OTHER THEMES

Playful Pedagogical Analysis of Studies with Board Games in Arboviruses

Rafaela Vieira Bruno[I]
Arnaldo Vianna e Vilhena Carvalho[II]
Renata Monteiro-Maia[I]

[I]Fundação Oswaldo Cruz (Fiocruz), Rio de Janeiro/RJ – Brazil
[II]Universidade Estadual do Rio de Janeiro (UERJ), Rio de Janeiro/RJ – Brazil

ABSTRACT – Playful Pedagogical Analysis of Studies with Board Games in Arboviruses. Controlling *Aedes aegypti*, the vector of pathogens that cause dengue, Zika and chikungunya is a priority, and raising the awareness of the population about prevention, through educational practices, may reduce the number of cases of these diseases. One of these practices is the use of educational board games. The present study analyzed five playful pedagogical proposals with board games, published between 2015 and 2019, and concluded that although 40% of the studies listen to the students, the approaches prioritize the memorization of factual and procedural contents. In addition, the proposals demonstrate the low playful literacy of the teachers and students involved in the research.
Keywords: **Arboviruses. Scientific dissemination. Board Games.**

RESUMO – Análise Ludopedagógica de Estudos com Jogos de Tabuleiro em Arboviroses. O controle do mosquito *Aedes aegypti*, vetor de patógenos causadores da dengue, Zika e chikungunya é prioritário, e sensibilizar a população quanto à prevenção, através de práticas educativas, pode impactar na redução do número de casos. Dentre essas práticas, existem propostas que exploram a ludicidade, incluindo o uso de jogos de tabuleiro educativos. O presente trabalho analisou cinco propostas ludopedagógicas com jogos de tabuleiro, publicadas entre 2015 e 2019, e concluiu que apesar de 40% dos trabalhos demonstrarem preocupação em escutar os alunos, as abordagens priorizam a memorização de conteúdos factuais e procedimentais. Além disso, as propostas demonstram baixo letramento lúdico nos professores e alunos envolvidos nas pesquisas.
Palavras-chave: **Arboviroses. Divulgação científica. Jogo de tabuleiro.**

Introduction

Arboviruses and their main vector – *Aedes aegypti* mosquito – occur endemically and significant throughout the country. The main resources to tackle this problem are public campaigns and science popularization in schools.

As for science popularization, playful learning means have reached an outstanding role as a strategy to bring the population closer to the problem arboviruses, the life cycle of the vector mosquito, and its preventive measures. Among these means, board games are the less approached; however, they are broadly approved by researchers and their target audience. According to the studies analyzed, what can motivate the use of this resource? What would be the expected return in terms of preventive measures? Which games can be used and what are the methods behind their dynamics? What kind of content do they develop? What are their building premises? And, finally, what kind of playful learning literacy is present in the different studies?

This article proposes a reflection about these questions through the compared analyses of five graduate dissertations using board games as an approach to raise the awareness about arboviruses. The studies – published between 2015 and 2019 – presented the theme to students of different educational segments, using various games and methodologies.

In order to contextualize the research, it is paramount to briefly review the diseases associated to *Aedes aegypti* in Brazil and their epidemiological data, the scientific information relevant to the population, and the actions taken by the country concerning health and education.

Arboviruses and current Brazilian context

Aedes aegypti vector's life cycle

Arboviruses are etiological agents of diseases such as dengue, chikungunya, Zika and yellow fever. They are spread by arthropods and develop part of their replication cycle in insects (Lopes; Nozawa; Linhares, 2014). They are significant causes of diseases in animals and human and have social and economic impacts (Marchi; Trombetta; Montomoli, 2018).

These viruses can be spread by urban arthropods, e.g., the *Aedes aegypti* mosquito (Donalísio; Freitas; Von Zuben, 2017). A great number of arboviruses circulate in tropical and subtropical zones, where these insects are abundant (Marchi; Trombetta; Montomoli, 2018).

Aedes (Stegomya) *aegypti* (Linnaeus, 1762) is original from Africa and has been initially described in Egypt, which originated its scientific name. It belongs to the family Culicidae and to the genus *Aedes* (Consoli; Lourenço-de-Oliveira, 1994). It measures less than 1 cm and it is characterized by its black color with white stripes on the body and legs. It usu-

ally feeds in the first morning hours and late afternoon, but it can behave in an opportunistically, biting the host when it gets closer to spots where they take shelter. Its lifespan lasts about 45 days and females can fly up to a thousand meters away from its eggs (Silva; Mariano; Scope, 2008).

Ae. aegypti has anthropophilic characteristics and feeds on sap. However, females need blood repast for egg maturation. During hematophagy, they can consume blood of organisms infected with the virus that causes dengue, Zika, chikungunya and other arboviruses. Females can lay about 100 to 120 eggs per gonotrophic cycle (period that encompasses blood feeding, eggs maturation and oviposition), which may trigger a fast population expansion (Silva; Mariano; Scopel, 2008).

Its life cycle has four stages: egg, larva, pupa and adult. Eggs are long and fusiform, measuring about 0.4 mm (Christophers, 1960). Females do not lay their eggs in the water, but on the inner walls of containers with water, right above the waterline, in breeding sites with standing water such as tires, cans, glass containers, bottles, plant saucers, cemetery flower vases etc. Breeding sites can also be found in containers with water stored for household purposes such as water tanks, open or poorly capped plastic drums and tins, as well as untreated pools and fish tanks (Consoli; Lourenço-de-Oliveira, 1994).

Eggs are resistant to desiccation and can survive for a long time, which poses a major obstacle to eliminating the mosquito (Christophers, 1960; Silva; Mariano; Scopel, 2008). According to Farnesi et al. (2009), after oviposition, eggs become impermeable and can remain viable for over a year. When laid, eggs are white, but quickly darken into a shining black color. This color makes it harder to identify eggs on containers, usually dark and shady, where females lay them. (Honorio; Lourenço-de-Oliveira, 2001).

Eggs hatching occurs after two to three days under high humidity. Larvae go through four instars and the duration of each stage depends on the temperature, feeding availability and larval density in breeding sites. In optimal conditions, pupation occurs in five days at most. However, if temperature is not appropriate and feeding is scarce, the forth larval stage may extend for several weeks (Farnesi et al., 2009).

Pupae do not feed, and that is the stage in which metamorphosis into adult stage occurs. Pupal stage takes about two to three days. Pupae stays on the water surface, which makes it easier for the adult insect to emerge (Lourenço-de-Oliveira, 2015).

The flying adult mosquito corresponds to the reproductive stage of the insect, with great dispersion relevance. Within 24 to 48 hours after emerging, they can mate and the mating may take place during flight. Lourenço-de-Oliveira (2015) states that a single mating is enough for the fertilization of all eggs the female mosquito may come to produce during its life.

Lourenço-de-Oliveira et al. (2004) report *Ae. aegypti* has already been eradicated from Brazil but, from 1970 on, it has been reintroduced.

Thereafter mosquito control campaigns have been reviewed, but unfortunately they have not been really effective due to the increased resistance of mosquitos population to the insecticides adopted, the low awareness of the community to the problem, and the lack of public policies with investments in infrastructure, such as regular water supply and trash collection.

There are three main mosquito control strategies. Biological control by predators, competitive species and mosquito pathogens to reduce population density. Chemical control by the use of insecticides and/or larvicides, which should be considered as a last resort to control vectors. The use of such compounds must be restricted to emergencies or situations when there are no other control strategies available (Brasil, 2011). Mechanical control – which consists in eliminating mosquitos breeding sites – is currently the most used and defended strategy to reduce the number of insects in Brazil. This strategy includes methods to eliminate or reduce the areas where vectors breed, such as the removal of standing water and any potential mosquito breeding sites. Other methods that can also be used to restrict the contact between human beings and the vector are mosquito nets, mosquito nets for windows or mosquito repellent clothing (Brasil, 2014). To improve the mechanical control, it is necessary that people know the mosquito life forms, since it is easier to eliminate 200 eggs than 200 flying mosquitos.

Factors of susceptibility to arboviruses endemics in the Brazilian territory

Brasil presents hot and humid climate with constant rain, which creates suitable conditions for the proliferation of several vectors associated to the spread of such arboviruses (Lopes, Nozawa; Linhares, 2014). However, climate has been changing over the years and it affects the biology of vectors, thus facilitating the dissemination of infections transmitted by these insects. Uncontrolled urbanization; poor trash collection, basic sanitation and urban cleaning services; deforestation; migrations, and adverse sanitary conditions associated to socioeconomic issues have turned insects into synanthropic vectors, which favors human infections (Lima-Câmara, 2016; Zucchi, 2016; Cunha; Trinta, 2017). Over the years, e.g., there has been an increased number of cases of dengue in cold regions such as the north of Argentina due to the gradually increased global temperature, with *Aedes albopictus* mosquito being a secondary vector (Ballarino, 2019).

Ae. aegypti and *Ae. albopictus* are highly relevant since they are associated with emerging and reemerging infectious diseases, which brings severe consequences to public health (Weaver; Reisen, 2010). Although *Ae. albopictus* is considered a secondary vector of these arboviruses in Brazil, its expansion and growing density has been a matter of concern for health authorities (Kraemer et al., 2015).

In the country, from December 2019 to April 2020, 603,951 probable cases of dengue were reported; 443 cases of severe dengue (SD), 5,325 cases of dengue with warning signs (DWWS) and 221 deaths were confirmed. Over the same period, 17,636 probable cases of chikungunya were reported in the country, with the southeast region ranking second highest incidence rate (9.3 cases/100,000 inhabitants) and Rio de Janeiro accounting for 16.6% of the cases. As for Zika, Brazil reported 2,058 probable cases, with incidence rate of 0.7 cases/100,000 inhabitants in the southeast region (SVS, 2020).

In the face of new outbreaks and of the introduction of new arboviruses in the country, as well as co-infections, strategies based on information, prevention and control, together with public health policies, become even more urgent. These methodologies must not be applied only in times of epidemics, but as preventive actions aiming at reducing the numbers of cases.

According to Zucchi (2016), controlling dengue and other arboviruses requires collective participation and educational approaches. Such approaches must lead to behavior changes boosted by knowledge transmitted to the population on vector control actions and characteristics of the disease. In this context, building political and commercial partnerships is critical, as well as education and urban planning. Thus, educational interventions through methods that address health promotion and the relevance of environmental problems are urgent and necessary, aiming at raising the awareness of the school community about *Ae. aegypti* prevention and control measures.

Mafra and Antunes (2015) state different government levels (federal, state and local) invest in publicity campaigns to stimulate citizens to take actions toward vector control. An example is the campaign to fight *Aedes aegypti*: "And how about you? Have you already fought the mosquito today? Protect you family.", which has already received a total investment of 12 million reais. The federal government budgeted 1.8 billion reais in 2019 to mobilize state and local governments, which received the resources through the Health Surveillance Program (Tokarnia, 2019).

Health promotion strategies at school level and the relevance of playful initiatives

School has been presented as a favorable space to raise the awareness of part of the population about decisions that impact public health (Gouw; Bizzo, 2015), beginning with children and adolescents, in relation to the issue of mosquitos breeding sites (Brasil, 1997). By triggering educational initiatives, the school community fosters the knowledge/information building and sharing about the importance and control of *Ae. aegypti*, aiming at reducing the number of breeding sites.

Successful interventions must reflect on the decrease in the number of arboviruses infection cases and may include several resources

acting in an integrated manner: classes, lectures, conversation sessions, posters, experiences and activities. Different forms of scientific dissemination involving playfulness – an important learning resource – have shown to be viable as measures of awareness and prevention of arboviruses.

The playful communication of any subject broadens people's interest and, for that reason, commercial marketing practices frequently seek to communicate products and services to the audience through humorous advertising and promotions that instigate costumers. When it comes to bringing health information to the school, this same playfulness is usually evoked, as seen in the visual identity of campaigns about dengue and other arboviruses (Figure 1) and in related games and playful activities offered.

Figure 1 – Image of publicity campaign for the control of *Aedes aegypti* promoted by the Health Department of the State of Tocantins

Source: Tocantins (2019).

Basically, these activities can be divided into those ones using electronic means for dissemination, including videos and specially games, and those working directly with the students through physical means, which includes literature, posters, board games and others.

In the field of non-electronic medias, a clear example of this range of strategies was proposed by Silva (2019), whose dissertation brings to the agenda many of those playful practices in an integrated manner: elaboration of comics, informative brochures, parodies, memes, quizzes and, finally, board games. According to the author, games were the activity that most integrated the students and school community, since the idea proposition to its execution in the culmination of the project. This and other studies will be part of our following analyses.

Analyses of studies on board games as an arboviruses dissemination and education practice published between 2015 and 2019

The approach to arboviruses by means of board games is mentioned discreetly, yet regularly, in Brazilian studies. Dozens of results are shown in a simple search for keywords like "arboviruses" + "board game" or "dengue" + "board game"[1] in major search engines such as Google Scholar[2]. However, it was not possible to find any prior study that has identified the historical occurrence of this methodological approach.[3] Furthermore, the scope of such results showed that the effective use of games in the scientific dissemination of arboviruses is vague.

A brief timeframe was analyzed, which brings us close to the most up-to-date panorama of scientific studies on arboviruses prevention using board games. To that end, searches on major academic databases aimed at studies published from 2015 to 2019. Years 2020 and 2021 were excluded from the analyses because we believe the profile of studies in the area may have been impacted by the changes faced during the coronavirus pandemic, period in which the data collection and this research were conducted.

Publications were selected from databases of recognized academic relevance. They are:

- Brazilian Digital Library of Theses and Dissertations (BDTD, Biblioteca Digital Brasileira de Teses e Dissertações - Ibict) (BDTD, 2021)
- Theses and Dissertations Catalogue – CAPES (2021)
- Arca/Fiocruz (ARCA, 2021)

In all databases, the search was made with keywords related to arboviruses, board games, using different keywords and their combinations: "board game", "educational game", "game", "arboviruses", "dengue", "Aedes"[4]. As a final result, we ended up with five master's degree dissertations on the use of board games as an approach of the scientific dissemination of arboviruses They are:

1) Dengue prevention behavior: effects of advertisements and a board game (Carneiro, 2015).

2) Desenvolvimento e avaliação de estratégias educativas para combater a Dengue, Zika e Chikungunya no ensino fundamental II (Ferreira, 2017).

3) Effects of the participation in a championship with an educational game about behaviors of children for dengue fever prevention (Nascimento, 2017).

4) Construção de um jogo educativo para adolescentes com ênfase no enfrentamento das arboviroses (Nóbrega, 2019).

5) Production of educational materials as an instrument for the control of Aedes aegypti: experience of an active teaching methodology in a fundamental level school in the city of Rio de Janeiro (Silva, 2019).

Scientific dissemination is still an approach little diffused among researchers, probably due to the low occurrence of studies on the theme. Another hypothesis is related to the low playful literacy that characterizes the Brazilian population and that can also be observed among researchers. This possibility will be further discussed.

Of the analyzed studies, only a few dissertations included board games as part of the research. It demonstrates that this approach is an object of academic interest for the scientific dissemination of arboviruses. However, reflections that foster this field of knowledge must be more encouraged.

According to the studies analyzed, the reasons that lead researchers to use games include: a) Assessing the behavior (verbal and nonverbal) of eight- and nine-year-old children exposed to race games about the proliferation of dengue when compared to exposition to the advertisement on the subject and to a control group (Carneiro, 2015); b) Developing an educational strategy for middle school students involving an answer-and-move race game with questions on arboviruses, and checking after 30 days if the information was absorbed (Ferreira, 2017); c) Checking with the parents of the eight- and nine-year-old children the behavior impacts of a "championship" at school with two different games – race game and quick reflex games (Nascimento, 2017); d) Listening to 13 to 15 years old students, build an answer-and-move race game (Nóbrega, 2019), and e) Designing a project of integrated playful activities with the students using materials related to arboviruses and their prevention, including an answer-and-move race game (Silva, 2019).

In all cases, the authors emphasized the importance of raising the awareness, informing and producing positive reactions on participants about arboviruses prevention, through the pedagogical use of board games. Four out of five of the studies also indicated that the games were motivating experiences, with improved school performance regarding the student's accrued knowledge on arboviruses. Nevertheless, although two studies point to improved behavior related to the prevention of mosquito proliferation, none could precisely verify the success rate in reducing the number of cases of arboviruses in the schools communities where the activities were conducted. On the one hand, this imprecision shows a lack of integration between educators, who are normally propose the activities, and the Municipal Health Department, through the Health Surveillance Department (responsible for monitoring the cases); on the other hand, researchers' conceptual difficulties about the pedagogical potential of board games limit the depth of proposals and analyses.

Specific analyses on the approaches and methodological and referential parameters of the games used in the studies

The concept of playful pedagogic literacy guides the analyses of the studies, combined with the social pedagogical and didactic perspective (Zabala, 2010) and game design theories (Zimmerman; Salen, 2003; Engelstein, 2019). The objective of this foundation is to allow a) a quantitative exploration of the collected data, their points of convergence and singularities in the studies analyzed, and b) observe the different playful pedagogical aspects, including how the studies explore the mechanics, themes and artistic characteristics of the games, among others.

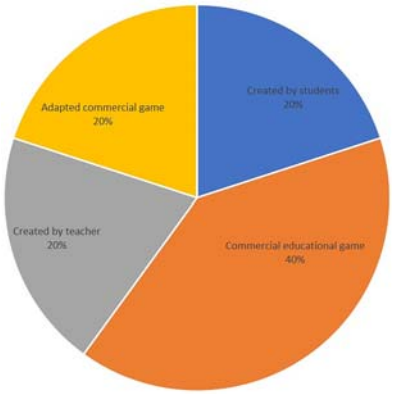
For this categorization, dissertations were read and the data on the type of games, didactics approaches, places where the research was conducted, games authorship, game social dynamics and its educational segment were organized. Sixty percent of the studies used only one game, while 40% combined a main game with complementary ones.

Authorship analyses

Game authorship demonstrates pedagogical choices that bring different meanings to the educational practice with games and have their own dynamics. Games created by students with different teacher mediation levels reveal the leading role of the students in relation to their learning process. Brazilian education is increasingly tending to this type of approach, which is considered an important mean to relevant learning (Pelizzari et al., 2002). On the other hand, this practice takes longer than simply presenting the content (the game) and, depending on the school demands, an existing game can be more viable. Pedagogically, it is always important to establish a careful dialogic, in which listening is crucial, but teachers' propositions are not inhibited either.

Of the studies analyzed, one uses a game created by the students with different levels of teacher mediation[5]. Two other used the same commercial game (Valentim, 2009). A game created by Nóbrega included listening to the students suggestions (Nóbrega, 2019). One of the studies adapted a commercial game[6] proposed by the researcher (Nascimento, 2017). These data are compiled in Graph 1.

Graph 1 – Games Autorship



Source: Elaborated by the authors.

Categorization of the interaction dynamics

Most games are considered competitive, i.e., players compete with each other. But other mechanics are included, from team competition to cooperative games in which all players work together to overcome the challenges proposed. The social mechanics of a game interferes in the experience and, thus, in the engagement of the students. The resistance of some students to competitive games, for example, is different in case of cooperative ones. The studies analyzed used only competitive games, 40% with individual competition and 40% with team competition.

The popularization of cooperative board games is still in early stages (Munhoz, 2018), little incorporated to the countries' everyday life in terms of playful activities. Therefore, it is once again evident that teachers (proponent part in the studies analyzed) and students are apart from a field of production, knowledge and use of games conceived with a contemporary design. Although there has been a boom in the area over the last years (Carvalho, 2019), apparently the field of scientific dissemination has not absorbed the innovation behind the phenomenon. It exposes the need for more access to playful pedagogical literacy by educators so that their approaches with games can broaden formative possibilities and increase their educational potential.

Type of game (categorization and mechanics)

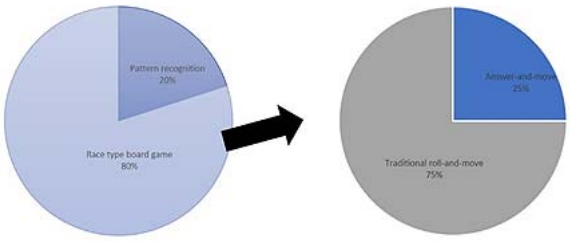
The field of board games categorizes the mechanisms that define the game dynamics. It includes elements such as luck, strategy, tactics and various cognitive and/or motor skills. Knowledge and comprehension of the game mechanisms, as pointed out in the study by Engelstein and Shalev (2019), have been increasingly used among scholars because of the perception that each mechanism or group of mechanisms produces specific cognitive, immersive, social, evaluative and reflexive

effects on the players. This criterion help us understand the playful formative basis of the social actors involved in the board game in educational situations about arboviruses – particularly that of the teachers.

Games Mechanics

In the sample analyzed, most of the games (four out of five) are variations of race games in which the main mechanics is that of "rolling and moving" or "answering and moving"[7]. These data are shown in Graph 2. The combination of race games and questions mechanics dominated these creations. The only exception was an adaptation of the commercial game "Tapa Certo" – Brazilian widely-known game in which players use a long-handled stick with suction cups at one end to slap and collect cards according to the proposed rules – that uses simultaneous action and pattern recognition mechanisms.

Graph 2 – Mechanics observed in the games



Source: Elaborated by the authors.

Although it does not seem to be an issue perceived by students and teachers, the low mechanics diversity when compared to the range of possible combinations in other games[8] demonstrates that game proponents are not skilled in the so-called playful literacy (Zagal, 2010). It is known, however, that game mechanics diversity can increase the interest in the game, which is essential in educational proposals (Costa, 2010). It allows the exploration of cognitive, social and reflexive aspects related to the awareness about each one's role in the prevention of arboviruses. Which games may arise from a team of students and teachers provided with this kind of knowledge/language?

Educational segment

The analyzed studies must be positioned according to the educational segments they seek to serve, since each study has its own demands and it's a gateway for different possibilities. The perception of teachers and students about board games and their capabilities can be understood by identifying which proposals are included in each segment. The studies concentrate on Primary and Middle School, being two in the first segment and the other three in the second.

Table 1 summarizes the information of the studies analyzed in this study.

Table 1 – General Table of Analyses

Author/criterion	Segment	Game (type)	Interaction	Authorship
Carneiro (2015)	F I	Answer and move	Individual competition	Third part game
Ferreira (2017)	F II	Answer and move	Team competition	Teacher-student partnership
Nascimento (2017)	F I	Answer and move + "Tapa-Certo"	Individual competition	Third part game + adapted game
Nóbrega (2019)	F II	Answer and move	Team competition	Teacher listening to the student
Silva (2019)	F II	Answer and move, only question, "fact or myth"	Individual competition	Students mediated by teacher.

Source: Elaborated by the authors.

Playful Pedagogic Literacy

The easy production and dissemination of information on the Internet has drawn attention of researchers all over the world about the need for new literacies beyond the conventional one, since it is not enough to make content/information available; a series of skills and competences are required regarding the interpretation, treatment and dissemination of information through the means it flows. Digital literacy is pointed out as a preventive response to the exposure of the population to fake news, which has brought many impacts to the citizen's social and political decisions throughout the world.

Digital language is not the only one with multimodal characteristics and requires skills inherent to a specific literacy. There is a multimodal trend in the learning process (Dias; Farbiarz, 2019) and, as well as in the digital world, board games formulate another linguistic structure that requires the elaboration and abstraction of specific signs. It is a highly polyphonic structure whose dialogic depends on the education and experiences of players and game proponents. This playful literacy makes individuals and their communities able not only to attain standardized information, but to deeply reflect about the experience provided by the game, including its themes and dynamics.

Just as it happens with book reading and digital literacy, the required skills for a playful literacy of board game include slow reading (Ginzburg, 2010) and the universalization of cultural assets that break the social stratification of the gaming culture. The social history of games demonstrates there has been social distinctions depending on the class of the player. Over time, many board games have been devel-

oped for a specific literate audience belonging to different elites, while others culturally spread over an audience with low purchasing power, which is often combated. In the stratified gaming culture, more complex games (chess or eurogames) are more disseminated and stimulated among individuals from wealthier classes, being part of the cultural capital, according to Pierre Bourdieu (1997, p. 86):

> The initial accumulation of cultural capital, the precondition for the fast, easy accumulation of every kind of useful cultural capital, starts at the outset, without delay, without wasted time, only for the offspring of families endowed with strong cultural capital; in this case, the accumulation period covers the whole period of socialization. It follows that the transmission of cultural capital is no doubt the best hidden form of hereditary transmission of capital.

In his theory, Bourdieu (1997) states that cultural capital is a type of capital used in the stratification principle almost as powerful as the economic one, achieved by means of an educational system in which schools separate students with different culture quality and quantity. Thus, on one side are those who own this "cultural capital", which is inherited and highly valued and, on the other side, those deprived of it.

As for board games, the disruption of this process – an important demand in the face of inequality – occurs by providing two types of access to the games, both depending on the playful literacy: physical and cultural, as well as critical domain that can identify social and cultural representations in art and other mechanisms and elements that constitute the games. Both accesses walk hand in hand and were summarized in our study under the concept of cultural assets.

In addition, playful literacy offers a range of experiential possibilities other than those the Brazilian educational context has traditionally defined as the concept of what a game is. Games built in the 21st century should be thought based on current players since nowadays they deal with new cultural demands that do not completely correspond to the model of games created centuries ago (Parlett, 2018), which is the case of race games.

If playful literacy should be a criterion to be considered by educators when proposing activities with games for the prevention of arboviruses, it does not establish itself when apart from pedagogical propositions in tune with that basis. This detachment can be noticed many times in the studies analyzed, even when overlooking signs of the low playful literacy mentioned before. For example: studies that promote games in the form of "championships" are not clear about how many game sets are available and what goes on with students when they are not participating in the game activity. What do they do? Where is their attention drawn to? Playful pedagogical literacy prevents this situation from happening.

In this regard, practices of scientific dissemination of arboviruses also demonstrate – beyond the lack of playful literacy – the playful pedagogical literacy, which can only be developed in the relationship with the basis of the game and of gaming.

Studies according to the content typology

The major theoretical reference in this case is the Spanish educator Antoni Zabala (2010) and his content typology. According to Zabala, the content explored in class can be categorized as factual, conceptual, procedural and attitudinal. Through this theoretical analysis, the studies were verified regarding whether and how they operate within these four aspects, which reveals how rich a proposed activity with board games can be.

By factual content the author means the knowledge objects and their most straight meanings. The way a mosquito looks is a factual content. The memory match game, for instance, allows the visual grasp of shapes and looks and their names, which contributes in a playful manner to retain this type of content. The game "Tapa-Certo" was adapted to the context of the *Aedes aegypti* control in one of the studies (Nascimento, 2017) improving factual content learning through pattern recognition mechanisms. Likewise, the questions and answers mechanism proposed by the race games addressed in the other studies can work for factual learning and as a starting point for more conceptual discussions.

Once the perspective of mosquito recognition and identification is developed, it is possible to elaborate about its nature, create categories and comparisons, explore the limits of what a mosquito is or is not as a specimen, its individual and collective performance and so on; that is the conceptual content. Therefore, games that require a mix of abstract analysis and creativity can be examples of how to work conceptually.

In overall analyses, we perceived the potential of questions and answers to start a conceptual process. However, the way they were used in the games resemble static memorizations, without the necessary associations among the different pieces of information and their abstractions. Educators that tried to bring reflections beyond memorizations and behavioral conditioning did not resort to games, but to other integrated activities, which included lectures and conversations. There was no questioning or propositions regarding the possibilities that the games were conducted with playful pedagogical literacy strategies capable of stimulating the students to reflect about the game practice itself.

On the other hand, procedural contents involve the mastering of practical actions – their mechanisms, their schedule etc. Based on this concept and on the previous example, learning how to eliminate mosquito breeding sites would be considered a procedural content. Games in which "the winner is who first empties the water from the vases" is eminently a procedural training. The aim of the commercial game

"Nossa turma contra a Dengue" ("Our gang against dengue") – aforementioned and used in the two master's degree theses on behavior science – is to stimulate behaviors and procedures that, according to the assessments, would have produced behavioral changes regarding the procedures to prevent the spread of the mosquito (Carneiro, 2015; Nascimento, 2017).

Finally, the attitudinal content in Zabala's (2010) theoretical proposal include every content that builds values and, therefore, promotes decision-making and changes or a broaden perception of a subject. When students develop a deeper understanding of the importance of preventing arboviruses that goes beyond an automated behavior, they attain the necessary attitudinal content for effective learning that, moreover, can be passed on as part of the proponent's value system. Games that involve discussions and opinion defense provide a great attitudinal exercise. An example of pedagogical methodology that aims at attitudinal content attainment is the debate. In the board games, such content is generally implied though the subjectivities contained in their authorship and in their art, rules and the consequent cultural, social and emotional aspects they evoke.

According to Zabala (2010), the different types of content are not only equally important, but complementary. When related to certain themes, they are two sides of the same coin. Both aspects together allow students to deeply reflect about what they study. Obviously, different pedagogies, with their formative strategies, objectives, even the ideology involved, will reinforce the relevance of some types of content over others. In this regard the theses analyzed seem aligned to an ever-present directive in Brazilian education that stimulates factual and procedural content teaching, without giving the necessary attention to conceptual and attitudinal content.

Under the premise of better quality education, the scientific dissemination with games must attain various types of content in a balanced manner, establishing a positive association between the proposed activity and the learning (Young Digital Planet, 2016).

Final Considerations

The low number of studies in the field of scientific dissemination of arboviruses demonstrates the low scientific interest in using the board games approach to this end.

The analysis of the studies points to educator's low playful pedagogical literacy as a possible reason for that. Without this instrumental body, formulating this type of proposal to the students becomes more difficult. Nevertheless, the natural playfulness present in the school environment makes the strategy of dissemination with board games interesting for the students, as shown in the studies analyzed.

However, the proposals were conducted under a limited conception from the point of view of the pedagogy associated to game design. A

series of methodological gaps could be observed when confronted with the contemporary pedagogical parameters endorsed in this analysis.

In fact, there are only variations of popular games – related to general culture and, therefore, familiar to students – which facilitates the collaboration in the activity. On the other hand, none of the studies analyzed the students and their behavior after the activities took place, thus, it was not possible to observe if the games methodologies used were effective to raise the awareness of students and to improve their actions in the active social participation for the control of arboviruses.

According to our analyses, most of the pedagogical dynamics proposed games aiming at retaining fact and procedures. Consequently, these games do not contribute to deeper reflections about the issue addressed, which would produce a more thorough conceptual comprehension and favor the students' personal construction of preventive measures against arboviruses as part of their values. In this study, we highlight the importance of knowledge on arboviruses to propose educational activities that reinforce not playfulness itself, but the positive combination of playfulness and scientific information.

Although it is not part of the scope of this study, further analyses should be conducted to deepen the reflection about other aspects of the studies analyzed, such as social reality of the groups of students and their singularities. The profile of the groups researched, their regional, economic, and social differences, among other aspects can be considered in the proposals and results of different pedagogical experiences.

Especially due to the scarcity of data, it was not possible to determine whether the homogeneity of proposals observed in the studies analyzed (race games with questions and answers) would result the same in all social contexts, with their diversities and singularities.

We also recommend further studies considering the profile of students involved in the activity and the impact of this profile on the methodological choices with board games. Some hypothesis may increase the high epistemological value of further researches, such as pedagogical proposals with board games to raise the awareness arboviruses control may have different effects in groups that, for example, live in different sanitary conditions; or that there may be differences in the repercussion of the experience among groups that are already engaged in the culture of board games and groups that are not.

Received on December 28, 2020
Approved on April 7, 2022

Notes

1 The results correspond to the search made with the search keys in Portuguese.

2 Last verification on August 21, 2020. Twenty-seven results were shown to the search key ['board game' arboviruses] and 209 for ['board game' dengue]. The verification of the content of each entry was not performed. The results correspond to the search made with the search keys in Portuguese.

3 Only one study tracking the use of games in general in the scientific dissemination of health has found publications between 1990 and 2012, with an average of two per year. See: Melo; Silva-Pires; Trajano (2015).

4 The search was made with the search keys in Portuguese.

5 Silva's study (2019) collected different creations from the students. The author highlighted some of them as the "myth or fact" and the questions and answers games, which were somehow incorporated to the race game that culminated in the game approach in her integrated strategy.

6 Nascimento (2017) used rules and materials of the game *Tapa Certo*, manufactured by Estrela Jogos e Brinquedos S.A.

7 In the roll-and-move mechanics, players roll the dice and move their playing pieces the number of spaces the dice landed on. The other mechanics mentioned, "answer and move", borrows the same logic and demands that the players answer correctly a question in order to move their playing piece.

8 Current studies point to 200 mechanics found in different compositions in literally thousands of board games, many of them created as of year 2000 (Carvalho, 2019).

References

ARCA. **Repositório Institucional da Fundação Oswaldo Cruz**. Manguinhos: Instituto de Comunicação e Informação Científica e Tecnológica em Saúde (Icict/Fiocruz), 2021. Disponível em: https://www.arca.fiocruz.br/?locale=pt_BR. Acesso em: 02 dez. 2021.

BALLARINO, Florencia. El Gobierno lanzó una alerta por el aumento de casos de dengue. **Perfil**, Argentina, 6 fev. 2019. Disponível em: https://www.perfil.com/noticias/salud/lanzan-un-alerta-por-el-aumento-de-casos-de-dengue.phtml. Acesso em: 26 maio 2019.

BDTD. Biblioteca Digital Brasileira de Teses e Dissertações. Brasília: Instituto Brasileiro de Informação em Ciência e Tecnologia (Ibicit), 2021. Disponível em: http://bdtd.ibict.br/vufind/. Acesso em: 02 dez. 2021.

BOURDIEU, Pierre. **A Economia das trocas simbólicas**. São Paulo: Perspectiva, 1987.

BRASIL. Ministério da Educação e Cultura. Secretaria de Educação Fundamental. **Parâmetros Curriculares Nacionais**: Introdução aos Parâmetros Curriculares Nacionais. Brasília: MEC/SEF, 1997. 126p.

BRASIL. Ministério da Saúde. Secretaria de Vigilância em Saúde. Departamento de Vigilância Epidemiológica. **Guia de vigilância do** *Culex quinquefasciatus*. Coordenação Francisco Anilton Alves Araújo, Marcelo Santa Lucia. Brasília: Ministério da Saúde, 2011.

BRASIL. Ministério da Saúde. **Orientações técnicas para a utilização do larvicida pyriproxyfen (0,5 G) no controle de** *Aedes aegypti*. Brasília, 2014. Disponível em: http://portalsaude.saude.gov.br/images/pdf/2014/julho/15/Instru----es-para-uso-de-pyriproxifen-maio-2014.pdf. Acesso em: 09 set. 2020.

CAPES. Coordenação de Aperfeiçoamento de Pessoal de Nível Superior. **Catálogo de Teses e Dissertações**. Brasília: Ministério da Educação (MEC), 2021. Disponível em: https://catalogodeteses.capes.gov.br/catalogo-teses/#!/. Acesso em: 02 dez. 2021.

CARNEIRO, Luciano. **Comportamento de prevenção da dengue**: efeitos de propagandas e de um jogo tabuleiro. 2015. 49 f. Dissertação de mestrado – Programa de Pós-Graduação em Análise do Comportamento. Universidade Estadual de Londrina, Paraná, 2015.

CARVALHO, Arnaldo Vianna. Rever e Renovar para Inovar: A expansão cultural dos jogos de tabuleiro modernos em compasso com as novas ideias para a educação. **Revista Dashboard Livre**, Brasília-DF, v. 1, p. 97-108, 2019.

CHRISTOPHERS, Sir Rickard. *Aedes aegypti* **(L.)** – The Yellow Fever Mosquito: Its Life History, Bionomics and Structure. Cambridge: Cambridge University Press, 1960.

CONSOLI, Rotraut; LOURENÇO-DE-OLIVEIRA, Ricardo. **Principais mosquitos de importância sanitária no Brasil**. Rio de Janeiro: Editora Fiocruz, 1994.

COSTA, Leandro Demenciano. **O que os jogos de entretenimento têm que os educativos não têm**: 7 princípios para projetar jogos educativos eficientes. Rio de Janeiro: Editora PUC-Rio, 2010.

CUNHA, Rivaldo V. da; TRINTA, Karen S. Chikungunya virus: clinical aspects and treatment – A Review. **Mem. Inst. Oswaldo Cruz**, Rio de Janeiro, v. 112, n. 8, p. 523-531, ago. 2017.

DIAS, Cynthia Macedo; FARBIANZ, Jackeline Lima. Jogos como gêneros multimodais: análise e elaboração crítica para multiletramentos. **Educação**, Santa Maria, v. 44, p. 1-28, 2019.

DONALISIO, Maria Rita; FREITAS, Andre Ricardo Ribas; VON ZUBEN, Andrea Paulo Bruno. Arboviroses emergentes no Brasil: desafios para a clínica e implicações para a saúde pública. **Revista de Saúde Pública**, São Paulo, v. 51, n. 30, p. 1-6, abr. 2017.

ENGELSTEIN, Geoffrey; SHALEV, Isaac. **Building Blocks of Tabletop Game Design**: An Encyclopedia of Mechanisms. Boca Raton: CRC PRESS, 2019.

FARNESI, Luana Cristina et al. Embryonic development of *Aedes aegypti* (Diptera: Culicidae): influence of different constant temperatures. **Mem. Inst. Oswaldo Cruz**, Rio de Janeiro, v. 104, n. 1, p. 124-126, fev. 2009.

FERREIRA, Fernanda Abraão. **Desenvolvimento e avaliação de estratégias educativas para combater a Dengue, Zika e Chikungunya no ensino fundamental II**. 2017. 116 f. Dissertação (Mestrado em Ensino das Ciências) – Programa de Pós-Graduação em Ensino das Ciências, Universidade do Grande Rio, Duque de Caxias, Rio de Janeiro, 2017.

GINZBURG, Carlo. **A história na Era Google**. Porto Alegre, UFRGS, nov. 2010. Palestra proferida no evento Fronteiras do Pensamento. Disponível em: https://www.youtube.com/watch?v=wSSHNqAbd7E. Acesso em: 13 out. 2020.

GOUW, Ana Maria Santos; BIZZO, Nelio Marco Vincenzo. Educação em saúde: contribuições de um estudo realizado em âmbito escolar. **Ensino, Saúde e Ambiente**, v. 8, n. 2, 2015. DOI: https://doi.org/10.22409/resa2015.v8i2.a21205.

HONÓRIO, Nildimar Alves; LOURENÇO-DE-OLIVEIRA, Ricardo. Frequência de larvas e pupas de *Aedes aegypti* e *Aedes albopictus* em armadilhas, Brasil. **Revista de Saúde Pública**, São Paulo, v. 35, n. 4, p. 385-391, ago. 2001.

KRAEMER, Moritz et al. The global distribution of the arbovirus vectors *Aedes aegypti* and *Ae. albopictus*. **Elife**, v. 4, n. e08347, jun. 2015.

LIMA-CÂMARA, Tamara Nunes. Emerging arboviruses and public health challenges in Brazil. **Rev. Saúde Pública**, São Paulo, v. 50, n. 36, jun. 2016.

LOPES Nayara; NOZAWA, Carlos; LINHARES, Rosa Elisa Carvalho. Características gerais e epidemiologia dos arbovírus emergentes no Brasil. **Rev. Pan-Amaz. Saúde**, Pará, v. 5, n. 3, p. 55-64, 2014.

LOURENÇO-DE-OLIVEIRA, Ricardo et al. *Aedes aegypti* in Brazil: genetically differentiated populations with high susceptibility to dengue and yellow fever viruses. **Trans. R. Soc. Trop. Med. Hyg**, v. 98, n. 1, p. 43-54, jan. 2004.

LOURENÇO-DE-OLIVEIRA, Ricardo. Biologia e comportamento do vetor. In: Valle, Denise; Pimenta, Denise; Cunha Rivaldo (Org.). **Dengue**: teoria e práticas. Rio de Janeiro: Editora Fiocruz, 2015.

MAFRA, Rennan Lanna Martins; ANTUNES Elton. Comunicação, estratégias e controle da dengue: a compreensão de um cenário público de experienciação. **Rev. Saúde Soc.**, São Paulo, v. 24, n. 3, p. 977-990, 2015.

MARCHI, Serena; TROMBETTA, Claudia Maria; MONTOMOLI, Emanuele. Emerging and Re-emerging Arboviral Diseases as a Global Health Problem. In: MAJUMDER, Md Anwarul Azim; KABIR, Russel; RAHMAN, Sayeeda (Ed.). **Public Health**: Emerging and Re-emerging Issues. United Kindgom: IntechOpen, 2018. P. 25-46.

MELO, Édina Sousa; SILVA-PIRES, Felipe do Espirito Santo; TRAJANO, Valéria da Silva. Identificação e análise de publicações sobre jogos como modalidade didática na educação e na saúde. **Revista Ciências & Ideias**, Rio de Janeiro, v. 6, n. 2, jul./dez. 2015.

MUNHOZ, Daniela Rosito. **Design de jogos de tabuleiro e dinâmicas cooperativas**: uma abordagem histórico-cultural. 2018. Tese (Doutorado em Design) – Universidade Federal do Paraná, Curitiba, 2018.

NASCIMENTO, Aline Rosa. **Efeitos da participação em um campeonato com um jogo educativo**. 2017. 57 f. Dissertação (Mestrado em Análise do Comportamento) – Programa de Pós-Graduação em Análise do Comportamento, Universidade Estadual de Londrina, Londrina, 2017.

NÓBREGA, Riani Joyce Neves. **Construção de um jogo educativo para adolescentes com ênfase no enfrentamento das arboviroses**. 2019. 101 f. Dissertação (Mestrado em Saúde da Criança e do Adolescente) – Universidade Estadual do Ceará, Ceará, 2019.

PARLETT, David. **Parlett's History of Board Games**: By the Author of the Oxford History of Board Games. Brattleboro: Echo Point Books and Media, 2018.

PELIZZARI, Adriana et al. Teoria da Aprendizagem Significativa segundo Ausubel. **Rev. PEC**, Curitiba, v. 2, n. 1, p. 37-42, jul. 2001-jul. 2002.

SILVA, Ione Rebello. **Produção de materiais educativos como instrumento para o controle do** *Aedes aegypti:* experiência de metodologia ativa de ensino em uma escola de nível fundamental no município do Rio de Janeiro. 2019. 148 f. Dissertação (Mestrado em Vigilância e Controle de Vetores) – Programa de Pós-Graduação em Vigilância e Controle de Vetores Instituto Oswaldo Cruz, Fundação Oswaldo Cruz, Rio de Janeiro, 2019.

SILVA, Jesiel Souza; MARIANO, Zilda Fátima; SCOPE, Irací. A dengue no Brasil e as políticas de combate ao *Aedes aegypti:* da tentativa de erradicação às políticas de controle. **Rev. Bras. Geogr. Médica e da Saúde**, Minas Gerais, v. 4, n. 6, p. 163-175, jun. 2008.

SVS. Secretaria de Vigilância em Saúde. Ministério da Educação. **Boletim Epidemiológico**: Monitoramento dos casos de arboviroses urbanas transmitidas pelo *Aedes aegypti* (dengue, chikungunya e Zika), Semanas Epidemiológicas 1 a

16, V. 51, abr. 2020. Disponível em: https://www.saude.gov.br/images/pdf/2020/April/24/Boletim-epidemiologico-SVS-17-.pdf. Acesso em: 09 set. 2020.

TOCANTINS. Secretaria da Saúde. **Peças da Campanha Estadual das Arboviroses (2018)**. Tocantins, 2018. Disponível em: https://www.to.gov.br/saude/pecas-da-campanha-estadual-das-arboviroses-2018/5zvdbj97u36h. Acesso em: 26 maio 2019.

TOKARNIA, Mariana. Ministério da Saúde antecipa campanha de combate ao Aedes aegypti. **Agência Brasil**, Brasília, 12 set. 2019. Disponível em: https://agenciabrasil.ebc.com.br/saude/noticia/2019-09/ministerio-da-saude-antecipa-campanha-de-combate-ao-aedes-aegypti. Acesso em: 26 maio 2019.

VALENTIM, Leonardo Borloti. **Nossa Turma contra a Dengue** [jogo de tabuleiro]. Serra: DP3 Soluções, 2009.

WEAVER Scott C.; REISEN, William. K. Present and future arboviral threats. **Antiviral Research**, Amsterdam, v. 85, n. 2, p. 328-345, fev. 2010.

YOUNG DIGITAL PLANET (Org.). **Educação no Século 21**: tendências, ferramentas e projetos para inspirar. Tradução Danielle Mendes Sales. São Paulo: Fundação Santillana, 2016.

ZABALA, Antoni. **A Prática Educativa Como Ensinar**. Porto Alegre: Artmed, 2010.

ZAGAL, José P. **Ludoliteracy**: defining, understanding, and supporting games education. Pittsburgh: ETC Press, 2010.

ZIMMERMAN, Eric; SALEN, Katie. **Rules of Play**: Game Design Fundamentals. Massachusetts: MIT Press, 2003.

ZUCCHI, Paola. Os desafios da dengue. **Rev. Fac. Ciênc. Méd.**, Sorocaba, v. 18, n. 2, p. 121-2, 2016.

Rafaela Vieira Bruno holds a B.S. degree in Biology from the Federal University of Rio de Janeiro (UFRJ, Universidade Federal do Rio de Janeiro), a master's degree, and a doctorate degree in Biology, both from this same institution. As a principal researcher at Fiocruz and Head of the Laboratory of Insects Molecular Biology (LABIMI, Laboratório de Biologia Molecular de Insetos) of the Oswaldo Cruz Institute (IOC, Instituto Oswaldo Cruz), develops research in the area of Medical Entomology and conducts studies on scientific dissemination of *Aedes aegypti* control.
ORCID: https://orcid.org/0000-0002-7082-9768
Email: rafaelav@ioc.fiocruz.br; rafaelabruno@gmail.com

Arnaldo Vianna e Vilhena Carvalho holds a master's degree in Education from the State University of Rio de Janeiro (UERJ, Universidade Estadual do Rio de Janeiro). Doctoral student at the Federal University of Rio de Janeiro (URFJ, Universidade Federal do Rio de Janeiro). Active member of research groups, IJEC, GPIDOC and LUPEA, and of the *Ludus Magisterium* network. Author of articles, speaker and organizer of national and international projects and events in the fields of games and education.
ORCID: https://orcid.org/0000-0002-0803-3793
Email: arnie_rj@yahoo.com.br

Renata Monteiro-Maia is a biologist with a master's degree in Immunology and a doctorate in Molecular and Cellular Biology, both from the Oswaldo Cruz Institute (IOC, Instituto Oswaldo Cruz). Researcher in public health at

the Laboratory of Insects Molecular Biology (LABIMI, Laboratório de Biologia Molecular de Insetos) of the Oswaldo Cruz Institute (IOC, Instituto Oswaldo Cruz). Currently researching about scientific dissemination and Science popularization, with emphasis on arboviruses.
ORCID: https://orcid.org/0000-0003-3345-0801
Email: renatamaia@ioc.fiocruz.br; renatamaia23@gmail.com

Editor-in-charge: Luís Henrique Sacchi dos Santos