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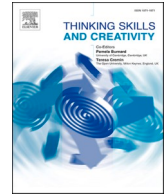
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Developing critical thinking skills through gamification

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ABSTRACT

Misinformation as well as the proliferation of fake news has been a problem during COVID-19 pandemic. This has affected many vulnerable communities in Brazil. The ability to understand and sort out pieces of reliable information and fake news has become a fundamental cognitive skill. In this study we report on the development of a serious game (a card-based role-playing game) using Brazilian folk heroes aimed to develop critical thinking skills to empower vulnerable communities affected by misinformation and fake news. Four groups located in the city of Goiânia (Brazil) participated in this research: one group of people experiencing homelessness; two groups of favela residents (one urban and one in the suburbs) and one group of recyclable material collectors from a cooperative. We gained entry and built trust with each of these groups and worked together for 10 months during the pandemic. We conducted participatory observations, individual interviews with each participant and discussed their daily interaction with information, specifically in the context of the covid-19 pandemic. The analyses of the observations and interview data gave us a glimpse of the communicative needs of the groups. Inserting players into a narrative where they can make decisions based on critical thinking and their own reflections on the pandemic was important for building knowledge and developing critical thinking in these communities. The nature of the game (interactive and cooperative) allowed participants to focus on problem-solving skills and group work. It encouraged them to use real-life knowledge and skills to solve the fictional problems presented by the narrative.

1. Introduction

“Liberating education consists in acts of cognition, not transferrals of information” (Freire, 2009 [1970], p. 170)

The global coronavirus pandemic has led to major changes in human behaviour, habits, and thought processes. Once simple decisions such as sending children to school, visiting the supermarket or meeting friends and family must now be preceded by complex assessments of the potential risks. People must make safe choices to the best of their ability based on the information available to them, which may be drawn from sources such as broadcast news, public health campaigns, social media posts and word of mouth. Unfortunately, not all of these sources are reliable. Misinformation has been a major issue worldwide throughout the pandemic (Zarocostas,

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2020), and understanding which information to trust has become a key cognitive skill.

Literature suggests that critical thinking can effectively combat misinformation (Machete & Turpin, 2020; Roozenbeek & van der Linden, 2019), but much of the existing research on teaching it has been carried out in schools or universities, and in the Global North (Cicchino, 2015; Halpern, 2001). It is time to develop methods for teaching critical thinking beyond formal education settings, beyond traditional teaching materials and classroom management and particularly to diverse learners from disadvantaged communities. Paulo Freire, on whose philosophy this project is grounded, saw education as central to the fight against oppression. He argued for a process he called 'conscientisation', where people are led to analyse and think critically about how inequality features in their lives. As Lucio-Villegas (2018, p. 163) writes, "It can be said that this process of becoming conscious is also the long and winding road to emancipation". Widening the scope of critical thinking education could contribute to building the emancipatory pedagogy Freire hoped for.

Disadvantaged communities in Brazil have been disproportionately affected by the COVID-19 pandemic. Limited access to specialised hospital care plays a role, as does the relative lack of official public awareness campaigns compared to higher-income districts. This is compounded by the prevalence of widespread misinformation and fake news, which have hindered efforts to mitigate the impact of the pandemic (Ricard & Medeiros, 2020).

Distinguishing accurately between real and fake news is a vital skill, particularly during the pandemic. However, it is a skill that must be learned, and as with any other type of education, the chance to learn and practice critical thinking skills is not evenly spread across the socio-economic scale (Freire, 1992, p. 71). This project, rooted in Dewey (1933) and Freire (1992) focussed on developing participant's abilities to make informed decisions by understanding and applying concepts such as making a point, identifying the supporting evidence on which the point is based and evaluating this evidence. We saw the need to develop critical thinking individually but also to negotiate it with others, to raise awareness on the consequences of one's own decisions on others. Two activities supported participants to develop these abilities: 1) Conversation circles sessions: during five sessions participants worked individually and in pairs with materials tailored to their realities (including degrees of literacy, disabilities, as well as contextual information); 2) Serious game: one session provided participants opportunities to collaboratively analyse information and draw reasoned conclusions about its accuracy. In the conversation circles, we engage in critical thinking activities moving along steps adapted from Bloom's taxonomy (1956), using materials which reflect participants' daily lives and stories from their communities. During these sessions, participants learn to deal with the onslaught of fake news that has become a dangerous part of everyday life. This learning empowers them to make informed choices about their own and others' health – something that has, perhaps, never been more important than now. This article focuses on a serious game to complement the conversation circles, aiming to develop critical thinking skills to empower vulnerable communities which are particularly affected by misinformation and fake news. In this article we report on the development and implementation of a serious game (a role playing game) in the context of developing critical thinking skills.

2. Serious games: brief review of the relevant literature

Serious games can be defined as "games whose primary intent is training or learning with definable learning goals, instead of being primarily intended for entertainment" (Harz & Stern, 2008, p. 13). Serious games can be used to enhance learning in a wide range of fields and for learners of all ages. They often incorporate simulations and role-play of real-life experiences, which can be used to support both formal and informal learning (Qian & Clark, 2016; Romero et al., 2014) and the engaging learning experience promotes effective recall (Boyle et al., 2016; Connolly et al., 2012; McDonald, 2017). Serious games can be digital or analogue, but some research suggests that analogue games may support learning more effectively than digital ones (Talan et al., 2020). This could be because of the increased opportunity for cooperation and communication between players, or because of the flexibility offered by analogue formats (ibid., p.494).

Mitgutsch (2011) differentiates between learning *in* games, where players acquire new knowledge or information, learning *through* games, where players develop skills based on their in-game interactions, and learning *beyond* games, where players are able to apply these newfound or newly-improved skills to the real world). This final type of learning can set in motion a "transformative learning process [...] in which the players explore new perspectives and develop new concepts of themselves, others and the world that they connect to real life circumstances" (ibid., p.56). Mitgutsch asserts that there is not yet conclusive evidence that such transformative learning can occur through serious games. However, there are growing indications that it might. Researchers and educators have found that participants' cognitive skills can be enhanced by the need to cope with a variety of challenging scenarios within the interactive game environment (Hwang et al., 2013; Prensky, 2001). Others in the education sector have noted the effect of game-based learning on players' problem-solving abilities and their ability to think critically (Michael & Chen, 2006; Qian & Clark, 2016; Romero et al., 2014). Serious games can be considered an effective tool for the development of 21st-century skills including communication, collaboration, and critical thinking (Romero et al., 2014). An ever-widening range of audiences are now recognising the potential of serious games to change the way players learn (McGonigal, 2011).

In this research project, a serious game provided the ideal complement for the critical thinking sessions. Although the project's goal was an educational one, in the widest sense of the word, it was vital that whatever activity was created for the participants did not *feel* academic. This would likely have discouraged participation, particularly by those who had negative experiences in school or who have had little formal education. Using a serious game creates a relaxed, engaging environment where participants are positioned not as 'learners' but as co-creators of knowledge.

2.1. Serious games, fake news, and COVID-19

In February 2020, WHO Director General Tedros Adhanom Ghebreyesus stated that, “We’re not just fighting an epidemic; we’re fighting an infodemic” (Zarocostas, 2020). The spread of misinformation has been a well-recognised issue since at least 2016, when the Oxford Dictionaries declared ‘post-truth’ their Word of the Year (Higgins, 2016). In post-truth situations, people are more easily influenced by emotions than by facts. The effects of misinformation and fake news have been particularly evident during the COVID-19 pandemic. Susceptibility to misinformation may make people less likely to get vaccinated against the virus and less likely to comply with public health measures (Roozenbeek et al., 2020, p. 12), endangering themselves and those around them. Conspiracy theories disseminated on social media have led to violence, with telecommunications masts in Europe, North America and Australasia destroyed due to a belief that COVID-19 is caused by 5 G technology (Jolley & Paterson, 2020).

Although recent studies have specifically targeted the COVID-19 ‘infodemic’, serious games research has a long history of exploring issues of misinformation and fake news. These studies have demonstrated that serious games can contribute to participants’ ability to identify and think critically about misinformation.

Roozenbeek and van der Linden (2018, 2019) base their research on inoculation theory, which suggests that exposing participants to incorrect information and providing them with means to argue against it can create ‘mental antibodies’ allowing them to recognise misinformation when they encounter it again, in much the same way that viral antibodies allow the immune system to recognise and react to a virus. Controlled exposure to misinformation could therefore provide a ‘vaccine’ against fake news (McGuire, 1964 apud Roozenbeek & van der Linden, 2018, p. 571). In their 2018 study, Roozenbeek and van der Linden created a multi-player board game in which players created their own misleading news articles. The game was designed to encourage players to think actively about the techniques used in misinformation, and they found that this process of ‘active inoculation’ did reduce the perceived reliability and persuasiveness of fake news articles (2018, p. 576). The researchers stress that their board game study was necessarily small-scale and exploratory; however, their 2019 experiment, which involved 15,000 participants playing an online browser game designed along the same principles, had similar results. Playing the game “significantly reduced the perceived reliability of tweets that embedded several common online misinformation strategies” (2019, p. 7). They also found the greatest change in those participants who had been most susceptible to fake news before playing the game, suggesting that inoculation could be of significant help to those most at risk of misinformation (2019, p.8).

Focussing on misleading multimodal texts, Clever et al. (2020) developed an app-based game in which participants have to match a headline to an image, and are rewarded both for successfully misleading others and for finding the true headline. Their study does not measure participant sensitivity to fake news before and after playing the game, so they are not able to identify whether the game succeeds in sensitising participants to fake news. Likewise, Katsaounidou et al. (2019) do not measure the effectiveness of their browser-based information-verification game, although their players did report feeling that it had helped them to better identify fake news. This is self-reported rather than empirically verified, but since these studies follow a similar process of inoculation to Roozenbeek’s and van der Linden’s, it is certainly possible that the games involved have similar effects.

Although the inoculation metaphor predates the outbreak of COVID-19, it seems particularly apt for the current moment. Basol et al. (2021) have designed a game along these lines which specifically targets misinformation around the pandemic. In *Go Viral!*, participants post on simulated social media sites and create their own conspiracy theories. Researchers found that participants were much more likely to identify manipulative misinformation about COVID-19 after playing the game (2021, p.6). Players were also more likely to suspect real news of being manipulative immediately after playing the game, but a follow-up assessment carried out a week later showed that this effect dissipated entirely with time, while participants’ increased sensitivity to fake news remained (2021, p.13). Basol et al. also found that players were less inclined to share fake news with others after playing the game (2021, p.14), suggesting that such interventions could be key in the worldwide fight against COVID-19 misinformation. *Go Viral!* has also been listed by the WHO as an anti-misinformation resource, and has been played over 300,000 times (Basol et al., 2021, p. 3).

Other researchers have focused on designing serious games to encourage responsible pandemic behaviour. Hernández (2020) created a game focused on COVID-19 prevention measures among the general public, and her results demonstrate the importance of game mechanics as well as informativity: her participants reported that the game provided useful facts, but was overly simple (2020, p.39). Suppan et al. (2020) targeted healthcare workers in long-term care facilities, identifying this as a sector where patients are particularly vulnerable to COVID-19, but where resources are lacking and overwork may impact workers’ ability to adhere to guidelines. Suppan et al. (2021) found that participants were significantly more willing to change their behaviour after playing the game than when they were shown infection prevention and control guidelines in a non-game format. The game is translated into German and Italian and will be deployed at the national level across Switzerland (Suppan et al., 2021).

The current project shares a range of attributes with the games mentioned above. As Roozenbeek’s and van der Linden’s (2018, 2019) inoculation approach, our project provides participants with small amounts of misinformation in a controlled environment, and scaffolds analysis and discussion. However, working with disadvantaged communities in Brazil required the development of a game that would be accessible with minimum technology to participants with a range of literacy levels, as well as one that was appropriate to the target culture. These requirements led to the use of a critical-thinking-focused tabletop role-playing game rather than the more common board game or digital (whether app- or browser-based) formats.

3. Serious role-playing games

The term ‘role-playing game’ (RPG) can refer to a range of phenomena including tabletop role-playing games, single-player video games, and multiplayer online games. In all these types of game, the player takes on a character role that is different from their

everyday persona. Tabletop RPGs, arguably the common ancestor of all the RPG genres (Zagal & Deterding, 2018) and the type of game used in this research, are usually played in a group led by a facilitator. The facilitator describes the fictional world for the players, who react by narrating their characters' actions. The game exists primarily in the facilitator's and the players' shared imagination. This open-endedness is the key difference between tabletop RPGs and other types of game and has led to some difficulty in defining RPGs at all: Zagal and Deterding describe them as "the exception, the outlier, the not-quite-a- game" (2018, p.19). However, it is this very open-endedness and flexibility that makes RPGs useful serious games, as they can be adapted to reflect a wide range of real-world scenarios (Ferrand et al., 2009).

Researchers have used serious RPGs to tackle subjects from wetlands management (Morardet & Milhau, 2012) to migratory bird identification (Chu & Chang, 2014). Several studies have used RPGs to encourage climate-adaptive farming practices (Salvini et al., 2016; Sautier et al., 2017; Villamor & Badmos, 2016), to explore climate-aware infrastructure planning (Schenk, 2014) or to raise awareness about the climate crisis (de Suarez et al., 2012; Rumore et al., 2016). These are highly complex issues involving a range of factors, tensions and stakeholders, and RPGs are able to capture this complexity without requiring extensive technical knowledge from the players (Flood et al., 2018, p. 5). They provide 'inhabitable learning systems' (de Suarez et al., 2012, p. 13) which are able to challenge inadequate mental models. De Suarez et al. compare games to flight simulators: in the same way that pilots can learn to fly using sophisticated simulations, decision-makers can learn to balance delicate issues using serious games (2012, p.12–13).

Various serious games can act as 'flight simulators', but collaborative RPGs are particularly effective for social learning. Assuming a role allows participants to depart from their usual viewpoints and consider other perspectives (Ahamer, 2013), and it empowers them to voice their opinions. As Morardet and Milhau note, role-playing "levels the playing field between stakeholders, allowing them to sit at the same table informally. Freedom of speech is higher in the game than in reality" (2010, p.47). The game provides a safe space for the exploration of contested issues, and for collaborative problem-solving.

Although the facilitator may provide guidance, problem solving is led by the players. Knowledge is not imparted by a lofty authority figure, but rather co-created by the group. Rumore et al. (2016) found that the social learning fostered in the RPG setting seemed to translate into increased awareness, political engagement and community action. Participants are empowered to take their newfound knowledge and skills beyond the game setting, and RPGs can become the catalyst for continued independent learning (Flood et al., 2018, p. 12). Social learning also provides space for the integration of local and traditional knowledge systems into decision-making processes (Villamor & Badmos, 2016).

Flood et al. identify three types of learning that can occur in games including RPGs: cognitive learning, where participants acquire new knowledge; relational learning, where participants develop communication and cooperation skills; and normative learning, where participants are led to question accepted norms and values (2018, p.17–8). RPGs may highlight certain aspects over others – for example, Schenk (2014) focuses on building understanding and cooperation between stakeholders, while Hertzog et al. (2014) emphasise disseminating information about water management practices – but all RPGs, to some extent, involve all three of these learning types. This makes them immensely powerful tools for capacity building, skills development and information sharing.

RPGs feature prominently in serious games research carried out in the Global South (Edwards et al., 2019; Hertzog et al., 2014; Morardet & Milhau, 2012; Salvini et al., 2016; Villamor & Badmos, 2016). In communities where there may be limited access to digital resources, or where literacy levels may vary, RPGs provide a low-resource, replicable medium for collective learning and engagement. The minimal written material involved also likely simplifies translation of the game into local languages where necessary (cf. Evans, 2013), or localisation to different cultures. The game itself provides a common language for the players, scaffolding discussion of the issues involved among participants with different knowledge bases (Eisenack, 2013), and far from being a hindrance, having participants with different backgrounds and stakeholder positions involved in the game enriches the experience for all players (Edwards et al., 2019).

An RPG therefore presented the ideal serious game format for this project. It provided an opportunity for participants to collaboratively develop critical thinking skills and deal with allegorical scenarios which reflected real-world issues; it required few resources and could easily be played in a range of settings; it was accessible to participants who did not have smartphones, and to those with lower literacy levels; it was easily replicated, both by the facilitators within this project and, potentially, by future projects. For some of the participants with lower literacy levels, the team noted the need to have more than one facilitator while playing. Even when participants did help each other out, it was important to make sure all of them could access all the information available at the same time.

Deciding to create a collaborative, analogue game enabled this project's success, but also changed its course. The team initially included game developers and programmers whose research focused on individual, digital games. As a result of the decision to pursue a RPG, these team members could not implement their initial research agendas and left to other projects. When working with vulnerable communities and designing empirically driven games these changes are to be expected, and researchers working with vulnerable communities are familiar with this risk.

4. Methods and initial results informing the game development

To design the RPG, which is the focus of this article, the team relied on various methods to assess and understand the participants' needs, as well as to design and implement the RPG. Our approach was ethnographic. The project lasted 18 months (from October 2019 to March 2021). A team of 7 researchers in Brazil (including 2 co-Is and 3 research associates/assistants) and 4 in Scotland (including PI, co-I and 2 research assistants) divided tasks during the lockdown. Some activities needed to be done in situ (e.g., observations, implementation of activities) while others could be done remotely (e.g., design of data collection instruments and of materials for the conversation circles and the game, training of community leaders, and data analyses). By the time travelling between Brazil and

Scotland was opened, PI and CIs worked together in Brazil to discuss findings with the participants on site and finish the project.

Once we received ethical approval, we started ethnographic observations (Brazilian team) to build trust and gain entry in four distinct communities (See Section 5 below). Simultaneously, the Scottish team worked remotely on a series of training sessions for local community leaders to act as local researchers. After gaining entry to four sites (3 months), we observed and interacted with participants for 6 months. Based on observations and informal conversations we designed a survey to capture how participants' get information on COVID-19 and news in general. Each participant could fill the questionnaire with a researcher. Based on the data gathered we designed a semi-structured protocol and conducted a series of semi-structured interviews to explore participants' perceptions on media, how/to whom they assign trust, how they access news, among other questions. The data collected during the survey and interviews informed the design of two key activities in the project: the conversational circles and the serious game. Interviews and focus groups were conducted at the end of the Conversation Circles sessions and at the end of the game session to explore participants' positions *vis à vis* fake news.

The characteristics of the participants influenced the project's focus on critical thinking about (fake) news. Findings from initial interviews ($n = 60$), conducted by researchers in situ to explore participant's selection of sources of news, showed that broadcast television is the main source of news and information for these communities. There are two main news channels, Globo and Record, with conflicting political leanings, which seemed to split the population into two camps. Interviews suggested a high level of trust towards information gained from either news channel, with some participants triangulating the information by viewing both channels. Word of mouth and WhatsApp are also seen as fairly reliable sources of information. Other sources such as Facebook are viewed as less trustworthy and are treated with some caution. This is a positive sign, indicating some awareness of the spread of misinformation on social media. However, mixed public messaging and the prevalence of scientific denialism within the Brazilian political sphere (Dall'Alba et al., 2021) mean that even information provided through authoritative channels may not be reliable. People also get information through the internet, friends and family. In this environment, critical thinking must extend to all information sources.

Community preferences also informed the design of the game. Interviews with community leaders and representatives suggested that phone-based games are unpopular and that phones are used exclusively for social media, further justifying the use of an analogue RPG rather than a browser- or app-based game. The interviews also highlighted that a game-based learning approach could provoke resistance, as participants might associate the game with gambling and addiction. Most forms of gambling have been banned in Brazil since 2008, but gambling addiction continues to be a problem, and treatment options are few and far between (Tavares, 2014). To avoid any adverse effects on participants, it was important for the project to ensure that the game did not use any mechanics that could resemble gambling or prove addictive, as community members might have refused to take part in the game activity for fear of addiction or for religious reasons.

Therefore, in order to protect participants and to foster open debate, an allegorical story was used for the game. The story, in which players discover and combat a blight in the rainforest, mirrors the COVID-19 pandemic but frees participants from the complex real-world dynamics surrounding it. This is an innovative measure, as serious RPGs (e.g. Morardet & Milhau, 2012; Rumore et al., 2016; Salvini et al., 2016; Schenk, 2014; Speelman et al., 2013; Villamor & Badmos, 2016) tend to replicate real-world scenarios rather than using allegory. This often seems to work well, as participants are able to gain factual knowledge about the issues involved as well as develop critical thinking skills (Salvini et al., 2016; Sautier et al., 2017). However, in some cases it has led to non-participation of stakeholders or conflict between players. For example, Hertzog et al. (2014) found that international companies involved in water



Fig. 1. Methods used.

management refused to participate in a role-playing activity, stating that they were unable to discuss their corporate strategies in public (2014, p.6). Villamor and Badamos, who note the processes of peer pressure at work during their game, quote one participant as saying to another, “We really need to talk after this game; I don’t like the way you manage your cows” (2016, p. 7). Future research could consider whether an allegorical approach, as used in the present study, might help to mitigate these frictions.

The research methods used in this research is presented in Fig. 1.

5. Participants and communities

The project targeted three participant groups in the city of Goiânia: residents from two favelas, members of a recycling cooperative, and people experiencing homelessness (PEH).

For over 100 years, Brazil’s metropolitan centres have been characterised by the presence of *favelas*. No longer properly translated as ‘shanty towns’ or ‘slums’, some *favelas* have developed into “consolidated urban villages built of masonry and reinforced concrete” (Cummings, 2015, p. 1). However, *favelas* still tend to be densely populated, with high levels of poverty, food insecurity and crime, and are still marginalised within Brazilian society. Fix and Arantes (2021) write that *favelas* “sum up contradictions and conflicts and simultaneously embody forms of resistance and urban imagination” (2021, p. 13). The most recent census reports that in 2010, over 11 million people or around 6% of the total population of Brazil lived in *favelas* (Pereira, 2020, p. 42).

Informal waste collectors or *catadores* perform a valuable social function in Brazil, collecting recyclable materials to be sold for processing. However, the work is underpaid, heavily stigmatised and brings significant health risks (Gutberlet et al., 2013). *Catadores* can find some protection from these issues by organising into cooperatives, which in Brazil are sometimes supported by governmental or nongovernmental organisations (ibid. p.4608). These cooperatives vary in size, level of organisation, and available resources, but they may provide training and safety equipment, and some campaign for better public recognition of the *catadores’* work (N. F. Ramos et al., 2013, p. 235). The cooperative involved in this research supports vulnerable people both by providing them with a stable income and by helping them to gain access to basic services such as vaccination programmes and child support. *Catadores* must also follow the rules of the cooperative, which mandate PPE and prohibit alcohol or drug use. During the pandemic, additional rules have been put in place to prevent virus transmission. The cooperative experiences high personnel turnover, as *catadores* move between areas or into other employment.

People experiencing homelessness live in precarious circumstances and often have difficulty accessing healthcare. In Brazil, the situation for PEH has deteriorated in recent years, particularly since 2017, as the result of economic and political instability (Honorato & Oliveira, 2020, p. 1065). Brazil’s National Policy for the Homeless Population, or Decree 7053/2009, defines PEH as “a heterogeneous population group having in common extreme poverty, interrupted, or weakened family ties, and lack of regular conventional housing, thus using public places and degraded areas as temporary or permanent living spaces, as well as shelters for temporary overnight stays or as temporary housing” (quoted in Nunes et al., 2021, p. 2). This heterogeneity sets the PEH group apart from the other two target audiences for this study. *Favela* residents and *catadores* are likely to have low levels of education, but PEH come from a wide range of socio-economic backgrounds and are likely to have had other living and employment situations prior to their experience of homelessness. Nunes et al. (2021) highlight PEH as a complex population with distinct needs which existing public health services rarely meet, and this has remained the case during the pandemic. The charitable organisation that assists PEH involved in this research has delivered thousands of masks and hygiene kits to PEH and provides over 1500 meals per day. They have also worked hard to raise awareness about COVID-19, finding that since PEH are isolated from usual channels of communication, they have limited access to information about the pandemic. In the table below (Table 1) we present the number of participants per site attending the conversation circles and the RPG.

Each of these three groups have distinct characteristics, but there is one main commonality: all are particularly at risk from COVID-19. Crowded living conditions in the *favelas* make social distancing or self-isolation impossible, and facilities for handwashing are often limited or non-existent (Pereira, 2020). For *catadores*, infections and illness resulting from exposure to contaminated materials have been an issue since before the pandemic (N. F. Ramos et al., 2013). For PEH, the exhortation to “stay home” is impossible to follow (Honorato & Oliveira, 2020). All these factors increase the risk of COVID-19 transmission, and measures to raise awareness of safe pandemic behaviour among these populations are vital. This project aimed to contribute to this effort.

The following section briefly discusses the ‘conversation circles’, a series of workshops designed to build the critical thinking skills

Table 1
Participants per site.

Site	Participants		Female		Male	
	CC	GS	CC	GS	CC	GS
Cooper-Rama (<i>catadores</i>)	8	11*	5	7	3	4
Favela Buena Vista	9	9	0	0	9	9
Favela Vila Lobó	10	9**	10	9	10	9
Joaquim Lúcio Square (PEH)	14	14***	5	5	9	9

CC – Number of participants who attended at least 3 of the total of 5 Conversation Circle (CC) sessions.

GS – Number of participants who attended the single Game Session (GS).

* - Three GS participants attended less than 3 CC sessions.

** - One GS participant attended less than 3 CC sessions.

*** - Two GS participants attended less than 3 CC sessions.

which participants then need to apply during the serious game.

6. Conversation circles

Before playing the game, participants take part in workshops or ‘conversation circles’ (CCs) designed to develop critical thinking skills and apply them during the game experience. Each of the five CCs begin with a social activity intended to build trust between participants, then progress to activities focused on critical thinking, and end with guided reflection on what has been learned during the session.

The sessions gradually increase in complexity, scaffolding in-depth critical thinking in an accessible and enjoyable way. Learners are given explicit information about critical thinking techniques (Abrami et al., 2008). They are encouraged to apply these techniques to familiar, everyday situations such as deciding which pair of shoes to buy as well as to more abstract topics such as trusting or not trusting a person. After completing the five sessions, participants are well-equipped with conscious critical thinking skills, which they can then apply effectively during the serious game.

Conversation circles and the serious game complement one another in raising awareness on critical thinking. While the CCs included discussion and training for participants, the serious game provided reflection about the content presented in the conversation circles. It also provided the opportunity for participants to work with others as well as to negotiate and plan strategies and courses of action. Games allow for interactive teaching-learning strategies and knowledge construction. Their fun, interactive and cooperative nature encourages group problem solving, one of the project’s aims.

7. Facilitating critical thinking in the game

Critical thinking is “a metacognitive process, consisting of a number of sub-skills (e.g., analysis, evaluation and inference) that, when used appropriately, increases the chances of producing a logical conclusion to an argument or solution to a problem” (Dwyer et al., 2014, p. 43). One of the earliest attempts to classify the processes involved in critical thinking, Bloom’s taxonomy of educational objectives (1956), identifies six thinking processes, divided into lower-order and higher-order processes. Dwyer et al. note that although more recent work has built on this framework, the six categories of thought defined here remain fundamentally consistent with modern conceptions of thinking (2014, p.43). For Dwyer et al., the six key learning outcomes are memory, comprehension, analysis, evaluation, inference and reflective judgement (ibid, p.43), as can be seen in Fig. 2. Memory and comprehension facilitate the higher-level thinking skills; analysis, evaluation and inference combine to enable reflective judgement (ibid. p.49). It is this reflective judgement that empowers critical thinkers to reject fake news and make informed decisions on topics such as COVID-19 vaccination or safe pandemic behaviour.

The importance of teaching critical thinking has long been recognised (Halpern, 2001). However, it is notoriously difficult to teach (Willingham, 2008). Approaches to teaching critical thinking, and the success of those approaches, vary widely. Meta-analysis of studies on teaching critical thinking has shown that both the type and the pedagogical basis of the teaching methods used have significant effects on whether and how much participants’ critical thinking improves (Abrami et al., 2008, p. 1120). It seems to be particularly important that participants are explicitly told that they are learning critical thinking skills: the least effective interventions were the ones that embedded critical thinking techniques implicitly into course material (ibid., p.1120). Participants in this project were informed during the recruitment process that the conversation circles and game would focus on critical thinking, and so they

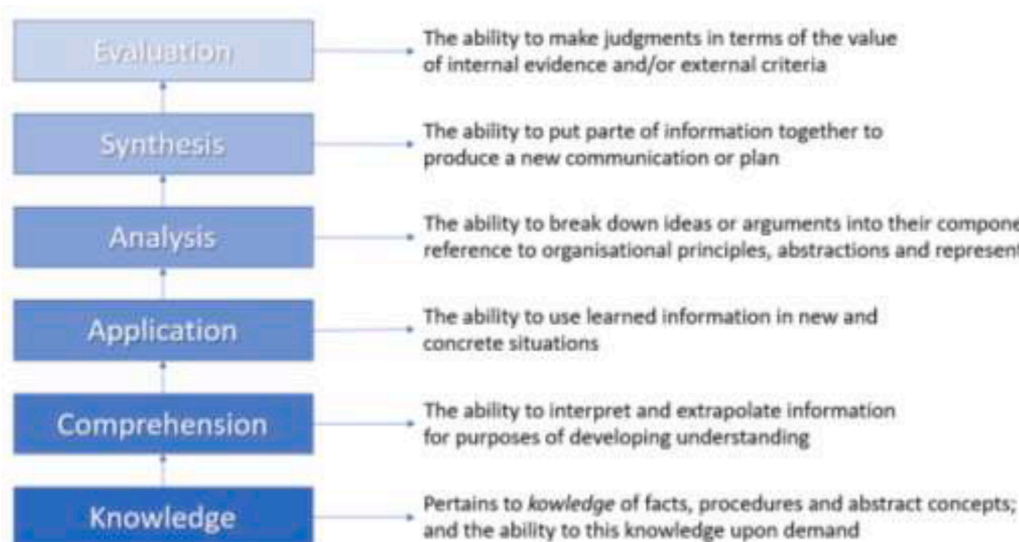


Fig. 2. Bloom’s taxonomy (adapted from Dwyer et al., 2014, p.43).

were aware of the project's goals from the outset.

As demonstrated in the literature review, serious games and game-based learning have been used to teach a wide range of knowledge and skills. Although most games do not explicitly teach critical thinking, many have the requisite complexity to foster it (Romero et al., 2014, p. 158) and recent projects are turning towards a specific focus on critical thinking (Cicchino, 2015; Halpern et al., 2012; Lee et al., 2016; McDonald, 2017). In an analysis of 20 studies focused on teaching critical thinking, Mao et al. (2021, p. 19) found that game-based learning (GBL) had a significantly positive impact on players' critical thinking skills, particularly when the game involved role-playing.

Cicchino (2015) outlines six principles of GBL which a game must fulfil in order to foster critical thinking. Although Cicchino's work mostly comes from elementary school groups, we found these basic principles can be applied to adults, as can be seen in Table 2.

Within the game setting, these principles led to engagement, collaboration, higher-level (in the Bloom's taxonomy sense) discourse, and a meaningful experience for players. The overall outcomes of a game created based on this framework include deeper and longer-lasting understanding of the content, flexible understanding which can be adapted to new situations, and increased critical thinking skills (Cicchino, 2015, p. 4). Since these were the planned outcomes of this project, a game-based learning environment was developed according to these six principles.

In the freeform tabletop roleplaying game, participants take on the roles of traditional Brazilian folk heroes. The story evolves through the actions of the characters, as interpreted by the facilitator, following a basic pattern of play. First, the facilitator sets the scene, providing situations to which players can react. The players then collectively decide how they want to act or respond, and the facilitator describes the effects of these actions on the story. The facilitator has the final say on what happens, ensuring that gameplay never deviates too far from the intended plot. Some of the narrative is emergent, but certain points in the game involve pre-set choices which players must resolve appropriately for the story.

To help structure play for participants unfamiliar with role-play, players are provided with a set of cards describing their character's abilities. Cards were used because they are an effective and compact way of presenting knowledge. The cards include visual elements, which are helpful for players with lower literacy levels, and can be referred to throughout the game. They can also be hidden, which contributes to the communicative aspect of the game: players must share their abilities and knowledge verbally, rather than by showing their character cards to the group. The strengths and weaknesses listed on the cards help players decide on the best course of action for their character.

Players are also provided with a handout which describes the game environment. Like the cards, these use visual representations to ensure that all participants are able to understand the information provided.

The game complies with Cicchino's six principles in the following ways, as can be seen in Table 3.

Participants are thus able to develop transferable critical thinking skills in a safely allegorical environment. The information provided to players is inconsistent between sources, and the players must discuss and interpret it in order to assess its accuracy. This critical approach to new information is an essential skill in a 'post-truth' world (Higgins, 2016), and particularly during the COVID-19 pandemic.

8. Game characters and story

Players take the role of one of five characters based on Brazilian folk heroes. Each character can also be played by two or more participants working together, introducing a further layer of negotiation into play by requiring participants to agree on how their shared character should proceed. This also allows larger groups to take part in the game. Table 4 shows an example of the cards prepared for the game.

The character roles were modelled on Brazilian mythological heroes for several reasons. Many of these characters are seen as guardians of nature, which provides logical motivation for them to work together in the story setting. They have diverse skills, knowledge and abilities, meaning that each character can make a unique contribution to the team. Importantly, participants are usually familiar with the characters' abilities and motives prior to playing the game. Players can use their background knowledge of the characters to decide what they might do within the game, which alleviates some of the difficulty of role-playing for participants new to the format.

The characters' diverse knowledge bases are central to the game's goal of fostering critical thinking, as players synthesise their characters' knowledge to solve the problems presented in the story. The characters' skills and personality are less important to the game mechanics. For example, Saci Pererê's medical knowledge is the most important. If the game were to be translated or localised for other cultures, it would be vital to find characters with the same knowledge bases.

Table 2

Adapted from Cicchino, 2015, pp.3–4.

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- 1 The intervention must provoke critical thinking via one or more problem states
 - 1 The intervention must provide "just enough" challenge for players
 - 1 The intervention must provide opportunities for players to discover/ construct their own knowledge/understandings
 - 1 The intervention must provide a fictional world
 - 1 The intervention must be social and encourage collaborative interaction between players
 - 1 The intervention must be winnable – and by various avenues
-


Table 3

Adapted from Cicchino, 2015.

Principles of GBL (Cicchino, 2015)	
1 The intervention must provoke critical thinking via one or more problem states	The game presents the players with a problem: a blight discovered in the rainforest.
1 The intervention must provide "just enough" challenge for players	The game was designed to be challenging, but players are supported by the facilitator. The flexible RPG format means that the facilitator can adapt the game to the needs of specific groups.
1 The intervention must provide opportunities for players to discover/construct their own knowledge/understandings	Players are encouraged to discuss and decide upon solutions to the challenges they face among themselves. The facilitator guides reflection on the choices they make, reinforcing learning.
1 The intervention must provide a fictional world	The story is set in a fictional version of the Brazilian rainforest, and players take the roles of traditional folk heroes.
1 The intervention must be social and encourage collaborative interaction between players	Each character has pre-defined skills and weaknesses. The players must collaborate, sharing their knowledge and capacities, in order to make best use of the group's range of skills. None of the characters can complete the challenges alone, but each of them has a particular contribution to make to the team.
1 The intervention must be winnable – and by various avenues	Players can win the game by completing a series of challenges to cure the blight. There are various ways to do this.

Table 4

Example character.

	<p>Saci Pereré, a one-legged boy who wears a magical red cap and is a notorious trickster.</p>	<p>Strength: Saci Pereré can choose to disappear and reappear wherever he wishes. Weakness: Saci Pereré cannot interact with animals. Knowledge: Saci Pereré has extensive knowledge of herbs and medicine.</p>
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8.1. The story

The characters meet by a river in the rainforest and notice that something is wrong. They work together to cross the river and discover a blight on the trees. The characters investigate the blight by looking at it, smelling, touching or tasting it, or asking forest animals for information. A supernatural white deer, Anhangá, appears, and tells the characters about a kind of medicine that can be used to treat the blight. The characters can acquire this medicine by finding an amulet for Cuca, a mysterious alligator-like creature, or by making it themselves with ingredients they find in the forest. Applying the medicine to the trees cures the blight, but any characters who previously touched the infected trees now discover that they too are infected. They must now discuss whether to take the medicine themselves or not and justify their decision.

9. Results and discussion

The game was developed as a communicative strategy to establish a bridge between researchers and participants, but in a more relaxed and informal environment. Inserting the players in a narrative where they can make decisions based on critical thinking and their own reflections about the pandemic was important to the construction of knowledge in these communities. The nature of the game (playful, interactive and cooperative) helped to focus participants on problem-solving skills and groupwork outside of traditional methodologies, which was part of the project's aim. The game also helped to reinforce many concepts and habits that were discussed during the conversation circles, and it allowed participants to use real-life situations to solve the fictional problems presented by the game's narrative. They were also capable of comparing fictional characters and objects to real life events. Some evidence on these findings will be presented below.

In each community, the participants were separated into groups according to the number of people present during each session.

Local researchers narrated the game and facilitated discussions, presenting new cards and scenarios. More dynamic participation from local researchers was necessary to guide the participants during the game as the story evolved. Each of the communities included people with learning difficulties, and facilitators worked to ensure that all participants understood the dynamics of the game.

In many instances, some participants gave suggestions on how to advance the story and their suggestions sometimes came ahead of the facilitator's narrations, as for example, in Buena Vista, even before Anhangá appeared in the story, one participant asked if they had a glove to touch the slime and another commented that there could be a medicine to save the forest from the plague.

In Cooperrama, some participants associated the game with their own personal experiences to solve problems. For example, some participants had knowledge of plants, fungi and they decided to apply the remedy in the game to the soil, since fertilizers are also applied in this way. It was evident that some decisions were made based on participants' environmental awareness, as they work with recyclable materials. Many participants refused to cut down the trees, burn the forest to eliminate the pest or injure animals, even when it was necessary for the game to continue.

In all of the locations, there was suspicion about Cuca's morals. In Brazilian popular culture, Cuca is often presented as a villain and in the game, Cuca is portrayed as a character of dubious morals. In both the cards and the storybook she is described as a character with questionable traits, but she still helps the other characters during their journey.

In the Buena Vista *favela*, even though they did not fully trust Cuca, the participants believed that trusting Cuca was the best option. One participant compared Cuca to pop culture anti-heroes such as Batman and even joked that if Cuca tried anything against the group, she would be at a disadvantage, five to one, so they could beat her in a fight or tie her up. Another participant also compared Cuca to a bandit who only cares about gold, since at the end of the story, she asks the characters to find the *Muiraquitã*, an amulet buried in a nearby region. The story does not explain Cuca's intentions, desires or motivations, just that she wants to possess the amulet.

In Cooperama, one participant compared Cuca with Brazilian politicians due to the lack of clarity in their actions. In Vila Lobo, the group unanimously decided to take the medicine because they did not think Cuca was reliable. After some discussion, the second group of PEH chose to go to Cuca for the medicine, because they came to the conclusion that she had knowledge, and also because she is a being that lives in the forest. One participant commented that "she wants good things for the forest too". In addition, they did not feel confident preparing the remedy, even with the step-by-step procedure.

This evidence shows that participants demonstrated a high degree of creativity, critical thinking and the ability to associate game-based learning with reality. All noted the need to make collective decisions and find shared solutions. Among the observed critical thinking skills, there is an emphasis on the evaluation and analysis phases. In their testimonials gathered at the end of the session, participants talked about the importance of listening to others with respect, of being mindful of different points of view and of making decisions based on dialogue. One participant from the *favela* Buena Vista stated: "Listen and help friends when they need it... do not think only of yourself... to make decisions, we need to evaluate and always put ourselves in the other's shoes and that for every action there is a reaction". In the Vila Lobo *favela*, one participant even made an association between the forest and plague with the current pandemic, stating that we must join forces to fight COVID-19: "If we don't work together, the pandemic will last a long time". Therefore, the games showed to be efficient in building critical thinking among participants and offering opportunities for socialisation. One participant from Cooperama said: "I learned that you have to discuss to reach an agreement and I learned that people have different opinions. I learned this by having more dialogue with friends".

It is of course difficult to know whether the observed results will last over time. In a longitudinal game-based study on fake news inoculation, Maertens et al. (2021) found that for a group of participants who were regularly tested on their ability to identify fake news, the increased sensitivity to misinformation generated by the initial intervention lasted for up to three months. However, for participants who were not regularly tested, the effect dissipated within two months. They suggest that the assessments carried out with the first group may have served as 'booster shots', reinforcing the initial inoculation (ibid., p.12-13). Inoculation theorists have emphasised the role of boosters in forging long-term resistance to misinformation (Ivanov et al., 2018; Pfau et al., 2006).

A game-based intervention, if sufficiently engaging, could provide an organic way of delivering inoculation boosters. For example, in Eisenack's work with the commercially-available board game *Keep Cool*, some participants found the game so entertaining that they wanted to purchase it (2013, p. 345). Continuing to play the game could refresh the skills these participants gained in the initial intervention and playing the game with other people could spread these skills beyond the project's initial reach. There are some indications that a similar process could occur with this project: game facilitators reported community interest in holding more game sessions. At the time of writing this article, some sites have already completed their second and third rounds of workshops. However, it is unlikely that all participants will be involved in these sessions, and it is possible that those who are not may see their critical thinking skills developed during their involvement in the project degrade over time. Exploring whether this occurs and to what extent would be insightful for a future follow-up study.

10. Limitations of our study, final considerations and call for further research

Snowball/convenience sampling was carried out due to relationships of trust within the communities which worked well for this study. However, this sampling method is not without its limitations. As participants were self-selected, it is possible that those who decided to take part in the study were already interested in critical thinking, an inclination which could make them particularly receptive to learning about it. An entirely random sample might produce different results but, randomization of subjects and experimental design was not the goal of this study.

As previously outlined, this study covered a range of target populations, each with their own characteristics. This meant that for the purpose of this study, one small group of participants could be drawn from each participating site. Using this range of participants demonstrated that the game-based methodology can be effective across different disadvantaged communities. Observational evidence

indicates changes in how participants paid attention and listened to others, questioned the sources of information and justified their own claims. Differences in results between the groups, however, may be the result of individual tendencies and cannot be generalised to the wider community. A study focusing exclusively on, for example, PEH or *catadores* could draw wider conclusions about that community's particular tendencies around critical thinking. This could provide further insights into targeted methods of developing critical thinking with that specific population. There was also some turnover within the groups, as 27% of participants dropped out of the study during the circle conversation sessions. This happened mainly in the Vila Lobó *favela*, perhaps due to the fact that the facilitator was not a residing member of the community, impacting engagement. This suggests that the involvement of a residing community member as a facilitator is an important aspect of participant engagement.

An important consideration for the wellbeing of participants and the success of the project was to avoid conflict within the game setting. The COVID-19 pandemic and the government's handling thereof are highly-charged emotional issues. Additionally, in Brazil as in many other countries, public opinion is polarised. There were concerns that an open discussion of the pandemic could antagonise participants who support the government at the time or stifle debate if participants felt unable to voice their opinions for fear of others' reactions. Research has demonstrated that conflicting opinions about the pandemic can even lead to violence (Jolley & Paterson, 2020), and this risk should clearly be avoided at all costs when designing a research project. Consequently, the team decided not to include any statement/situation that might have the slightest potential of creating conflict among participants.

Looking ahead, our team plans to replicate this study in other vulnerable communities of Brazil. Our community partners have articulations with organizations that work with favela residents (such as Central Única das Favelas - CUFA), collectors of recyclable materials (such as the National Movement of Recyclable Materials Collectors - MNCR) and homeless people. Project materials have been developed in English and Portuguese. We also anticipate the possibility to work in other Spanish speaking countries in Latin America.

In sum, this study has contributed to the existing bodies of work on both serious games and critical thinking pedagogy. Previous work on game-based inoculation against fake news has tended to use digital games (Basol et al., 2021; Clever et al., 2020; Roozenbeek & van der Linden, 2019), and this study has demonstrated that an analogue RPG can provide an accessible, low-resource alternative. It has also shown that using an allegorical game setting rather than a realistic one (such as Hertzog et al., 2014) can remain relevant to real-world events while mitigating some of the tension involved in discussion of highly charged issues, as was the case with discussions about self-care during the pandemic in an environment of political polarization. Finally, it has illustrated that a game-based approach to critical thinking can be effective and engaging not just for schoolchildren (Cicchino, 2015, p. e.g.; McDonald, 2017) but also, as evident from the information on Table 1, for adult learners with varying levels of literacy and previous critical thinking experience.

CRedit authorship contribution statement

Claudia Viviana Angelelli: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Geisa Muller de Campos Ribeiro:** Data curation, Formal analysis, Investigation, Methodology, Resources, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Maico Roris Severino:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Eilidh Johnstone:** Visualization, Writing – original draft, Writing – review & editing. **Gana Borzenkova:** Data curation, Investigation, Resources, Writing – original draft. **Dayane Costa Oliveira da Silva:** Data curation, Investigation, Resources, Visualization.

Declaration of Competing Interest

The authors declare that there is no conflict of interest regarding this publication.

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