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Research Paper

Serious games vs The Disinformation: Are educational games effective against malicious content?

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Abstract. *Introduction:* The so-called "fake news" refers to fabricated and misleading information presented as news, often intended to manipulate the opinions of a target audience. As this content is systematically disseminated across social networks, identifying and controlling it poses a significant challenge. *Objectives:* This study sought to evaluate whether a serious game about information consumption has the potential to change players' perspectives on their behavior when encountering news in the online environment. *Methods:* Considering the motivational and emotional appeal of serious games—as well as their ability to facilitate learning across various subjects—we conducted a systematic mapping and developed a visual novel game with a focus on combating fake news. We also conducted a study involving 42 participants, administering questionnaires on information consumption both before and after they played the game. *Results:* The systematic mapping revealed that 10 games that included empirical evaluations assessing their effectiveness in teaching fake news identification, with all reporting statistically significant results. Similarly, our evaluation found statistically significant improvements across all 6 information-consumption self-assessment questions. *Conclusion:* The results of our evaluation and systematic mapping support the premise that serious games can enhance information literacy by improving users' ability to verify content. It is worth mentioning that the costs of designing an educational game must be considered when comparing it to other instructional materials.

Keywords: Serious Games, Fake News, User Experience, Visual Novel

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1 Introduction

The Internet has undoubtedly expanded access to information, yet its role in enabling unchecked content creation has led to a paradoxical reality. Social media platforms have become fertile ground for the viral spread of fabricated narratives—crafted to exploit emotions rather than facts [Olan *et al*., 2024]. Unlike traditional misinformation, fake news succeeds not through credibility but through psychological resonance, reinforcing biases and triggering impulsive sharing [French *et al*., 2023].

According to Olan *et al*. [2024], despite investments in tools designed to identify fake news on social media, the spread of misinformation remains an unresolved challenge. This persistence is attributed to societal engagement, discussion, and even the promotion of such content by users. The issue stems from a disconnect between fact-checking efforts and individuals' deeply held values and beliefs, which often fail to incentivize—or even actively discourage—the verification of factual accuracy. Furthermore, Generative AI has the potential to enhance and scale the production of fake news content. This underscores the growing need for robust mitigation strategies to combat misinformation and disinformation [Loth *et al*., 2024].

In this paper, we use the terms misinformation and disinformation interchangeably; however, it is important to note that the literature sometimes distinguishes between them. According to Tudjman and Mikelic [2003], *disinformation* refers to the deliberate production of false content with the intention of deceiving individuals, whereas *misinformation* denotes the unintentional dissemination of inaccurate information. In terms of impact, intentional disinformation often employs persuasive techniques and is carefully crafted and targeted at specific audiences, exploiting cognitive biases and emotional triggers.

Research reveals that much of the public has a limited grasp of how scientific research or journalism operates, leaving them ill-equipped to evaluate the credibility of the the information they encounter [Barbosa, 2019]. Moreover, skepticism toward established scientific methods and consensus further undermines informed judgment. Another point of concern is that automated fake news detection methods are still imperfect, which can lead to ambiguous situations. For instance, when an author employs sarcasm in a news piece, automated systems may misclassify the content da Silva and Garcia [2019]. This underscores the need for readers to remain aware of such rhetorical devices and to engage critically with the material they consume. To counter this, targeted education and public awareness campaigns are critical, not only to foster media literacy but to cultivate a culture of evidence-based reasoning.

Given the emotional influence of fake news, researchers and educators must develop context-aware initiatives. The work of Roozenbeek and van der Linden [2020] demonstrates how applying educational and psychological principles through serious games can reshape perceptions. Their intervention employs the "inoculation theory" to preemptively expose players to common misinformation tactics to build psychological resistance against real-world manipula-

tion. Santos and Pereira [2024] also used the inoculation theory, presented by the earlier, to design an educational system that trains individuals to identify fake news content.

Puska and Pereira [2023] conducted a sociotechnical analysis of digital misinformation, revealing key insights into its lifecycle. Their proposed model identifies four distinct stages: Creation, Dissemination, Consumption, and Reiteration. The study presents compelling evidence of deliberate practices at each stage: during Creation through the fraudulent attribution of credible sources; in Dissemination via high-reach communication channels and social networks; at Consumption through logical fallacies exploiting cognitive biases and false authority appeals; and in Reiteration via the repackaging of misinformation into different formats for alternative platforms. Their analysis provided valuable insights for understanding Brazil's misinformation ecosystem, emphasizing the critical need for sociotechnical literacy. The authors highlight how public awareness campaigns, education initiatives, and media literacy programs are essential for fostering more discerning information consumption practices [Puska and Pereira, 2023].

French *et al*. [2023] conducted structured surveys to examine how people perceive and share fake news on social media, as well as to investigate the cognitive biases that influence their credibility assessments. The study included 31 participants, of whom only 10 reported fact-checking before sharing content, while 21 admitted they did not. Among the reasons for not verifying information, the most commonly cited were: 1) confidence in their own ability to identify fake news, 2) preference for sources they deemed trustworthy, and 3) a lack of concern or willingness to put in the effort to verify.

A meta-analysis study by Lu *et al*. [2024] explored the impact of media literacy interventions on individuals' ability to assess the credibility of fake news. Synthesizing data from 33 independent studies comprising over 36,000 participants, the study found a significant positive effect of such interventions. The authors highlight that game-based interventions presented the best results, due to their interactive and engaging nature. In addition, the study revealed that characteristics such as age, gender, intervention channel (online or offline) and exposure time did not significantly influence the effectiveness of the interventions.

According to Jones-Jang *et al*. [2021] there are four distinct literacy domains that may enhance fake news detection: (1) media literacy, (2) information literacy, (3) news literacy, and (4) digital literacy. Media literacy denotes the capacity to access, analyze, and produce information for specific goals. News literacy specifically addresses comprehension of journalistic production and societal roles. Digital literacy reflects adaptive competence in evolving technologies. Finally, while media literacy emerged from print/audiovisual contexts, information literacy developed specifically for digital ecosystems, emphasizing navigation and verification of reliable sources. While conventional wisdom suggests that media-literate individuals exhibit greater skepticism toward dubious content, Jones-Jang *et al*. [2021] demonstrate that among these literacies, only information literacy shows a statistically significant positive correlation with accurate identification of misinformation.

The 2022 Addition to the Brazilian National Common Curricular Base (BNCC) includes the integration of Computing in Basic Education as a knowledge area from early childhood to high school. Information literacy is given the same importance as other Computing skills in the context of basic education. Particularly, the Digital Culture axis lists essential skills for safe and responsible use of computational technologies, aiming to teach students to critically access information on the Internet and to distinguish reliable from unreliable content. Moreover, fundamental skills include understanding the dynamics of information sharing on social networks, and the ability to assess the truthfulness, credibility, and relevance of information, as well as identifying its dissemination purpose [BRASIL, 2022].

As noted, Lu *et al*. [2024] reveals that gaming-based interventions were the most effective approach for enhancing media literacy and improving users' ability to assess the credibility of misinformation. Another systematic review, presented by Kiili *et al*. [2024], focused on combating misinformation through serious games, identified a growing trend in research over the past three years. However, the authors note that the number of empirical studies remains limited. The few existing studies have yielded positive and relevant empirical results, suggesting potential for increased research in this area [Lu *et al*., 2024; Kiili *et al*., 2024]. While this outlook is promising, the scarcity of studies makes it difficult to identify effective design and evaluation methods for serious games in information literacy.

Our research focused on evaluating the effectiveness of educational games designed to teach critical web content consumption and combat fake news. The following research question guided our study: "Can a serious games serve as an effective intervention strategy against misinformation?". To this end, we conducted a systematic mapping and developed a visual novel-style game where dialogue and outcomes are shaped by player interactions. Additionally, we employed pre- and post-test questionnaires to assess the game's potential impact on participants' awareness and behavior regarding information consumption.

The study involved 42 participants, and our findings support a positive response to the research question. As future work and seeking to adjust possible limitations, we hope to carry out the research with a larger number of participants and, also, verify the application of the serious games developed for a primary and secondary education audience.

Section 2 details the methods used for conducting the systematic mapping (Subsection 2.1), developing the game (Subsection 2.2), and its evaluation (Subsection 2.3), as well as ethical considerations (Subsection 2.4). Section 3 describes the results of each of these outputs (Systematic Mapping (3.1), Developed Game (3.2), and Evaluation Results (3.3)). Finally, Section 4 presents our conclusions.

2 Methods

2.1 Systematic Mapping

Within computing, serious digital games designed to train users in identifying fake news have emerged as a promising tool. To comprehensively review the literature, we conducted a systematic mapping considering search the the words "*fake*

news, *game* and *digital*", following the PRISMA statement [Page *et al.*, 2021]. We conducted searches in the Web of Science and in the Brazilian Computer Society OpenLib (SOL) databases. The objective of the mapping was twofold: first, to identify serious games designed to combat misinformation; and second, to verify whether the evaluations conducted provided evidence of the effectiveness of these games in achieving this purpose.

The inclusion criteria required studies to: (1) present a digital serious game about misinformation, and (2) include empirical evaluation of the game's effectiveness. The exclusion criterion was applied to documents that were not research articles (e.g., calls for papers, books). No studies were excluded based on language, since the Web of Science database returned only articles in English, while the SOL database returned articles in both English and Portuguese.

2.2 Game Design

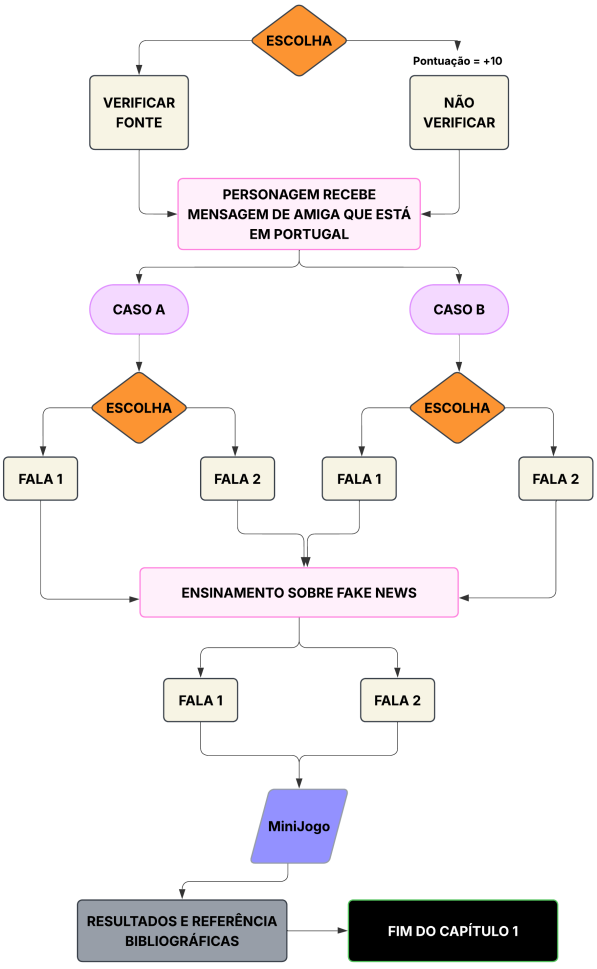

Figure 1. Decision-making flowchart of the character's interaction with a fake news scenario.

The game was developed following the User-Centered Design (UCD) methodology proposed by Norman [2013], complemented by the 7-step framework of Marfisi-Schottman *et al.* [2010]. In practice, UCD was applied through a user needs analysis (interviews with a Philosophy teacher), iterative prototyping and feedback loops (scripts, flowcharts, and prototype testing with users), and the alignment of content with the context of use (realistic scenarios). This ensured that the design remained user-driven while also benefiting from the collaboration of a domain expert in media literacy education.

The game was developed using a UCD methodology Norman [2013], with collaboration from a domain expert - a Philosophy teacher specializing in media literacy education for adolescents and adults at a technical school. Notably, as this was a rapid, low-budget development project, we exclusively utilized free and open-source tools and resources for all aspects of production, including both the development platform and artistic assets.

To establish our design and documentation framework for serious game development, we conducted a comprehensive review of existing methodologies, with particular attention to the systematic results presented by Gurbuz and Celik [2022]. This analysis enabled us to critically assess available documentation tools and select the most viable option for our specific development requirements. The selected methodological framework was the 7-step method proposed by Marfisi-Schottman *et al.* [2010].

The development methodology by Marfisi-Schottman *et al.* [2010] organizes the serious game creation process into seven key phases: (1) establishing pedagogical outcomes, (2) determining game genre/model, (3) describing the game general scenario (including characters, settings, narrative, etc.), (4) curating reusable assets, (5) detailing (scene-level) design, (6) controlling pedagogical quality, and (7) creating specific documentation for subcontractors. In this research, the seven steps were adapted and organized into a methodology proposed by the authors, as illustrated in Figure 2. Our adaptation includes a few differences. We incorporated the literature as a source of requirements, given that awareness regarding fake news and information consumption is a relatively recent topic, which allows for the identification of emerging pedagogical strategies. We also identified the design elements most relevant to the development of a visual novel. Finally, we emphasized the cyclical process, a characteristic of User-Centered Design that is integrated into our methodology. The incorporation of literature and the use of reusable, open-source resources were essential to enabling agile and low-cost development, particularly because we had limited domain specialists and no dedicated design professionals.

Steps (1)-(3) were addressed during the Requirements phase, which involved literature review and collaborative exchanges with our domain expert. The reference materials selected by our expert informed the initial game objectives (Step 1), which needed to incorporate the following key themes: clickbait headlines, confirmation bias, sharing of misinformation, source verification, fact-checking tools, conspiracy theories, filter bubble algorithms, and the Brazilian General Data Protection Law (LGPD). The visual novel genre (Step 2) was selected due to its current popularity and development feasibility. We created the game's general description (Step 3) using a flowchart tool[1]. Figure 1 illustrates part of the flowchart of *Chapter 1*.

[1]Full diagrams are available at the GitHub URL listed at the Declarations section.

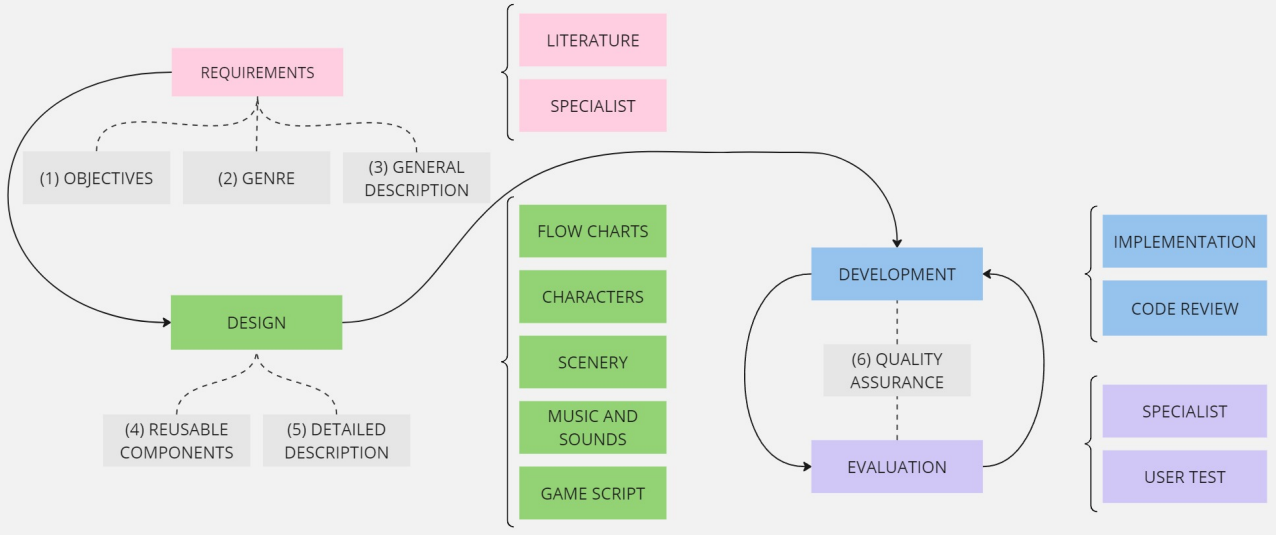

Figure 2. The adapted 7-step method applied in the development of the game.

Steps (4) and (5) (curating assets and scene-level design) were implemented during the design and development phase, while Step (6) – control of pedagogical quality – was incorporated by the quality assurance and evaluation stages. Given the project's lack of external collaborators or subcontractors, Step (7) was omitted. The Steps (4) and (5) are detailed following, while the evaluation methodology (Step 6) is presented in Subsection 2.3.

To explore the gameplay elements of visual novels, we employed the teaching strategy taxonomy introduced by Camingue *et al.* [2020]. The taxonomy categorizes strategies into choice-based interactions, scripted sequences, minigames, exploration, and non-interactive narration. These approaches can be combined to enhance engagement and interactivity in learning. Consequently, alongside conventional narrative, scripted, and choice-based interactions, we integrated a minigame into each chapter to reinforce key concepts through an alternative, interactive format.

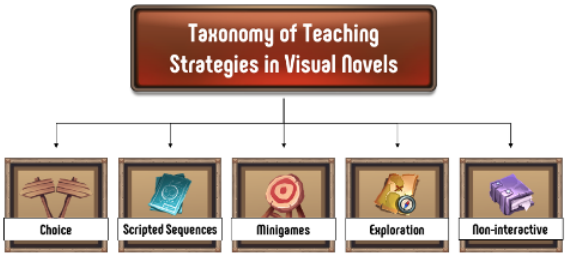

Figure 3. Taxonomy of teaching strategies in visual novels by [Camingue *et al.*, 2020].

Regarding content development, the reference materials selected in collaboration with the specialist included books, research papers, journalistic articles, and the documentary *The Social Dilemma* (2020, dir. Jeff Orlowski). References were included at the end of each chapter. The visual novel format enabled the translation of these complex themes into gameplay, allowing for deeper exploration than other genres would permit. However, incorporating minigames proved more challenging, as the themes required adaptation to less natural interactive formats.

For the storytelling design, we first used flowcharts to outline each chapter's scope, including player-choice branches. After finalizing the flowcharts, we detailed each chapter's script with all character dialogues, choices, and consequences, including the minigames description. The textual script served as the foundation for creating and selecting the game's multimedia content. All resources used are free and open, available under Creative Commons licenses. The character artwork is original, created specifically for the game using the mobile tool PitzMaker[2]. The game menu includes proper attribution to all media authors.

For development, we selected tools and an environment suitable for rapid prototyping. Ren'Py[3], a platform dedicated to visual novel development, combines a custom scripting language with Python programming Ciesla [2019]. It features a declarative scripting language that's easy to learn and simplifies character and scene definition while emphasizing dialogue and choices. Listing 1 shows an excerpt of the source code for a scene. The dialogue then branches based on this interaction.

2.3 Game Evaluation

In previous works, we evaluated the game through two methods: (1) expert review of presentation and pedagogical goals, and (2) user testing with five undergraduate students. Detailed results from this evaluation are available in [Cunha *et al.*, 2024].

To assess potential impacts on information consumption behaviors, we developed a questionnaire addressing participants' encounters with social media content [Cunha *et al.*, 2024]. The original questionnaire was modified into a 6-item version to simplify the evaluation process. For comparative analysis, the same instrument was administered both pre- and post-intervention. Table 1 presents the reformulated items. The questionnaire employs a 5-point Likert frequency scale (i.e., Never, Rarely, Occasionally, Frequently, Very Frequently).

[2]Available at: `https://play.google.com/store/apps/details?id=com.EightStudio.PitzMaker`. Accessed on 30 mar. 2026.

[3]Available at: `https://www.renpy.org/`. Accessed on 30 mar. 2026.

```
    image cenaCafe = "cenaCafe.jfif"
    image pers = "char1.1.png"
    image clara = "char2.1.png"
    define p = Character("Personagem", color = "#FF0000")
    define cl = Character("Clara")

    scene cenaCafe

    show clara at left with pixellate:
        zoom 0.4
        yalign 0.65

    cl"Oi, há quanto tempo! Tudo bem?"

    show pers at right with pixellate:
            zoom 0.4
            yalign 0.65

    p"Oi Clara, é mesmo!"
    p"Estou bem, e você como está? Vai que dia para Portugal?"
    cl"Estou bem também, vou na próxima segunda! Por conta da viagem, até voltei a usar redes sociais."
    cl"Inclusive, vi seu Facelook esses dias."
    p"Eita, tinha algo ruim?"

    if compart == "1":
    # If [the player] shared fake content in Scene 4:
        cl"Preciso te falar uma coisa, fiquei meio decepcionada que você compartilhou fake news."
        p"Ah, nem prestei atenção. Achei que era verdade, ué."
        cl"Fala sério, achei que você seria mais atento, você não pesquisa as fontes antes de compartilhar?"
        p"Ah, nem..."
    else: # If [the player] DID NOT share fake content in Scene 4:"
        cl"Não. Ainda bem que você não compartilhou nenhuma fake news, meu Facelook está estanho."
```

List 1: Example of source code for a game scene in a declarative language.

Table 1. Questions about information consumption patterns.

Q01	My main sources of information are social media platforms.
Q02	I fact-check the accuracy and source of news that appears on my social media feeds.
Q03	I trust news articles and images shared by my close friends and family.
Q04	I only read headlines of news stories I see on social media.
Q05	When a news story seems shocking, I check if it's been reported by other reliable sources.
Q06	I only share news from credible sources with clear authorship.

2.4 Ethical Issues

The project received approval from the Research Ethics Committee of the São Paulo Federal Institute of Education, Science and Technology under protocol number 57851422.5.0000.5473. The user testing protocol incorporated safeguards to maintain participant neutrality, including blinded procedures where applicable. All data were anonymised and are securely maintained with access limited to core researchers.

In addition, the study complied with the Brazilian General Data Protection Law (LGPD), and we adopted an ethics-by-design perspective throughout the game life-cycle. The game follows the story of a protagonist navigating life during the early COVID-19 pandemic, where players encounter both factual and false news through everyday scenarios. The dialogue was designed to encourage players to engage with external tools to verify the accuracy of the news they encounter. This approach was intended to minimize potential emotional distress while avoiding the exposure of participants to actual disinformation content, thus preventing harmful effects.

Participants were reminded that they could withdraw at any time without penalty, and a brief debriefing at the end of the activity offered guidance on reliable information sources. We also acknowledge that the sample is relatively highly educated, which may introduce sampling and design biases; this limitation is explicitly considered in our discussion of the results. Throughout the project, our procedures were guided by the Brazilian Computer Society (SBC) Code of Conduct, emphasizing responsibility in HCI research, respect for participant autonomy, and the protection of sensitive data.

3 Results

3.1 Systematic Mapping

The search was conducted in April 2025 and considered 5 years of publications, time ranged from 2019 to 2024, since no papers published in 2025 were found. From 50 articles and proceeding papers, we were able to identify 13 digital games presented by 16 papers that followed the defined criteria. In this section, we detail these works and their key findings.

The *Factitious* game, developed by Grace and Hone [2019], collected data from over 45,000 players to analyze patterns in fake news identification. The authors found that,

within their sample, fake news detection ability is usually correlated with older age until approximately 70 years old, after which detection performance declines. Their analysis also revealed a positive correlation between higher education and accuracy in distinguishing real from fake news. Their large-scale study provides empirical evidence supporting game-based approaches for both studying misinformation engagement patterns and developing targeted intervention strategies.

MAthE the Game, proposed by Katsaounidou *et al.* [2019] - Figure 4, is a quiz-based game that presents real-world news items which players must classify using "real" or "fake" buttons. The game integrates four verification tools (search engine, reverse image search, image verification, and debunking site) allowing players to assess news credibility within the game itself. Their evaluation (n = 111) suggests the gamification approach enhances both learning outcomes and learner engagement.

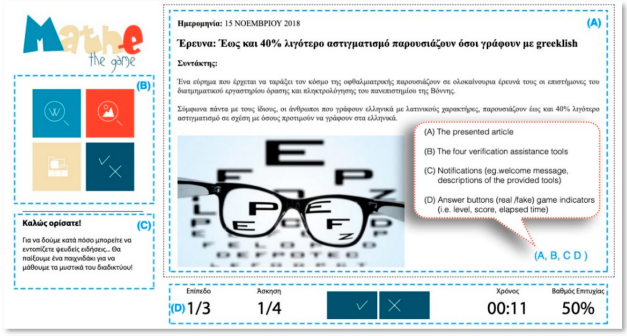

Figure 4. Screenshot of the Mathe the Game interface by [Katsaounidou *et al.*, 2019]

Roozenbeek and Van der Linden [2019] pioneered the concept of "cognitive immunity" through preemptive exposure to weakened doses of misinformation, a strategy called psychological inoculation. Their online game *Bad News* teaches players six common disinformation techniques: impersonation, emotional language, polarization, conspiracy theories, discrediting opponents, and trolling. Controlled intervention trials with 15,000 users demonstrated that players significantly improved at recognizing these techniques while gaining confidence in their judgments. Basol *et al.* [2020] and Maertens *et al.* [2021] replicated Roozenbeek and Van der Linden [2019] experiment with more rigorous experimental designs, observing that participants rated fake news headlines as significantly less reliable after playing the *Bad News* game. The success of "Bad News" led to a subsequent game, *Harmony Square* to further investigate the psychological inoculation through games [Roozenbeek and van der Linden, 2020].

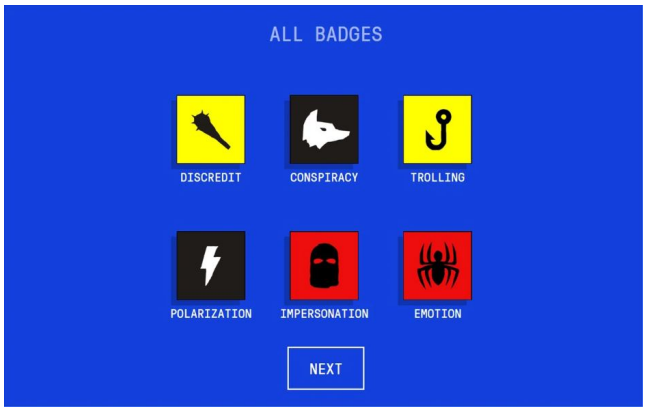

Figure 5. Badges for Identifying Types of Disinformation in the Game by [Roozenbeek and Van der Linden, 2019]

The serious game *Brain Company*, digitally developed by Maekawa *et al.* [2021], replicates social media dynamics, requiring players to: (1) assess online content, (2) make sharing decisions, and (3) experience follower count consequences. Evaluation results (n = 566) revealed that most participants mentioned the "verified account" mark was the main factor in assessing the posts' credibility and mentioned the account holder as the primary criteria. However, post-game reflections showed increased awareness of this bias.

Paraschivoiu *et al.* [2021] developed *Escape Fake*, an augmented reality escape room game for media literacy education. Their design process and evaluation results (n = 49) highlight the engagement potential of AR serious games for information awareness. Thereafter, Buchner [2025] evaluated the *Escape Fake* game with 28 teenagers and their analysis revealed strong effects across knowledge acquisition, critical attitude toward online information trustworthiness, confidence in future fake news recognition and information discernment ability.

In *Missed Information* [Aguilar and De La Vega, 2021] players assume the role of professional fact-checkers for a social media company, evaluating fictional news articles using provided verification tools. Post-game assessments with 35 participants revealed significant self-reported learning outcomes, with participants demonstrating increased confidence in fake news identification capabilities.

BotBusters, proposed by Feltrero *et al.* [2023], is an educational game that trains young people to recognize manipulated visual news through a social media simulation. By immersing players in a scenario-based environment, it combines Media and Information Literacy (MIL) and Sustainable Development Goals (SDG) education with practical training in critical thinking and fact-checking. The authors collected data from 2,483 players; however, the evaluation focused on engagement aspects rather than the game's effectiveness in teaching.

Neylan *et al.* [2023] later adapted the psychological inoculation theory into an interactive storytelling game named *Cat Park*. By incorporating real politically balanced misinformation examples in their assessment (equal left/right-wing fabricated posts). Their results (n = 380) confirmed that properly designed serious games enhance fake content detection while maintaining research neutrality. However, they noticed that, unlike previous works, their participants

do not become significantly more confident in their ability to identify fabricated content.

Capecchi *et al*. [2024] presents an evaluation of the game *Social4School*, Figura 6. The game employs a quiz-based format that requires players to critically evaluate three key elements of each news item: (1) source credibility, (2) publication date relevance, and (3) topic consistency. Following this analysis, players must decide whether to share the content on their simulated profile. Subsequently, they are prompted to justify their decision by assessing the news veracity and providing a rationale for their sharing choice. According the authors, evaluation findings (n = 217) demonstrate the platform's efficacy as an educational tool for fostering critical fake news analysis skills.

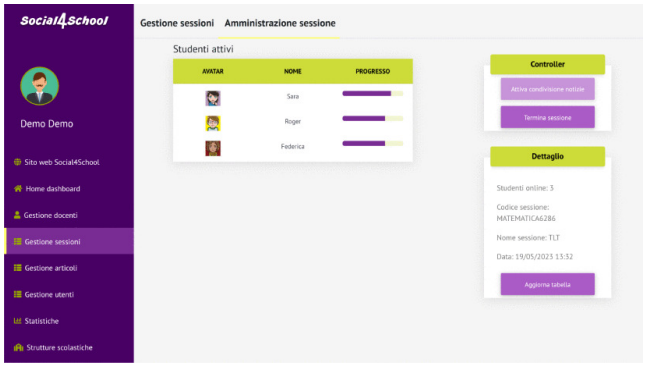

Figure 6. Dashboard of the Social4School platform by [Capecchi *et al*., 2024].

It is important to notice neither of the later cited games are available in Portuguese. Among the results, we identified identified three digital games discussed in four articles Passos *et al*., 2021; Barreto and Lima, 2022; Moreira *et al*., 2024; Cunha *et al*., 2024. In Cunha *et al*. [2024], we presented our first results (n = 5) of the *Fato ou Fake* game, including a less detailed description of the game and results of a pilot-test. The other game, titled *JEDi*, is a board-based game designed by Passos *et al*. [2021] and evaluated in the study of Moreira *et al*. [2024]. The players have to roll a dice and identify whether a content is fake or real. The authors observed that students (n = 3) showed progressive performance improvement, with consistently increasing accuracy rates across rounds. The evaluation conducted by Moreira *et al*. [2024] employed pre-test/post-test questionnaires, revealing modest gains in news verification accuracy among participants (n = 180).

Barreto and Lima [2022] presented the digital game *50 Years After the Coup*, developed for History education, which immersed players in Brazil's Military Regime era as historical agents. Through seven narrative phases, players' decisions dynamically alter both personal fates and national outcomes, requiring prior historical knowledge to resist misinformation manipulation. The authors created a rich educationally experience with complex branching narratives aligned with curricular objectives. However, the work did not fit our criteria as it lacked an empirical evaluation.

3.2 The Game

In terms of pedagogical design, the game presents strategies, embedded within the story's narrative, for identifying fake news. The resulted scripted dialogues are educational, allowing players to recognize poor choices (e.g., shared a fake content inside the game). We created fabricated examples mimicking real-world fake news for the game, carefully designed to avoid influencing players' opinions about existing content. Additionally, the dialogue was designed to encourage players to engage with external tools by searching online to verify the accuracy of the news they encounter in the game.

The developed game follows the story of a protagonist navigating life during the early COVID-19 pandemic. Through everyday scenarios, players encounter both factual and false news that influence narrative progression, with their choices directly impacting the storyline. A core design focus was news authenticity verification. The primary objective is to enhance players' awareness of fake news production/dissemination processes while developing practical skills to assess content validity—empowering them to form individualized, well-informed opinions. The main character acts, mainly, as a fact checker. During dialogues, characters encourage players to conduct web searches and apply previously learned tips to identify news authenticity, serving as an educational support mechanism. Figure 7 displays four in-game scenes: two depicting the protagonist's conversations with other characters, one presenting a player dialog-choice and one showing a "message receive" scenario.

Regarding the development of the minigames, we encountered two main challenges: one related to the developer's limited experience with implementing games in Python (which was necessary to add distinct interaction mechanisms to the Ren'Py engine), and the other concerning the gamification of content associated with the theme of fake news. In the first case, we chose to rely primarily on the resources available in Ren'Py, employing a choice-based model to implement the minigames. To differentiate these from traditional choice mechanisms, we incorporated graphical elements such as news clippings and drag-and-drop interactions.

Concerning the gamification, the first minigame focused on the identification of false headlines. The second addressed the classification of news items into contextual "bubbles". The third, which was not implemented, was designed to address the identification of fake news manufacturing strategies (e.g., sensationalist headlines, false attribution of authorship, lack of detail, etc.). Figure 8 shows an example of the minigame of identifying fake headlines and Figure 9 displays the minigame interface where players classify news items according to their "bubbles".

Minigames' outcomes provide only immediate player feedback without affecting narrative branching, which remains exclusively determined by dialog choices. These choices influence both immediate responses and later story outcomes through an accumulated decision-point scoring system.

The game, titled *Fato ou Fake*, is freely available as an open-source software under the GNU General Public License. We generated distributions for Windows Linux, macOS and Android.

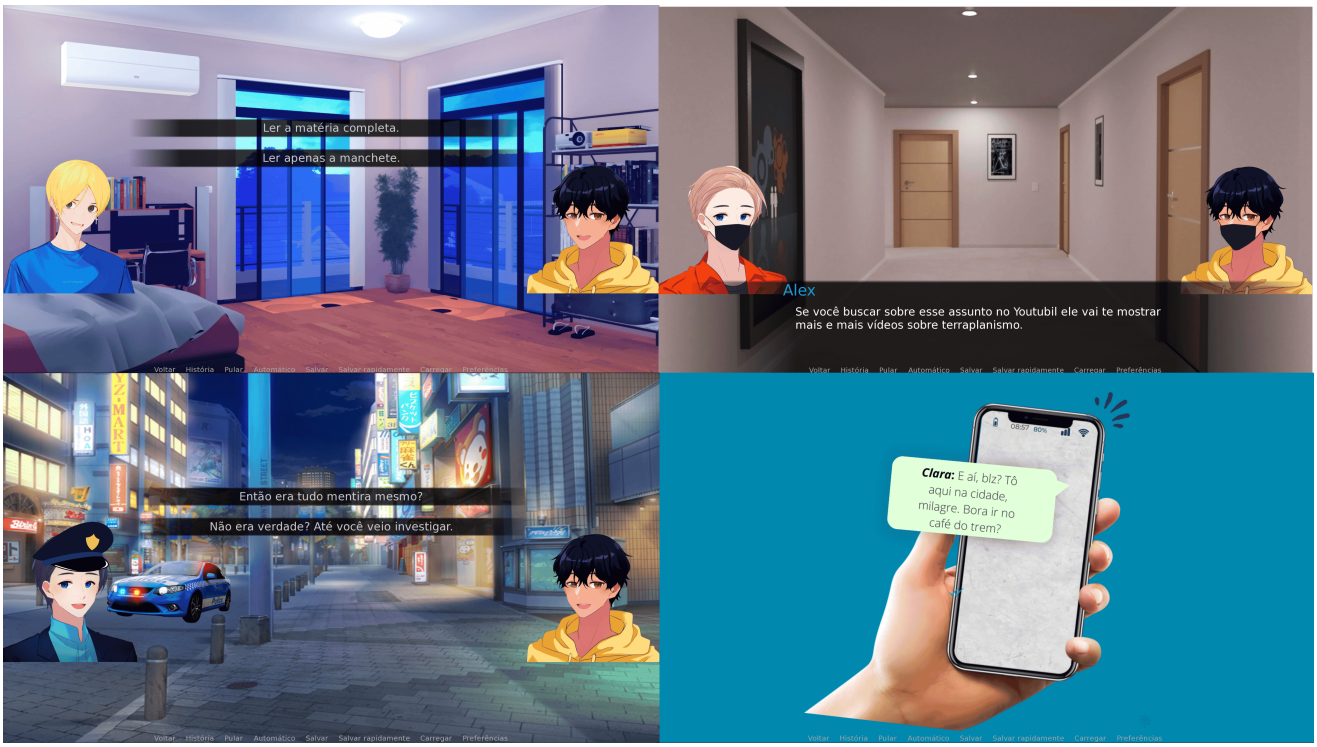

Figure 7. Sample scenes of the *Fato ou Fake* game.

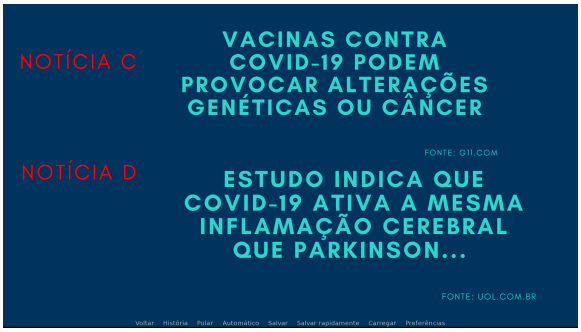

Figure 8. Screenshot of the fake headlines identification minigame.

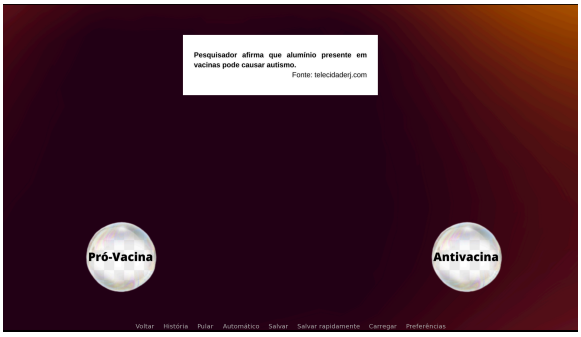

Figure 9. Screenshot of the news "bubble" classification minigame.

3.3 Evaluation Results

The participant group did not show a balanced gender distribution (14 female, 28 male), with all participants either currently pursuing or having completed higher education. The majority (n = 37) enrolled in computer science–related fields. The mean age was 24 years (range: 20–59). Figure 10 displays the pre- and post-test responses to the questions listed in Table 1, including both mean values and standard deviations. Q1, Q3, and Q4 indicate improvement when levels of agreement decrease, whereas Q2, Q5, and Q6 indicate improvement when levels of agreement increase. This pattern is clearly visible in the graphical representation (Figure 10), as all questions showed improvements.

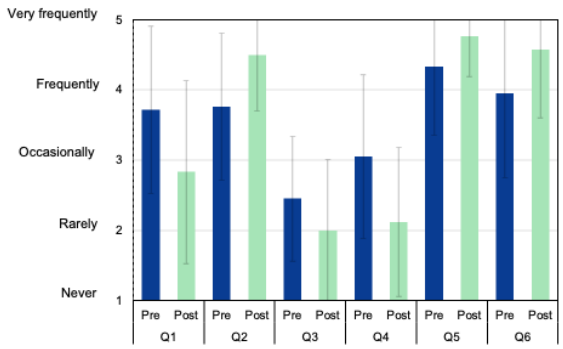

Figure 10. Graphical illustration of the questionnaire results.

We statistically analyzed participants' responses to information consumption questions before and after the game intervention. The Shapiro-Wilk test indicated non-normal distributions for all question responses ($p < 0.05$), so the Mann-Whitney U test was used for all statistical analyses. For all questions, there was a statistically significant difference ($p < 0.05$): Q1 ($p = 0.002$), Q2 ($p = 0.0005$), Q3 ($p = 0.014$), Q4 ($p = 0.0003$), Q5 ($p = 0.0214$), and Q6 ($p = 0.005$), suggesting that the game's content encouraged participants to adopt a more critical approach to evaluating information.

We obtained positive results in the qualitative feedback, with participants expressing clear engagement and recognition of the game's educational value. Below, we present four examples of participant comments:

1. *I found it easy and very straightforward to understand. I thought it was very good in showing the importance of*

sources and how news is used in politics to divide the population.

2. *I liked the way the minigames were made, but I think something more fun would attract more of the public. The sources at the end are extremely important.*
3. *It is a simple game but very relevant for people to get a sense of how impactful fake news can be. I believe it is something that is talked about a lot in daily life, especially during the COVID period and election times, but the impacts are not widely publicized and therefore not always taken seriously!*
4. *The game is very good, innovative, and very didactic, besides being very aesthetic and easy to play. Very good work!*

These results are encouraging and align with findings previously reported in the literature, indicating that serious games can provide educational value capable of influencing individuals' awareness as consumers of digital content. However, considering that the participants were individuals with higher education, their prior academic background may have affected the outcomes. Even so, measurable changes were observed, which may suggest the potential of this approach to educate less-informed individuals about information consumption in digital media environments.

Moreover, the visual novel genre demonstrated promising effectiveness as an educational strategy for addressing information consumption and fake news. Its accessible implementation and narrative-driven, text-based format offer a playful yet structured way to engage users with complex themes. Given these advantages, visual novels represent a valuable avenue for further exploration in the literature, particularly as a medium capable of integrating educational content with interactive storytelling.

4 Conclusion

The originality of the proposed game lies in its unique integration of the Brazilian educational and cultural context. From an educational perspective, the game builds upon the competencies outlined in the Digital Culture axis of the BNCC by adapting them into interactive learning experiences. Rather than addressing these skills only at a conceptual level, the design of the game situates players in scenarios where they must actively decide by analyzing online content, comparing trustworthy and untrustworthy sources, reflecting about algorithms of social networks, and questioning the credibility and purpose of what is shared. In this way, the educational objectives of the BNCC are implemented through gameplay, making abstract digital literacy skills more engaging. By addressing these skills, the game provides a pedagogical tool that reinforces key competencies established in the Brazilian curriculum.

In addition to being in Portuguese language, the game scenarios reflect interactions familiar to Brazilian students. For instance, the way the main character engages with friends, which is designed to resonate with everyday communication styles. Furthermore, the game also introduces the Brazilian LGPD (General Data Protection Law), a legal framework specific to Brazil that regulates the collection and processing of personal data.

Finally, the narrative format enhances personalization: the responses of the characters change dynamically based on the player's choices, making the learning experience both interactive and adaptive. This combination of curriculum alignment, cultural grounding, and narrative interactivity distinguishes the game from existing approaches.

Our systematic mapping identified 13 proposed games evaluated across 16 studies, including our own initial work. Among these, only one study did not include any form of evaluation but was retained due to its focus on Portuguese-language contexts. Another study solely assessed participant engagement with the game. The remaining 10 studies all presented empirical evaluations measuring the games' effectiveness in teaching fake news identification – with all reporting statistically significant outcomes. These findings support the efficacy of digital game-based interventions in promoting information literacy and critical media engagement.

A key limitation across all studies (including ours) is the absence of comparative analysis with traditional educational methods (e.g., lectures or instructional materials). While games may enhance engagement, their high development costs – as highlighted in this work – necessitate further research to determine whether their educational value justifies the creative and implementing efforts when compared to lower-cost alternatives, like workshops or seminars.

It is worth noting that ethical considerations were scarcely addressed in the studies identified through our systematic mapping. We hypothesize this stems from the minimal requirements for ethics committee approvals in computer science research across many countries. We anticipate increased attention to ethical protocols in future publications.

The game developed and evaluated in this study was designed to address specific needs in information literacy and critical media awareness. The evaluation conducted with 42 participants yielded statistically significant improvements in 6 out of 6 key metrics, demonstrating measurable gains in self-reported awareness after gameplay.

Our study has two primary limitations: sample size (n = 42) and the participants' educational background, which consists predominantly of higher education students in computing. Furthermore, the game would be particularly relevant in primary/secondary education settings. However, this would require modifications to the ethics approval process, as research involving minors necessitates stricter protocols and parental consent. Given the sensitive nature of fake news research involving minors, parental consent procedures would need careful design to address potential discomfort with the evaluation content.

Our findings support a positive response to the research question: Can serious games serve as an effective intervention strategy against misinformation? However, we observed a scarcity of published studies on this topic in the Brazilian context. Future work will focus on (1) enhancing the game's design and (2) conducting larger-scale evaluations with basic education teenagers. Furthermore, we intend to incorporate elements of inoculation theory, whereby players are exposed to common persuasive tactics used in disinformation, alongside guidance on how to recognize and resist them.

Declarations

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Authors' Contributions

Contributions according the Contributor Role Taxonomy (CRediT): **BCRC**: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Software, Supervision, Validation, Writing – original draft, Writing – review & editing. **SSR**: Conceptualization, Methodology, Writing – original draft. **CDOS**: Conceptualization, Methodology, Writing – original draft.

Competing interests

The authors declare that they have no competing interests.

Availability of data and materials

The *Fato ou Fake* game is available on `https://github.com/brunaru/Fato-ou-Fake-Game` under the GNU General Public License. The applied questionnaire is available at `https://forms.gle/vzebrmYT8rB1zzdk9`. We anonymized questionnaire results and made them available in a spreadsheet for reproducibility and verification: `https://docs.google.com/spreadsheets/d/1MafMm4a-OdVe5tecGpFN5e2XQa75DNqRusLJz-iKiQg/edit?usp=sharing`.

Further relevant information

We utilized Generative AI exclusively for Portuguese-to-English translation support. In strict adherence to open-source ethics, we prohibited any AI-generated content in both the game's development and its final assets. The research team conducted all data analysis through manual methods, deliberately avoiding any AI-based analytical platforms to ensure the General Personal Data Protection Law compliance.

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