (2017). Jogos sérios em ambiente virtual para ensino-aprendizagem na saúde. *Revista Rene*, 18(5):702–709.

Gee, J. P. (2003). What video games have to teach us about learning and literacy. *Comput. Entertain.*, 1(1):20.

Gentry, S. V., Gauthier, A., L'Estrade Ehrstrom, B., Wortley, D., Lilienthal, A., Tudor Car, L., Dauwels-Okutsu, S., Nikolaou, C. K., Zary, N., Campbell, J., e Car, J. (2019). Serious gaming and gamification education in health professions: Systematic review. *Journal of Medical Internet Research*, 21(3):e12994.

Hunicke, R. (2005). The case for dynamic difficulty adjustment in games. In *Proceedings of the 2005 ACM SIGCHI International Conference on Advances in Computer Entertainment Technology*, pages 429–433.

Juul, J. (2011). *Half-real: Video games between real rules and fictional worlds*. MIT Press.

Lee, L. Y.-K. et al. (2020). Practice and technique of using face mask amongst adults in the community: a cross-sectional descriptive study. *BMC Public Health*, 20(1):1–11.

Lewandowsky, S., Ecker, U. K. H., e Cook, J. (2017). Beyond misinformation: Understanding and coping with the "post-truth" era. *Journal of Applied Research in Memory and Cognition*, 6(4):353–369.

Lima, M. A. et al. (2023). Jogos didáticos no ensino de ciências: um panorama da produção encontrada na biblioteca digital brasileira de teses e dissertações. *Revista de Ensino, Educação e Ciências Humanas*, 24(3):327–334.

Luenberger, D. G. (1979). *Introduction to dynamic systems: theory, models, and applications*. Wiley, New York.

McGuire, W. J. (1964). Inducing resistance to persuasion. some contemporary approaches. *C. C. Haaland and W. O. Kaelber (Eds.), Self and Society. An Anthology of Readings, Lexington, Mass. (Ginn Custom Publishing) 1981, pp. 192-230.*

MultiRio (2020a). Pode ou não pode? `https://multi.rio/index.php/conteudo-geral/15967-pode-nÃčo-pode` [Accessed: 2023-05-29].

MultiRio (2020b). Quiz rio contra o corona. `https://multi.rio/index.php/jogos/15983-quiz-rio-contra-o-corona` [Accessed: 2023-05-29].

Ochani, R. et al. (2021). Covid-19 pandemic: from origins to outcomes. a comprehensive review of viral pathogenesis, clinical manifestations, diagnostic evaluation, and management. *Infez Med*, 29(1):20–36.

Pollard, C. A. et al. (2020). A pandemia covid-19: uma crise de saúde global. *Genômica Fisiológica*, 52(11):549–557.

Ribeiro, C. C. M. et al. (2022). Os jogos e educação popular em saúde: uma revisão bibliográfica dos jogos educativos no contexto da pandemia da covid-19. *Revista Práxis*, 14(27).

Rodrigues, C. M. et al. (2019). Pula carrapato: o game como ferramenta comunicacional em saúde.

Roozenbeek, J. e van der Linden, S. (2019). Fake news game confers psychological resistance against online misinformation. *Palgrave Communications*, 5(1).

Schell, J. (2008). *The Art of Game Design: A book of lenses*. CRC Press.

Shi, Y. et al. (2020). An overview of covid-19. *Journal of Zhejiang University. Science. B*, 21(5):343.

Shute, V. J. e Rahimi, S. (2021). Stealth assessment of creativity in a physics video game. *Computers in Human Behavior*, 116:106647.

Sánchez, J. L. G. et al. (2012). Playability: analysing user experience in video games. *Behaviour & Information Technology*, 31(10):1033–1054.

Talic, S. et al. (2021). Effectiveness of public health measures in reducing the incidence of covid-19, sars-cov-2 transmission, and covid-19 mortality: systematic review and meta-analysis. *BMJ*, 375.

Vard, A., Rahani, V., e Najafi, M. (2018). Claustrophobia game: Design and development of a new virtual reality game for treatment of claustrophobia. *Journal of Medical Signals amp; Sensors*, 8(4):231.