COVID-19 - Did You Know? A Mobile Serious Game about the Pandemic: Design and Evaluation Study

Juliano De Souza Gaspar, Eura Martins Lage, Fernando José Da Silva, Érico Mineiro, Isaias José Ramos De Oliveira, Igor Oliveira, Rayner Guilherme De Souza, Juan Rodrigues Oliveira Gusmão, Camila Fernanda Donadoni De Souza, Zilma Silveira Nogueira Reis

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Juliano De Souza Gaspar[1*] PhD; Eura Martins Lage[1*] PhD; Fernando José Da Silva[2*] PhD; Érico Mineiro[2*] PhD; Isaias José Ramos De Oliveira[1*] MSc; Igor Oliveira[3*]; Rayner Guilherme De Souza[1*]; Juan Rodrigues Oliveira Gusmão[1*]; Camila Fernanda Donadoni De Souza[3*]; Zilma Silveira Nogueira Reis[1*] PhD

[1]Faculdade de Medicina da Universidade Federal de Minas Gerais Belo Horizonte BR
[2]Departamento de Tecnologia de Design, Arquitetura e Urbanismo da Universidade Federal de Minas Gerais Belo Horizonte BR
[3]Curso de Design da Universidade Federal de Minas Gerais Belo Horizonte BR
[*]these authors contributed equally

Corresponding Author:
Juliano De Souza Gaspar PhD
Faculdade de Medicina da Universidade Federal de Minas Gerais
Rua Alfredo Balena, 190
Belo Horizonte
BR

Abstract

Background: While a treatment or the vaccine against COVID-19 is not available, access to information about the new coronavirus, transmission route, and ways to prevent the spread of infection are critical sanitary measures worldwide. Serious games have advantages in the dissemination of reliable information during the pandemic, as they can offer qualified content while providing interactivity with the user and have great reach over the internet.

Objective: This study aimed to develop a serious game with the purpose of bringing scientific-based information on prevention and personal care against COVID-19. Besides, it proposed to assess the players' knowledge about COVID-19 topics.

Methods: The study was carried out with the interdisciplinary collaboration of specialists in health sciences, computing, and design at the Federal University of Minas Gerais, Brazil. The health recommendations were grouped into six thematic blocks, presented in a quiz format. The software languages were based on the Progressive Web App with the Framework Ionic, JavaScript, HTML5, CSS, and Typescripts (Angular). Open data reports of how users interact with the serious game were obtained using the Google Analytics API. The visual identity, logo, infographics, and icons were carefully developed considering a selection of colors, typography, sounds, and images suitable for young audiences. Cards with characters were introduced at the end of each thematic topic to interact with the player reinforcing the correct answers or alert the need to know more about the disease. The players' performance was assessed by the rate of errors and successes and analyzed by the linear correlation coefficient, over seven weeks. The agile SCRUM development methodology provided quick and daily interactions by developers through a webchat and sequential team meetings.

Results: The game “COVID-19 - Did you know?” was available for free in the university public domain, on April 1st, 2020. The access number was 17,571, until September 2020. Disclosure actions such as reports on social media and television had a temporal correspondence with a greater access number. The players’ error rate in the topic “Mask” showed a negative trend ($r = -.83$; $P = .01$) over the weeks of follow-up. The other topics showed no significant trend over the weeks ($P < .05$).

Conclusions: The gamification strategy for health education content on the theme of COVID-19 reached a young audience, considered a priority in the strategy of orientation towards the social distance. Specific educational reinforcement measures were proposed and implemented based on the players' performance. The improvement in the users’ performance in the topic about the use of the mask may reflect more information or adherence to its use over time.

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Keywords: coronavirus; COVID-19; e-learning; mHealth; digital health; gamification; serious game; mobile apps; public health informatics.

1. Introduction

Background

Two months after the first COVID-19 reports in China, the first case was officially registered in Brazil [1,2]. Simultaneously, the new coronavirus was already identified in more than 50 countries, accounting for 87,000 cases and 3,000 confirmed deaths according to the World Health Organization [3]. In November 2020, on the date of preparation of this paper, more than 52.4 million affected people and 1.2 million deaths have already been registered worldwide [3]. In the same period, in Brazil, more than 5.8 million cases and 164 thousand deaths by COVID-19 were registered [4].

In the absence of a short-term treatment or vaccine, access to information about the new coronavirus, its transmission route, and how to prevent the spread of infection has been the focus of health strategies. So that countries could prepare themselves to face the pandemic, the World Health Organization (WHO) provided guidance and training to prevent and delay the disease transmission. Personal hygiene recommendations, such as washing hands frequently with soap and water, wearing masks in public, avoiding handshakes and, whenever possible, social distancing continue to be widely disseminated through various communication channels with the population [5]. However, for such measures to be effective, in addition to boosting governments, community awareness and engagement are considered critical factors to control the disease [6].

The disease caused by the new coronavirus is relatively mild in young adults, teenagers, and children [7]. Most of them, even when infected, are asymptomatic or oligosymptomatic, bringing concern of the potential of this population group in the transmission of the disease, especially in direct contact with those who are at risk group [8]. Also, the physical and social distancing drastically reduced the opportunities for collective engagement among young people, causing psychological distress in many and leading to the breaking of the distancing pact, so relevant at this time [9]. Another important fact is the ease of adolescents in handling the technology, which is vital to keep the communication channels open, informing and supporting each other besides sharing with most of the community.

Digital health solutions can be a promising approach to face COVID-19 spreading, allowing the use of digital tools that effectively support institutions, facilitating the wide dissemination of information [10]. Communication during a pandemic must reach the target population in time, clearly and objectively. Combating misinformation and fake news about the origin, dissemination, and treatment of COVID-19 are strategies that allow citizens to increase adherence to the measures recommended during the crisis [11]. Thus, a good communication strategy avoids confusion and distrust that can have negative consequences for the individual and society [11].

In the context in which we have strict rules on social distancing, a serious digital game can offer significant advantages for the dissemination of information and learning, since it doesn't require physical presence, increases interactivity with the content, provides wide information coverage [12]. A serious game is characterized as a game in which the main purpose is not entertainment and fun [13,14]. It can be a powerful tool for the development and acquisition of new knowledge and skills by experienced users, as well as by beginners [15].

Objective

The study aimed to develop and evaluate a serious game for mobile platforms to bring

information about prevention and personal care against COVID-19.

2. Methods

Study design

The study is applied research, has an interdisciplinary profile between Medicine, Computer Science, and Design. In this study, the development, implementation, and evaluation of a serious game that addresses topics on preventive measures and information about COVID-19 are presented. Teenagers are the target audience for this serious game, but it also applies to literate children and adults.

Theoretical basis

A literature review on COVID-19, gamification, serious games, mobile applications, and e-learning was carried out. Concerning the topics on COVID-19 disease and prevention recommendations, it was decided to use only the information and recommendations available on the WHO website [3]. In addition to the initial research, periodic queries were made to the WHO website to obtain updates on recommendations and guidelines for action. A team with specialists of doctors, professors, and medical students reviewed and validated all content used in the serious game.

Learning Objectives

The learning content of this serious game was grouped into six topics presenting specific WHO recommendations for the population, with an emphasis on issues related to the daily lives of teenagers:

- Coronavirus: information about COVID-19 and vulnerable groups;
- Mask: why and how to use, how to do it;
- Take care: about the transmission of COVID-19;
- Cleaning: care for cleaning the home and working and study tools;
- Health: about personal health, routines, and life habits;
- Social: socializing with friends and school, how to shop, care outside the home.

System Requirements

Based on the learning objectives and the identification of the target population, the system requirements were defined and a search on specialized websites on characteristics of frequently used devices was carried out. Items such as screen resolution and the amount of internet access via cell phone, tablet, or desktop [16], as well as aspects such as reach, necessary network, and data consumption were analyzed. The design team also considered specific characteristics for gamification and gameplay [15]. The most important requirements that guided the development are:

- The game must be accessible on different platforms (mobile and web desktop);
- It does not require registration for use;
- It does not use gaming platforms that require robust hardware, that is, it is possible to run it with simple processors and little memory;
- It consumes little internet browsing data;
- It must keep the player's score history;
- It must allow sharing the results of the phases on social networks;
- It must allow viewing a personal and global ranking of the game;
- It must offer information complementary to the questions of the game;
- It offers information about the project, the institution, and the team.

Design and Development

Agile SCRUM development methodology [17] was used in this project, systematically gathering the multidisciplinary team around the project. Weekly tasks were defined for each participant according to their qualifications. The tasks were developed during a cycle (Sprint) lasting one week [18], fast and daily interactions were made through a webchat and weekly meetings (online) with the entire team, to present the results of the week and definition of new tasks for the new Sprint.

To create a multiplatform application, the PWA (Progressive Web App) software development methodology with the Ionic Framework, using JavaScript, HTML5, CSS, and TypeScript (Angular) programming languages were used. For the development, the Visual Studio Code tool [19] was used and the code management was controlled with the Bitbucket tool [20] to allow the team to collaborate on codes and test them through the Git versioning system [21]. The API (Application Programming Interface) Web Storage [22] was used to store information in the user's browser about the use and performance of the questions.

Open data reporting from the Google Analytics API was the source of information on how users interact with serious gaming [23]. Only information related to the use of the game is collected such as the type of device, screen resolutions, clicks on the right and wrong answers, how users accessed the game (via external links, social networks, search engine searches, news sites), and the time spent in the game. Even considering only very generic data, data retention by Google Analytics has been configured for maximum storage of 26 months on its servers [24].

Communication and diffusion of the game

Complementary actions were implemented to the game diffusion. Among these, the creation of social networks accounts on Facebook [25] and Instagram [26] stand out, in addition to sending e-mails with disclosure to the population previously registered in the Faculty of Medicine of UFMG newsletter [27]. E-mails were also sent specifically to coordinators and teachers of elementary and local high schools.

Statistical analysis

The data used in this analysis were retrieved from the Google Analytics weekly reports. Data such as the access number, the number of right answers, and wrong answers were analyzed.

Continuous variables were represented in median values and categorical variables in absolute and relative values. Specifically, for the number of right and wrong answers, were calculated the hit rates and error rates for each topic aggregated by week. Pearson's correlation coefficient was used to assess the temporal variation over the weeks and the Student's t-test was calculated to assess the significance of the results found by the coefficient. The significance used was P <0.05 and the calculations were performed on Google Sheets.
Line graphs were used to present the variation of error rates over the weeks evaluated and the trend line was presented with Pearson's linear correlation coefficient (r) for topics with statistical significance. Sector charts and maps also used to describe the categorical variables.

Ethical aspects

This project does not use sensitive user data since the game developed does not perform user registration and does not have an associated database. The data used in the analysis of this study are generated by indirect reports (generated by Google Analytics) and with temporary data to access the site. This project seeks to comply with all data usage laws in force in Brazil

and Europe, including clarifying to the user the indirect use of non-sensitive data, in an objective, clear, and timely manner. The project was developed and supported by the Center for Health Informatics of the Faculty of Medicine and the School of Architecture at the Universidade Federal de Minas Gerais (UFMG).

3. Results

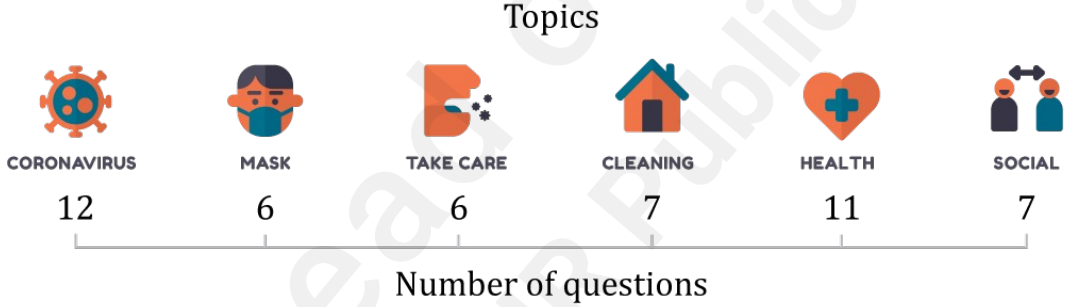
The game "COVID-19 - Did you know?" was available for free on the web, on April 1st, 2020. Using the PWA methodology, it was published on the server of the Faculty of Medicine of UFMG, not requiring submission to application stores and can be accessed directly on website [28].

During the development process with the SCRUM methodology, 23 cycles lasting one week were performed. In each cycle, several independent tasks were assigned to the team members, among which we highlight: literature review, definition of system requirements, quiz preparation, development of the game logic, interfaces, ranking players, final design, software testing, English and Spanish translation, publication of the game online.

Learning Objectives

Learning objectives were defined based on the target population and the information was grouped into the topics Coronavirus, Mask, Take Care, Cleaning, Health, and Social. Figure 1 shows the six topics with the number of questions created in each set.

Figure 1. Questions grouped by learning objectives topics



The game

Design experts created the visual identity of the App. The dedicated logo and icons were developed (Figure 1), in addition to the selection of colors and typography to meet the requirements defined in this project. The Attribution-Non-Commercial-Share-Equal 3.0 Brazil license (CC BY-NC-SA 3.0 BR) [29] allows the free use of all images, infographics, and information pieces created for non-commercial purposes. Figure 2-A shows the splash screen interface, using a minimalist concept with the game logo and the brands of the School of Architecture and the Faculty of Medicine of UFMG.

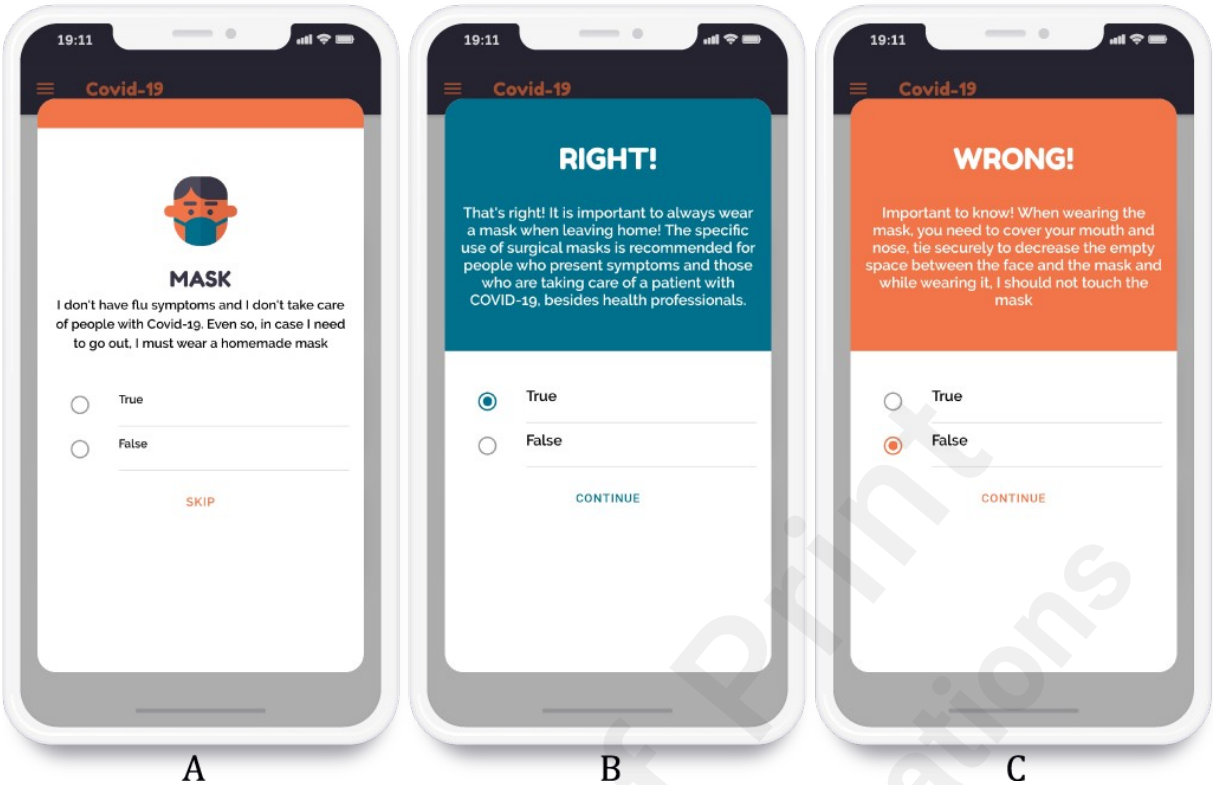
Figure 2. Interfaces of the game's initial screens: Splash (A), Home (B), and Menu (C)

The serious game main interface (Figure 2-B) has buttons to access each set of questions on the defined topics. Along with each icon, a progress bar is displayed with the player's evolution in the topic. A quick access bar was created at the top, allowing the player easy access to the ranking, changing the language of the game, and other information. In the upper left corner, a standard menu button gives access to all the resources and information of the game (Figure 2-C). In the menu, it is possible to reset the score in the game, access the WHO website, learn more information about the topics, learn more about the project and development team, in addition to consulting the complete Privacy Policy.

The game was developed to be multi-language to reach an audience beyond the borders of Portuguese-speaking countries. The second version of the App was available in September 2020, and besides the Portuguese language, it added English and Spanish. In this version, all questions, answers, feedback, infographics, privacy policy, and complementary information have been translated into new languages.

When selecting a topic in the main interface (Figure 2-B), a set of questions are presented to the player who can answer or skip the question (Figure 3-A). When answering the question, feedback about the hit or error answer is presented to the player (Figure 3-B, 3-C). Audiovisual effects through icons, colors, and sounds were used for the questions, as well as for each type of feedback. All images have the "alt" attributes of the HTML5 language defined according to W3C recommendations [30], which helps to describe the image when it cannot be reproduced by the browser, or even when the user uses a reading aid software to visually impaired.

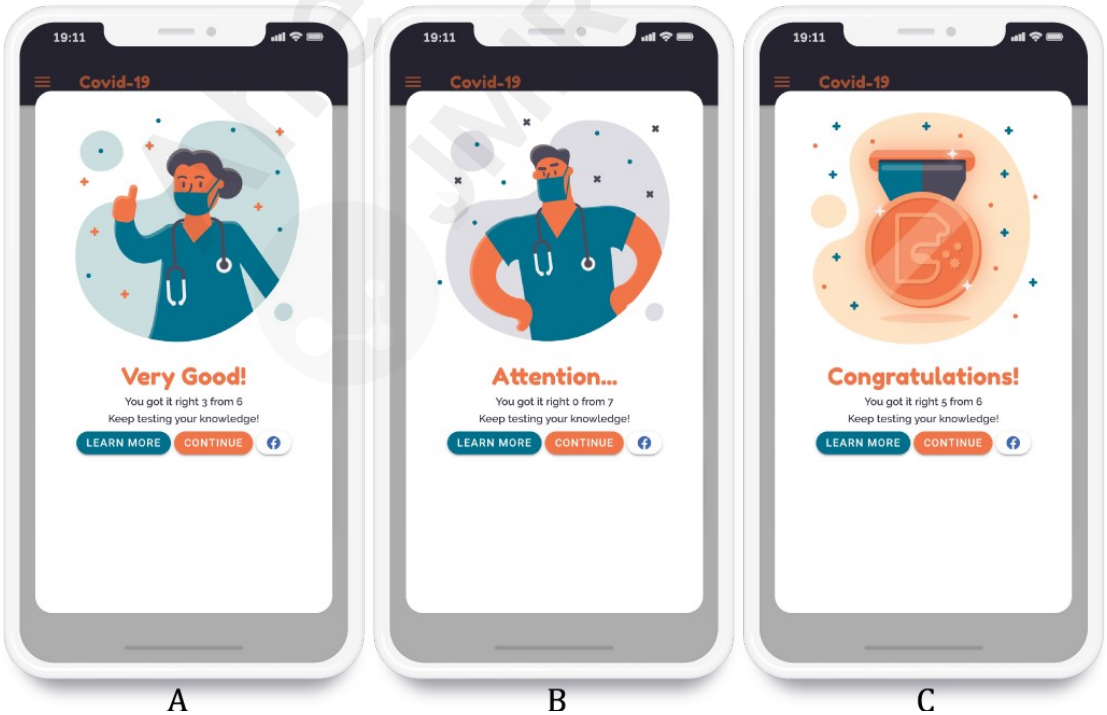
Figure 3. Interfaces with questions (A), the hit answer (B), and the wrong answer (C).



A B C

When finishing a topic, cards with a doctor cartoon appear congratulating the player for the questions answered and finishing that topic (Figure 4-A) or asking for more attention on the topic (Figure 4-B). The doctor cartoon appears in the female and male versions randomly. The user is also awarded different medals for each topic successfully completed (Figure 4-C). The card also has a button to learn more about the topic, and continuing to the next topic or posting their performance on Facebook.

Figure 4. Cards with results (A, B) and medals (C) by topic.



A B C

The Local Storage resource was employed to save user data locally and Google Analytics to collected non-sensitive user data. In order to comply with the “General Data Protection

Regulation" (GDPR) in force in Europe and the Brazilian corresponding legislation, a notice about the use of the data is presented as soon as the App starts. Through it, the user is informed that no personal data is collected, however, "cookies" and similar methods can be used to save the score [31]. The use of non-sensitive data is also requested, as well as the invitation for the user to read and accept the Privacy Policy containing the detailed information (Figure 5-C). The reader can consult Appendix I of this article to read the complete Privacy Policy.

Figure 5. Personal and global ranking (A), diffusion actions (B), and privacy policy (C).

With the player's score being stored in the browser, using Web Storage technology, it is possible to show a progress bar on the main screen with the user evolution by topic (Figure 2-B), also allowing to compare the user performance with the others players in the global ranking interface (Figure 5-A). Also, it allowed to implement an algorithm that when selecting a topic that the user has already played, only questions not yet answered or with wrong answers are shown to the player. The calculation of the global ranking of hit answers by topic is made from the reports generated by Google Analytics, which in this case, collects the user clicks in true or false answers. It was opted to create a session publicizing images created by the project and disseminated on social networks (Figure 5-B).

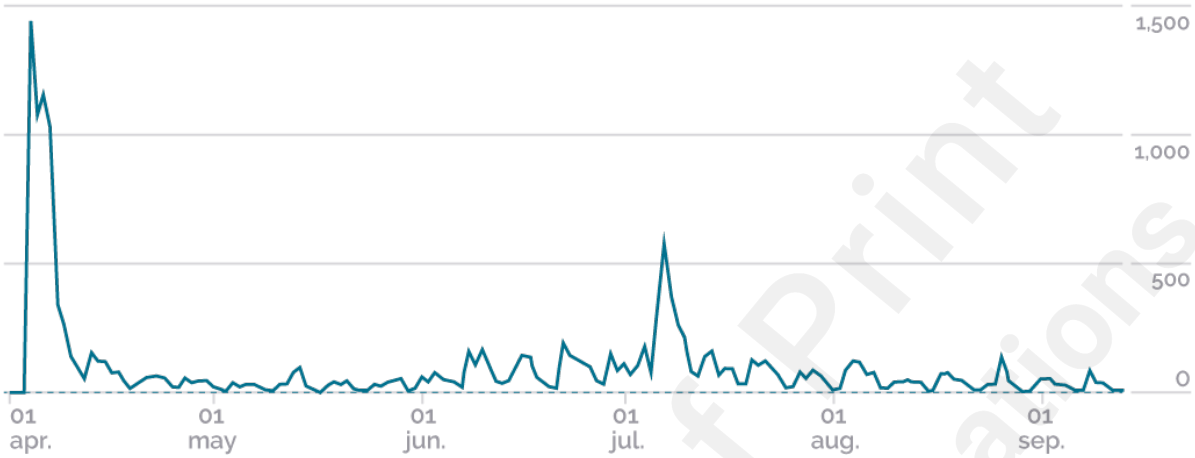
Figure 6. Infographics with complementary information on the topics.

The “Learn More” section presented infographics (Figure 6) with tips on how to proceed in situations related to each topic. Tips for the practice of physical activity, use of masks, how to proceed when leaving home, how to organize the work at home, hand washing care, and other personal care.

Evaluation

This topic shows the data extracted from the reports generated by Google Analytics. Between April 1st and September 13th, there were 17,571 access (Figure 7). In this period, the type of device for accessing the game was primarily through smartphones (79.8%), followed by computers (19.2%) and tablets (1.0%). The average duration of the game using time was 3 minutes and 34 seconds, in the analyzed period.

Figure 7. Distribution of game access between April and September 2020.



Source: Adapted from Google Analytics.

Figure 8 shows two graphs on how the users access the game website and where they come from. Most access is through direct access (79.3%), which involves situations in which the user types the address directly into the browser, accesses links saved in favorites or links in PDF files, and in some cases with links by e-mails (Figure 8-A). Then, there is access through references (8.2%), which includes access via links on other sites, as in the case of news reports and articles. There are also 7.5% of users who arrive by searching for keywords related to the game on searching sites and 5.1% by links on social networks. Most users are from Brazil (98%). This period analyzed is before the publication date of the multi-language version (Figure 8-B).

Figure 8. Distribution of game users by type of access channels (A) and by countries (B) between April and September 2020.

A B

Source

: Adapted from Google Analytics.

Adjustments to the software and the Google Analytics settings available from July, 20th, 2020, also enabled to extract from the reports the users' correct and error answer rates by questions, both individually and grouped by topic. The correct answers rate between the topics varied between 69% and 89%, as shown in Figure 9.

Figure 9. Hit answer rate per game topic between July 20th, and September 13th, 2020.

The error rates were analyzed weekly grouped by topics (Table 1). Only for the topic “Mask”, was observed a negative trend (-.83) with a significant correlation (P = .01). The other topics did not have significant results.

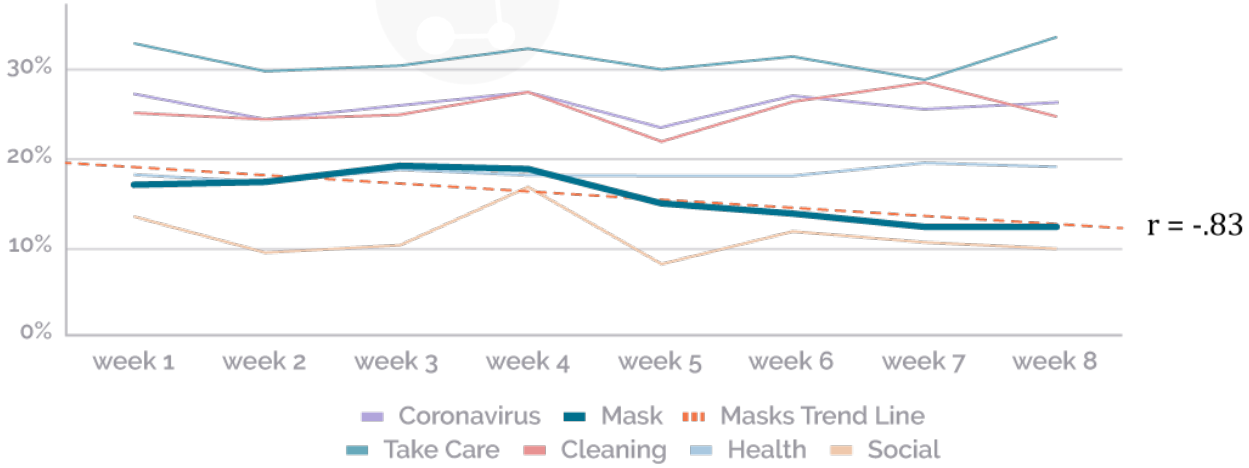
Table 1. Error rates by topic per week (July 20th to September 13th, 2020)

Topics/week	1[a]	2[a]	3 [a]	4 [a]	5 [a]	6 [a]	7 [a]	8 [a]	r [a]	P [b]
Coronavirus	27.2	24.5	26.2	27.4	23.5	27.0	25.5	26.3	-.07	.87
Mask	17.0	17.3	19.2	18.8	14.8	13.7	12.2	12.2	-.83	.01
Take Care	33.0	29.8	30.5	32.4	30.0	31.5	28.8	33.7	-.002	.99
Cleaning	25.1	24.4	25.0	27.5	21.9	26.4	28.6	24.8	.25	.52
Health	18.1	17.4	18.6	18.0	17.9	17.9	19.2	19.1	.62	.08
Social	13.5	9.1	10.0	16.7	7.9	11.7	10.4	9.7	-.24	.53

[a] Pearson's Correlation Coefficient, [b] Student's t-test

The graph in Figure 10 shows, over the weeks evaluated, the error rates grouped by topics. The linear trend (r = -.83) for the significant topic (Mask), indicated a downward trend in the error rates.

Figure 10. Error rates by topic grouped by week (July 20th to September 13th, 2020).



Publicizing actions

Images and texts were produced by the designers' team related to the issues with the highest number of errors analyzed weekly (Figure 11). In this stage, images from the Unsplash [32] and Pexels [33] repositories were searched, selected, and used, which are offered free of charge by these platforms. From these images, graphic pieces were developed and published on the social networks Facebook [25] and Instagram [26] created for the project.

Figure 11. Examples of images for post on social networks

Other actions to publicize the serious game were carried out by sending informative e-mails both to the Faculty of Medicine of UFMG newsletter, as well as specific e-mails to teachers and coordinators of elementary and high schools. Offering the game as an educational strategy for homeschooling. This action involved contact by e-mail with 2476 schools between April and May, and another 1020 schools in September.

The lowest bounce rates observed in Google Analytics reports are from accessed through newspaper links, interviews, and links from Google Classroom (38%).

Software Usability and Testing

The development team sought to meet the Heuristic Usability principles proposed by Nielsen and Molich [34]. Aspects such as offering simple dialogues, speaking the user's language, minimizing the user's memory overhead, having consistency maintaining a pattern of behaviors and icons, offering continuous feedback to the user, demarcated exits with options to leave and return, provide shortcuts, avoid error situations, when necessary to offer clear error messages, have an easy and intuitive interface or offer help and clear documentation were considered [35].

The serious game has undergone empirical testing of software development. White box tests were performed based on testing game structures on specific parts of the development code for each component. Also, black-box tests were performed to validate the system requirements defined initially. Functional and non-functional items such as performance, disclosure, acceptance, released versions (alpha and beta) were evaluated. The observed inconsistencies were included in adjustments and incremental corrections in subsequent phases of the development cycle (Sprints).

Additionally, at least one visually impaired person used the game. His report was positively describing that he managed to use the game clearly with the help of a specific reader for the visually impaired. He also reported the lack of information about the images related to the end of each topic. His feedback led to subsequent adjustments to improve the experience for these users, such as the inclusion of alternative texts to the respective images.

4. Discussion

The members of the multidisciplinary team composed of doctors, designers, programmers, teachers, and students were able to propose and develop solutions, based on multiple aspects, to implement the identified requirements, as recommended by Caserman and collaborators [15]. The weekly meetings were used as benchmarking to present the results of the week, evaluating the items already implemented, and propose new requirements for the development of an effective and attractive serious game.

The SCRUM development methodology proved to be efficient, allowing the project into small increments, which allowed for tests, quick changes when necessary and weekly deliveries to the end user. Functional software deliveries in a shorter period (week) generate greater customer satisfaction and provide a development environment with motivated individuals as reported by Tobias and Spanier [36].

On January 30, 2020, WHO declared that the outbreak of the disease caused by the new coronavirus, the so-called COVID-19, constituted a Public Health Emergency of International Importance. This statement aimed to improve coordination, cooperation, and global solidarity to try to stop the spread of the new coronavirus. On March 11, 2020, WHO characterized COVID-19 as a pandemic. Since the outbreak was declared and the pandemic was characterized, WHO has sought to inform the population about the health risks presented by COVID-19, considering that reliable information is as important as other protective measures. Well-informed people can make informed decisions and adopt positive behaviors to protect themselves and their families [37].

Much information about COVID-19 has been presented to the community, but few initiatives are aimed at younger people. Thus, this audience was chosen because it has been more resistant to the recommendations of health authorities. Also, when infected, teenagers have few symptoms but can transmit the virus. It was sought, through digital technology, to contribute to the rapid diffusion of information about the new coronavirus and COVID-19, promoting changes in the attitude of the population [38].

Limited or insufficient health literacy was associated with less adoption of protective behaviors, such as vaccination, hand hygiene, and other self-care measures [39]. It avoided addressing specific issues in any country or region, avoiding major differences between the information provided by WHO and the COVID-19 coping guidelines in each nation.

The use of PWA technology allowed the development of a hybrid App that uses resources offered by browsers with the advantages of using smartphones as a traditional App [40]. This technology makes the App compatible with most browsers, allowing it to be used in different devices such as computers, tablets, and smartphones [41].

Using the Web Storage technology offered from HTML5 enabled to store player data such as position in the game, hit questions, and personal ranking locally more securely than using Cookies [22]. The development with Web Storage ensures that data will never be transferred to the server by the browser as it can happen with Cookies, ensuring greater adherence to user data security policies.

Regarding the visual identity of the App, different factors were considered during development. The seriousness of the topic addressed, which requires the promotion of accessibility, usability

and information. Thus, it is considered the use of typography that offers good legibility, adequate contrast between colors, icons, and images that are easy to recognize [42,43]. Also, guaranteeing access to simpler devices and reducing noise ˙n information, the visual identity was developed aiming at a lean and responsive design [44]. The other factor to be considered is the fun aspect characteristic of games, in which more subjective issues such as attractiveness, entertainment, and aesthetics are provided, as proposed by Caserman and collaborators [15]. In contrast the use of vibrant colors, flashy and stylized typography, illustrations, sounds, and a graphic unit between the elements were strategies dedicated to the target used.

During six months of game analysis, among the 17,500 users accessing, there are two (April and July) that coincide with reports made in written and television newspapers about the game, added to the actions of sending informative emails for the college newsletter. The game was accessed mostly by smartphones (79.8%), which indicates a good choice when prioritizing resources and functionalities for this type of access to the detriment of accesses by computers and tablets.

The weekly monitoring of error answer rates allowed to improve the text of some questions and answers. Just as the weekly assessment of answers grouped by topics allowed the team to develop complementary actions with images and informative texts for publication on social networks with the most mistakes in the week.

Finding statistical significance in reducing the trend of the error rate on the topic “Mask”, brought some questions to the team. Since this study is not a controlled clinical trial, it is not possible to say that the population is more informed about the importance and use of masks; however, it is an issue that stands out and suggests the need for further studies.

The lowest bounce rates seen in Google Analytics reports are from access from newspaper links, interviews, and from Google Classroom. Considering that the bounce rate indicates when a user opens and then closes the website (without interacting with it), a lower bounce rate in these segments may indicate that a disclosure focused on news channels and teachers may have been the most assertive way in acquiring new users for this serious game.

Limitations

As it is not a controlled study, making analysis limited to infer that the results are from a population formed by teenagers, according to the target population of this project. This is reinforced by the fact that the game does not have a user registry, is online, and open to the community, making the data analyzed in the current study does not allow inferences about who used the App.

Another limitation was that the sample used to assess the time series was seven weeks. Despite finding statistical significance in a topic, an evaluation for a longer period will be needed to state more safely that there is a decreasing error rates for that topic.

5. Conclusions

This study managed to comply the proposed objectives when developing and making a serious game available to young people, bringing reliable information on topics related to the prevention of COVID-19. Also, the multidisciplinary profile of the team was able to bring to the project reflections of its paradigms making the game reach compliance with the technical, legal,

functional, and attractive requirements expected for a serious game. Extrapolating the initial requirements, it produced promotion and dissemination actions, and increased accessibility, making it multi-language and accessible to people with visual impairments. This publication can be an example, not only for other students and teachers, but also for future interested in the application of good practices in the development of serious games App. We hope that the game will continue to combat misinformation on the topic and expand the population's engagement in preventive measures against COVID-19.

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Conflicts of Interest

The authors declare no competing financial interests.

Abbreviations

API: Application Programming Interface
BR: Brazil
BY-NC-SA: Attribution Noncommercial Share Alike
CC: Creative Commons license
COVID-19: Coronavirus (SARS-COV-2) disease
CSS: Cascading Style Sheets
GDPR: General Data Protection Regulation
HTML5: Hypertext Markup Language revision 5
PWA: Progressive Web App
SCRUM: Scrum is an agile methodology
SPRINT: Sprint is a repeatable fixed time-box during which a product is created
UFMG: Universidade Federal de Minas Gerais
WHO: World Health Organization
W3C: World Wide Web Consortium

Appendix 1

Privacy Policy: https://site.medicina.ufmg.br/covid/privacidade

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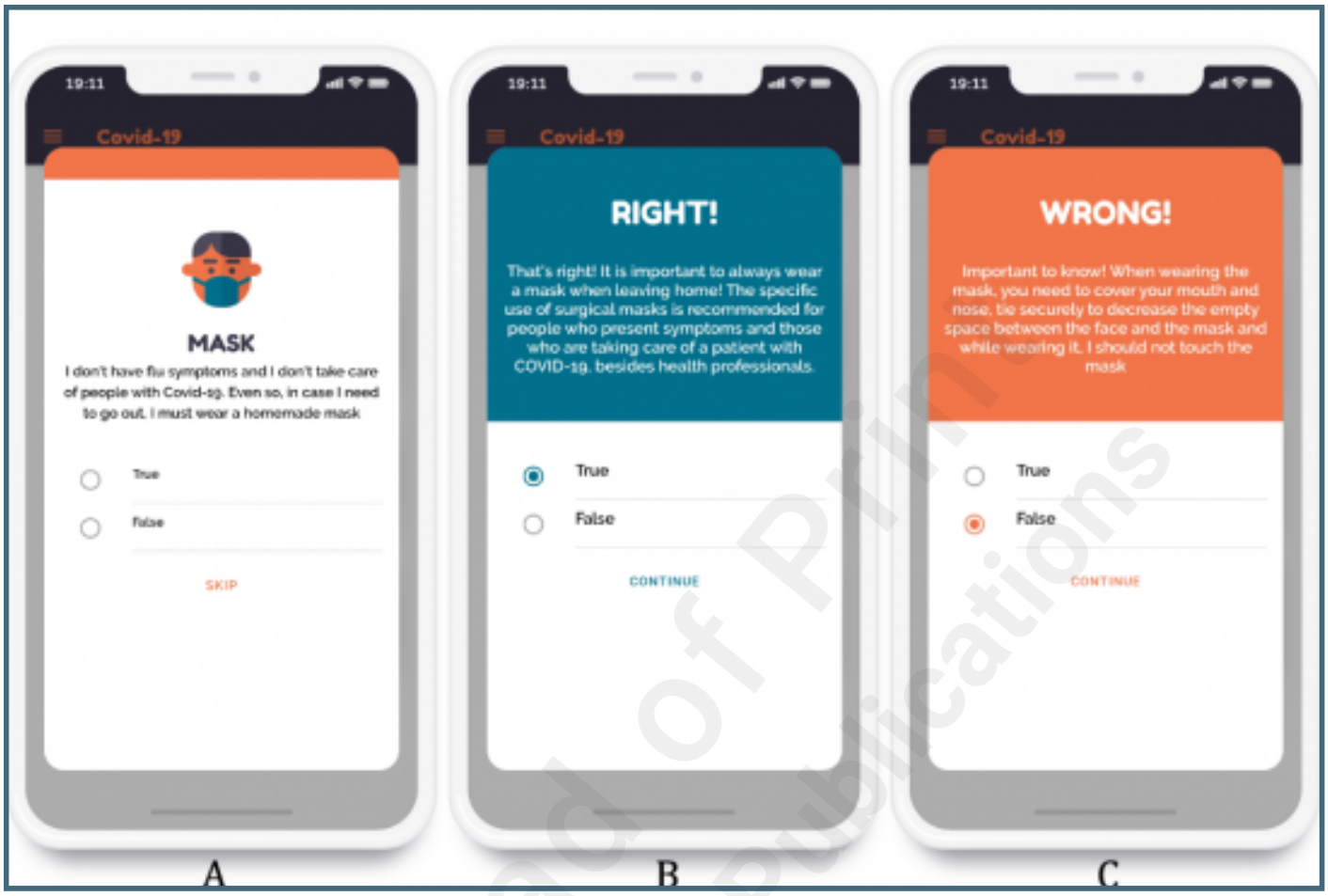
Supplementary Files

Figures

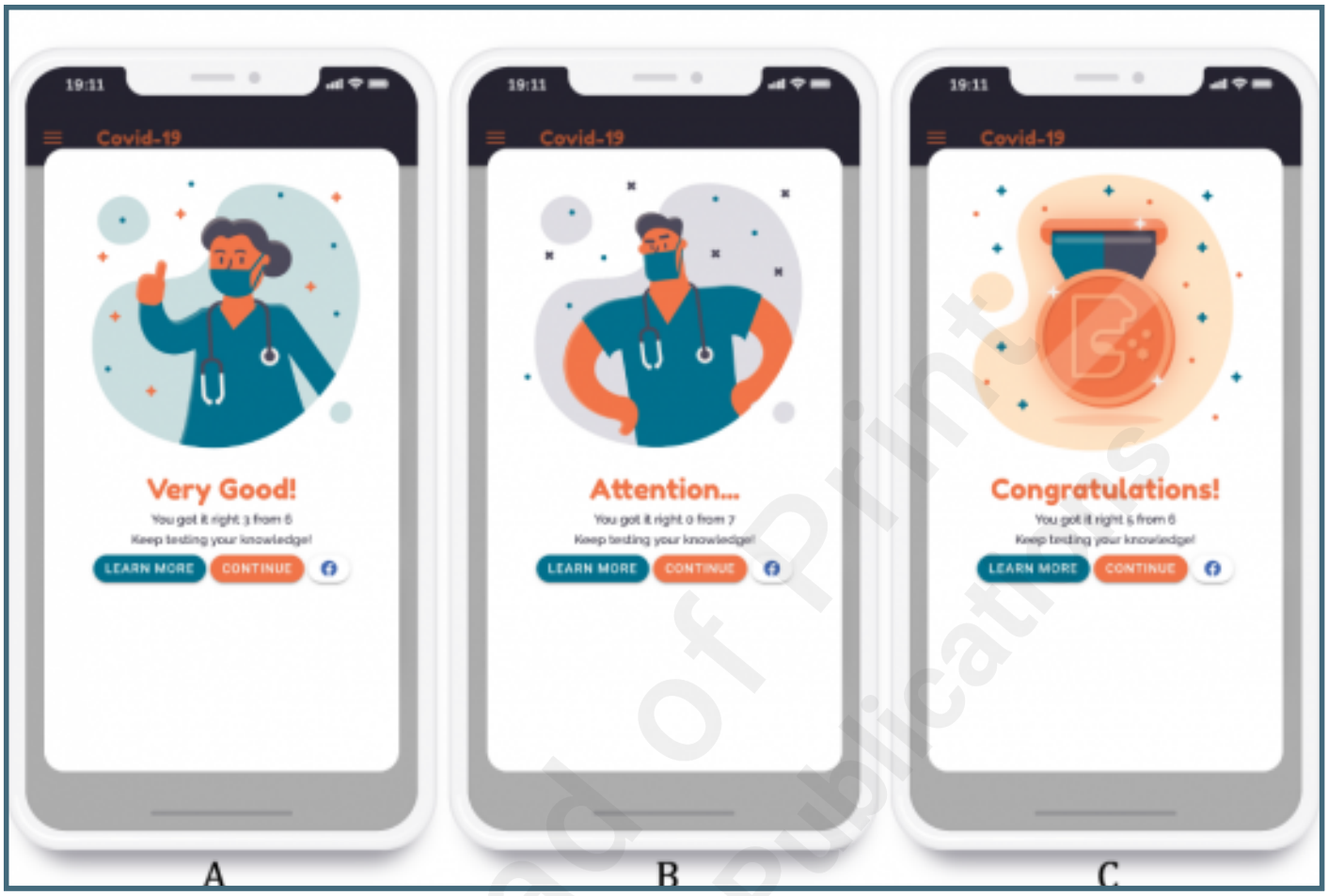
Questions grouped by learning objectives topics.

Interfaces of the game's initial screens: Splash (A), Home (B), and Menu (C).

Interfaces with questions (A), the hit answer (B), and the wrong answer (C).



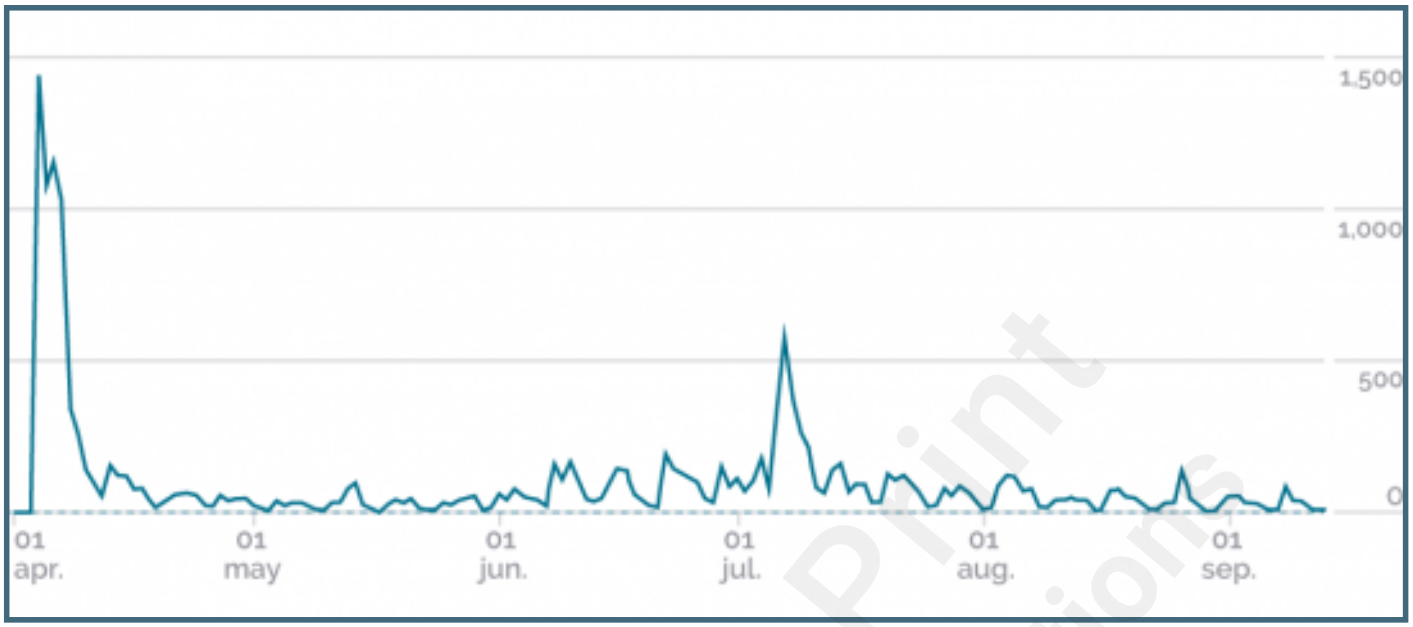
Cards with results (A, B) and medals (C) by topic.



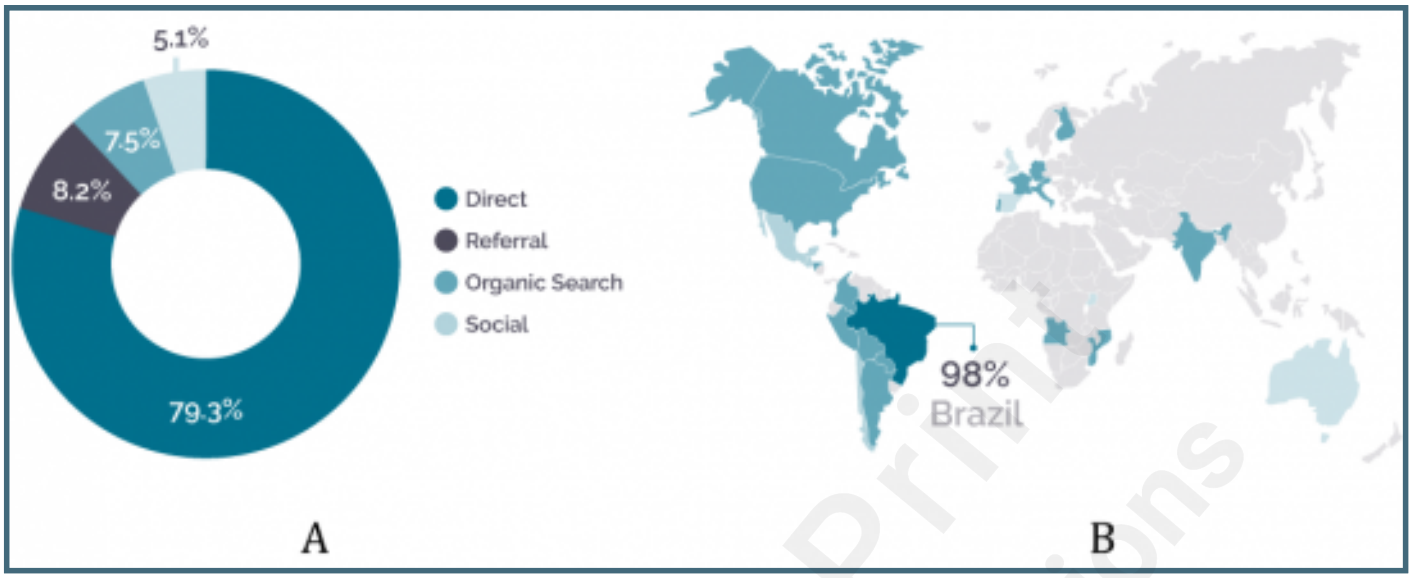
Personal and global ranking (A), diffusion actions (B), and privacy policy (C).

Infographics with complementary information on the topics.

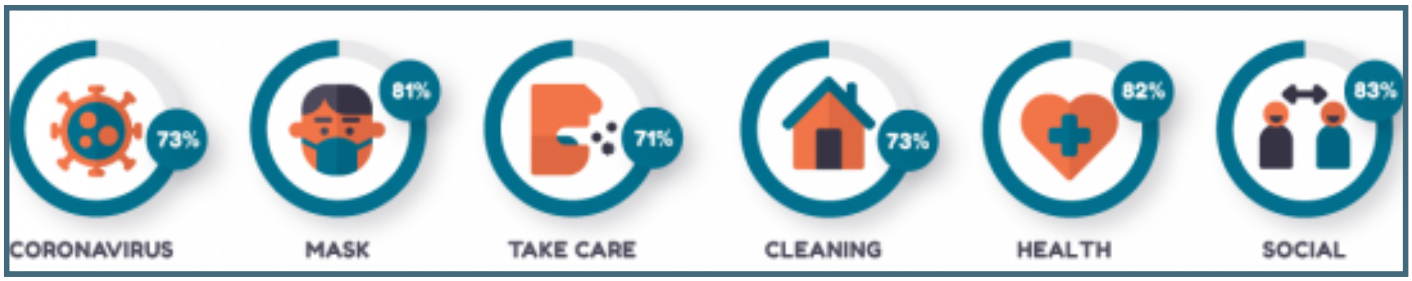
Distribution of game access between April and September 2020.



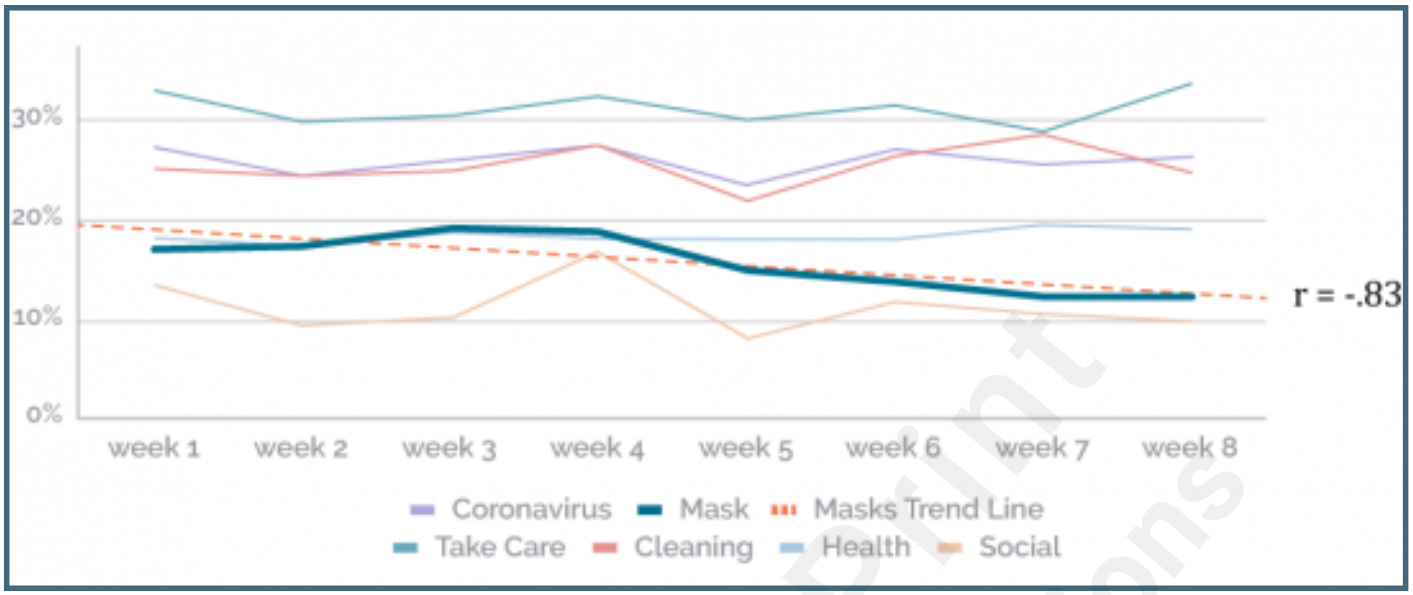
Distribution of game users by type of access channels (A) and by countries (B) between April and September 2020.



Hit answer rate per game topic between July 20th, and September 13th, 2020.



Error rates by topic grouped by week (July 20th to September 13th, 2020).



Examples of images for post on social networks.