Stop-Dengue: Game for Children and Adolescents with Down Syndrome

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Abstract

This work aims at presenting an educational game for people with down syndrome with a focus on learning how to prevent and diagnose, viral Dengue disease. STOP-Dengue game was developed considering bibliographic research, a search for apps classified as games on the Google Play platform for smartphones, and a survey applied to a group of parents and caregivers to identify the best kind of educational stimuli for children and adolescents with down syndrome. The game presents details about Dengue viral disease, encouraging the active participation of children in the learning of this subject. A group of students with down syndrome participated in the evaluation of STOP-Dengue. The results showed that participants learned the concepts about Dengue, and the majority were satisfied with the game.

Keywords: Learning, Games, Down Syndrome, Aedes Aegypti, Dengue.

1. Introduction

Dengue is one of the biggest public health problems in Brazil. Although several studies have shown significant results in reducing the spread of the Aedes Aegypti mosquito, the institutions responsible for controlling health policies are not able to implement them in different regions of the country simultaneously (Araujo, 2015; Maciel-de-Freitas, 2014; Carvalho, 2015).

Early identification of Dengue focus is important for decision-making and implementation of sanitary and public health measures (Brasil, 2016). Government campaigns included home visits to prevent mosquito

breeding sites for decades. They also count on the active participation of the population to detect and eliminate larvae that develop in aquatic habitats found in homes and neighborhoods.

According to Freitas et al. (2019), children are disseminators of information in their family and, through education, the community can know, learn, and participate directly in effective actions to combat Dengue. Thus, they can assume the role of transformation agent, spreading information and supporting behavioral changes in community groups (Alok, 2020).

However, in general, children with different intellectual disabilities do not receive information that is accessible to their level of understanding of this problem (Mastebroek, 2016). Therefore, it is essential to offer learning possibilities on this topic for children with different levels of cognitive impairment. Despite the prognosis, these children can learn from motivational stimuli.

According to Conners et al. (2008) children with Down syndrome have problems with short-term memory that prevents the proper behave of cognitive functions. Recent results pointed out that playful activities stimulate the memory of these children, especially when they use computer games (Cruz Netto, 2020). Shalash et al. (2018) stress that several studies have shown positive effects of games in stimulating perceptual skills, visual and spatial abilities, short-term memory, attention, and reaction time in children with Down syndrome.

In this context, this paper´s main objective is to present the educational game named STOP-Dengue to educate children with Down syndrome about preventive care, and diagnosis of the Dengue viral disease, transmitted by the Aedes Aegypti mosquito.

Game's development has followed the steps proposed by Teixeira, Cruz, and Gonçalves (2017): storyboarding, organizing the development process, and mapping the game's criteria. In the validation phase, a case study (testing) has been carried out with a group of students in the countryside of Minas Gerais, Brazil. This research was approved by the State University of Rio de Janeiro Research Ethical Committee with number 13149219.7.00005282.

This paper is organized in five sections, this introduction, followed by section 2, which presents the methodology of this research. Section 3 describes the STOP-Dengue game. Section 4 details the use of the STOP-Dengue by children with Down syndrome in a Public School. Section 5 presents the conclusion of the work and future works.

2. Methodology

This work was developed supported by the process described in Figure 1. The research has a quantitative and qualitative nature, addressing both methods at different moments. Firstly, a literature review concerning this theme has been searched in Scholar Google, Pubmed, and Medline's libraries. The applications classified as games in the Google Play platform for devices with the Android operational system was also searched. This platform is the most popular for smartphones in Brazil.
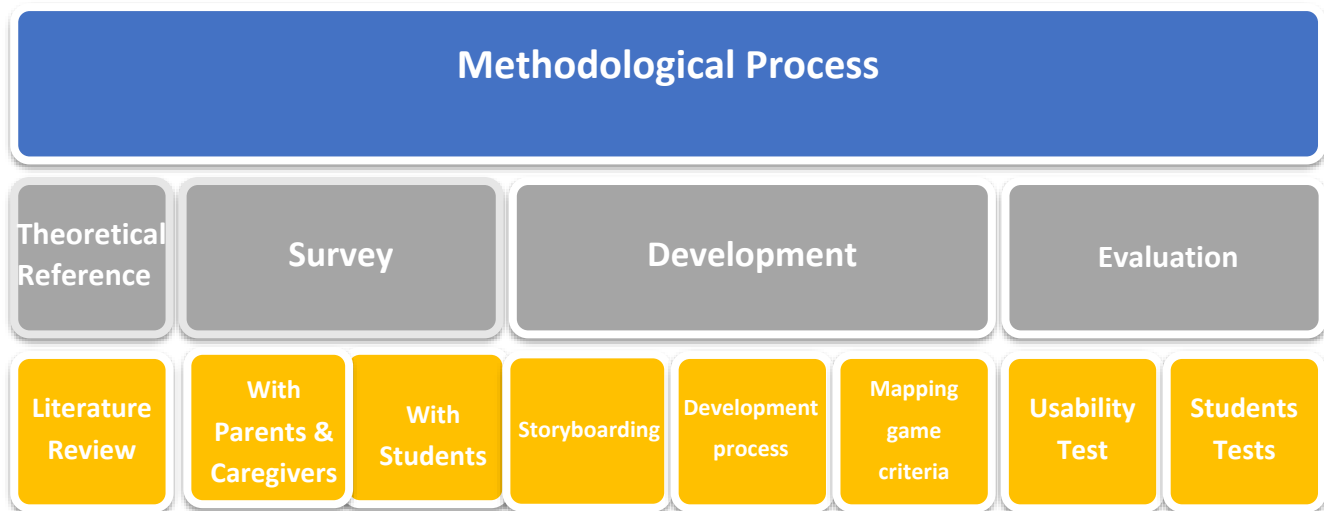
Figure 1: Research methodological process

In the literature review, terms in Portuguese and English have been defined, besides the inclusion and exclusion criteria of papers. At first, we identified 548 papers, and after four steps (title and abstract reading, removal of double works, introduction and conclusion reading, entire work reading), 19 relevant papers have been identified.

Among the papers, a systematic review has been identified with articles between 2001 and 2012 (Araújo, 2013), concluding that technological resources can and should be present in classrooms, especially with inclusive education. Several papers (Pereira, 2013; Brandão, 2015; Domingues, 2017; Farias., 2013; Diatel, 2016; Lima,2011; Menezes, 2016; Oliveira, , 2017; Pinto, 2013; Rodrigues, 2014; Santos, 2012; Serra, 2017) have used and analyzed games and game therapy aspects as an educational resource for people with Down syndrome.

In the Google Play search, the terms used were: Down syndrome, and Dengue. Concerning the games search about Down syndrome, four games have been found: Jade Autism, Downex, Ludkids Games, and Special Words. All these games have activities that aim at skill ability development, especially skills linked to alphabetization or prerequisites for it.

In the Dengue games´ search, ten games were found; eight of them are in the education or teaching categories, one classified as an adventure (Aedes Aegypti – The Epidemic), and another as action (Zika Smash). All games have activities that demand motor skills. Some games (Out Zika RP against dengue and XDengue) have a quiz that reinforces learning about the subject. In some games (Against dengue the game, Out Zika RP against dengue, Zika Smash, and Den game), orientations and tips related to prevention were presented. All games had as unanimous goal to pulverize (or exterminate) mosquitoes and collect all the mosquito focuses. The use of augmented reality was present in several games as well, such as Brinquelonas Super Agent and AEDES in focus – The Game.

After selecting and analyzing the papers and games, we applied a questionnaire to parents and caregivers of children with Down syndrome to know the profile, wishes, and perceptions of these children to define the graphical and activities elements that should be present in the game. A group of 77 participants answered the questions. The Syndrome Down individuals had ages varying between 1 and 41 years old.

The average age was 8.4 years, with a standard deviation of about 7.4 years that stress high heterogeneity in the age range. Age, although relevant, in this case, cannot be considered in a restricted way, as it does not match habitual intellectual development (Hodapp, 2003). People with Down syndrome, even at a high age, can be represented here.

Based on the results of literature research and survey we observed that children with Down Syndrome prefer games with challenges, simulation, and awards. The games should be a playful, simplified with a clear and objective layout, presence of vibrant colors and ludic images; activities and environments elements close to everyday life; capital letters; error indications; tasks of association, memory and motor skills to exterminate dengue mosquitoes and sources of contamination; in addition to presenting tips on prevention and care against dengue. They should have a logical explanation for each action and awards. Objectivity is the main factor and the preference for games that involve challenges and associated decisions. The results of the bibliographic research and the responses of the families pointed out that people with Down syndrome have low ability to concentrate for long periods.

3. Game Development

STOP-Dengue goal is to teach children with Down Syndrome essential information about Dengue and ways to prevent this disease. The game encourages participation in the learning process through a narrative that induces empathy with some characters. Ana, the best friend of the main character (player), has been sick with Dengue. Initially, the player must understand the situation and from this fact, the journey of knowledge begins. He must fight the mosquito that transmits the disease. During this battle, he knows the symptoms of Dengue, Aedes Aegypti mosquito characteristics, locations of the main foci of insects, and the safe use of repellents and insecticides. The game supports learning by immersion in the content exploring funny images. It includes two mini-levels tests, to stimulate the short-term memory by memory and reasoning tasks.

Considering that people with Down syndrome learn from visual information and 50% of them have difficulty in seeing, Stop-Dengue game adopted bold colors on the buttons, and large images, and letters. (Movimento Down, 2013).

An additional feature of the game is the possibility of identification with the characters and situations. The player can see himself within the narrative, experience new physical appearances, being able to choose different avatars. All characters have physical characteristics of people with Down syndrome and can be chosen to represent the players.

The game implementation used the Godot tool (Godot, 2019), an engine for game development compatible with platforms 2D and 3D.

To play, players must click on a button (Figure 2a). Then they must choose a character (avatar) from the available options (Figure 2b) and give him/her a name.

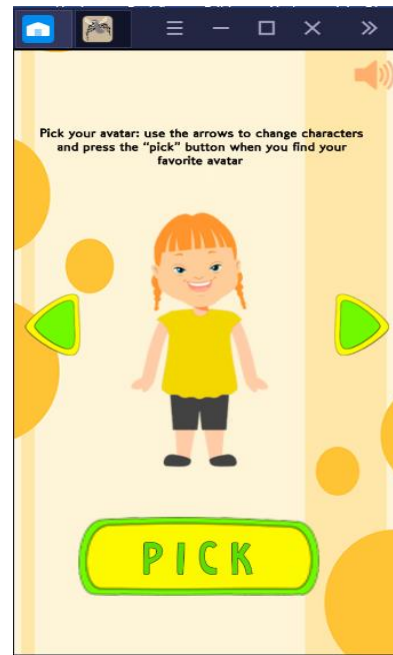Figure 2a: STOP-Dengue home screen

Figure 2b: Avatar choice screen

The first scenario is the school (Figure 3a). There, the first situation is presented: the player notices that his/her friend Ana did not come to school. Then, the child's character is sent to Ana's house to investigate what happened to her. The character interacts with Ana and her mother. In the next step (Figure 3b), the player can know some Dengue symptoms by clicking on the yellow spots over Ana's body.

In the second level, the player knows a new character (the Biologist), who introduces herself (Figure 4a), and presents some characteristics of the dengue-transmitting mosquito (Figure 4b). The Aedes Aegypti mosquito can be viewed through a magnifying glass, and the game presents additional information about the mosquito by clicking on the "¡" icon.
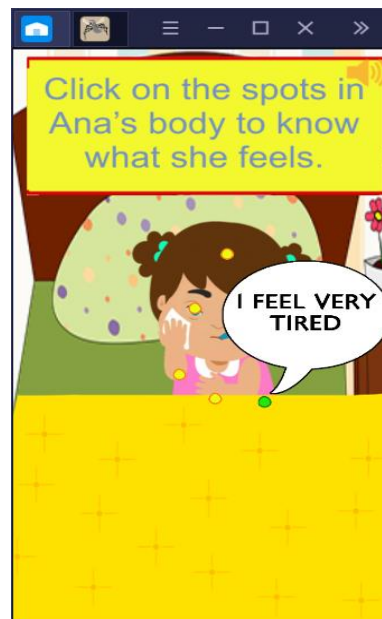

Figure 3a: STOP-Dengue level 1

Figure 3b: STOP-Dengue level 1

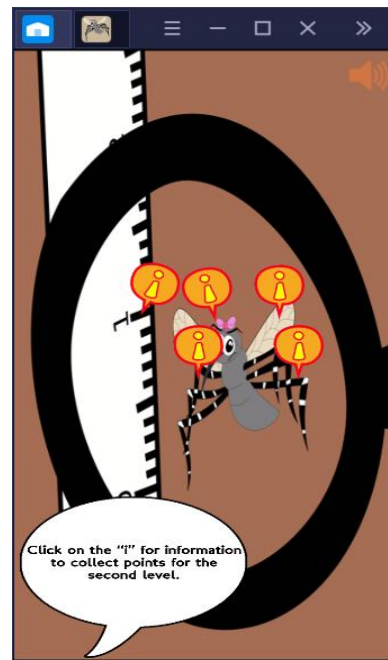Figure 4a: level 2 - conversation with the biologist

Figure 4b: level 2 - information about
the mosquito

The goal of the 3rd phase is to present fundamental sources of mosquito proliferation, illustrating places where the mosquito can lay its eggs. Following several screens, players can visit different environments where they can know breeding focuses (Figure 5a).

The game has two mini tests that players must answer questions related to the theme. In the activity, named smart battle (Figure 5b), the player "fights" the Aedes Aegypti mosquito, using the insecticide or repellent for this.   The biologist character provides instructions on how to carry it. At the end of the game, the player avatar and Ana appear in the room healthy and ready to play in the yard (mosquito-free). The player points obtained during the adventure game levels are displayed in the screen top with the bottom option to restart and play again.

Figure 5a: level 3-mosquito proliferation focuses

Figure 5b: level 4 - Smart battle

4. Results from a Pilot Study

To observe how players, perform and the educational value of this game, a pilot study was developed with eight students with Down syndrome from a fundamental level school in the countryside of Minas Gerais, Brazil. Participants were identified by the following nomenclature P1, P2, P3, P4, P5, P6, P7, and P8. The students participated in the experiment as an extra curriculum activity.

In general, we observed complete adherence from the participants, without negatives or hesitation in any phases.

Only one student (P7) was not literate, and the monitor helped to play the game. The other students can read and write. Among the eight students, only two are women. The participants have familiarity with the handling of technological devices, especially smartphones. A question about the use of virtual games confirms that they usually play.

P8 had an interest in participating in using his smartphone. However, he received instructions to use the device that contained the pre-test, the post-test, and the game evaluation questionnaire. The first activity consisted of the application of an online pre-test that the students answered with the help of the monitors, the second one a characterization questionnaire. Regarding age, the majority is in the age group of 18 to 25 (five students representing 62.5%).

Four students (50%) have a school level of education. Three have an elementary school level, and only one has a primary level. Summarizing, most of them have at least concluded elementary school, which makes them competent not only to play the game but to understand the knowledge passed through this educational resource.

However, when faced with answers about writing competence, 25% know how to write but need help from a monitor, 10%, which means one student, cannot write, and 65% masters this skill. Furthermore, knowledge of the world is required to answer the questions presented before the game is applied. Therefore, only two students pointed out that they do not know the Aedes Aegypti mosquito, but one of these students knew sicknesses that the mosquito could cause.

The students were asked if they knew the symptoms of Dengue before and after the game. Their answers are in Figure 6. Then, a list of seven Dengue symptoms were presented for students to indicate which were Dengue symptoms. Two groups of 4 students were created, considering the students' perception of the disease. All students who considered knowing the symptoms of Dengue hit, on average, four symptoms of dengue. A student who believed he did not know the Dengue symptoms marked all correctly answers.
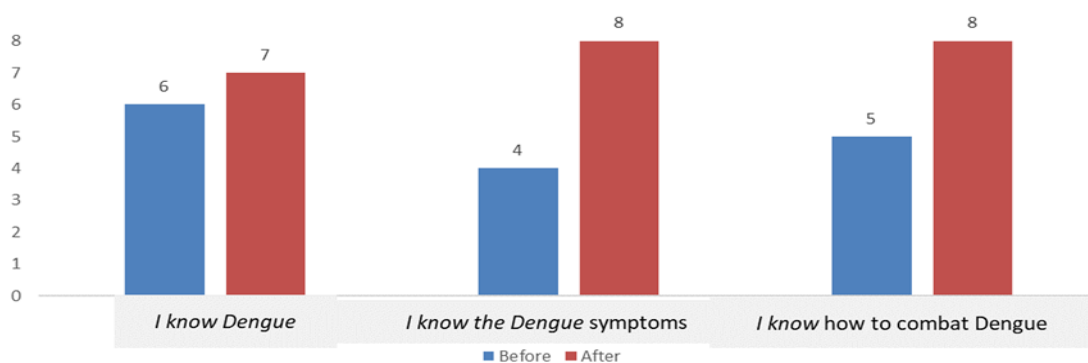

Figure 6: Students' Perception Knowledge Before and After using STOP DENGUE

After using the game, all students claimed to know the symptoms of Dengue (Figure 6). The Dengue symptom that became known to everyone was "Pain behind the eyes", which was the least known before the game. "Headache" also had its recognition increased, and no student returned to mark "Blue spots on the body" as a Dengue symptom.

In a comparative analysis between the perception questionnaires applied BEFORE and AFTER the game (Figure 6), it was observed that all students learned about the symptoms and prevention after the game, once more showing its success rate.

A great acceptance of STOP-Dengue was observed after playing the game. After the game's explanation about Dengue, its symptoms, and how to combat it, there was only one negative answer from a student (P2) concerning this information, according to Figure 7. However, this is questionable, since the student answered he does not know about Dengue, but answered he had learned about it, knows its symptoms and how to combat it. Thus, this is considered an inconsistent answer without great negative weight for general analysis. Meanwhile, all the other students informed they know and learned more about Dengue, representing a positive point for the game's objective of teaching about Dengue.
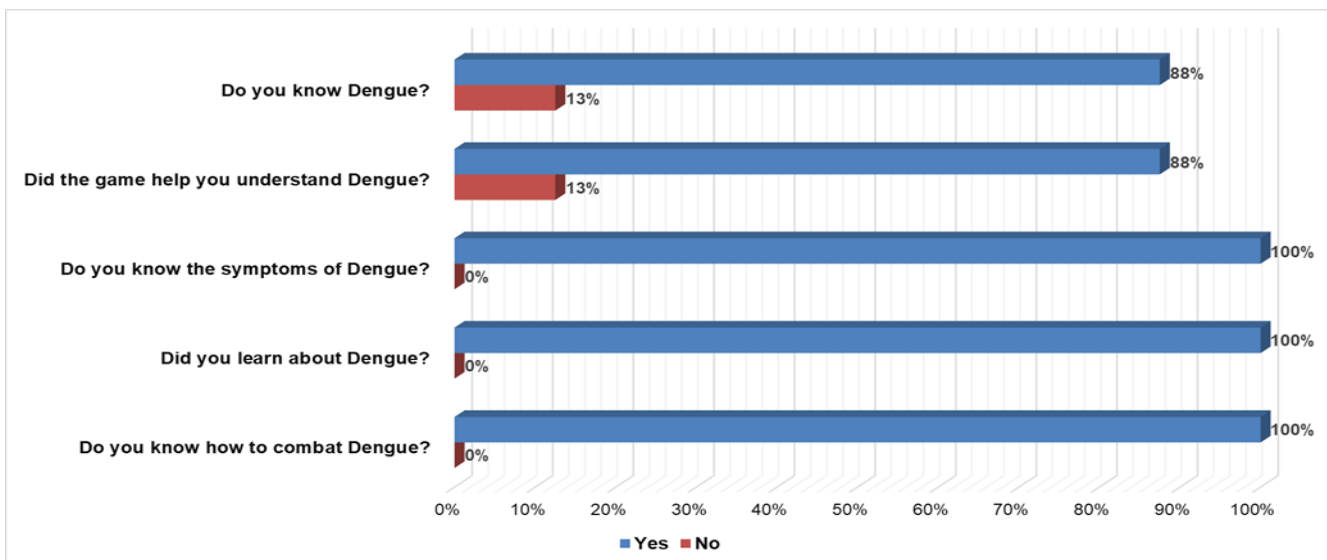

Figure 7: Students´ answers after using S TOP-Dengue game

All students liked the game and its characters. They also considered that language and instructions presented during the game were clear, and the final score encouraged them to play. The images and colors were interesting and attractive. Only one student said he did not like the songs very much; the others said they appreciate them. Figure 8 summarizes these answers.

Only one student considered that the game is not easy to play (Figure 8) and did not think that the plot helped to understand the necessary care with the mosquito. Two students considered the game to be too fast, while for others, the time was adequate.

All students stated they would recommend the game to a friend to broaden knowledge about fighting dengue.

Student P5 has had negative feelings towards the game and did not want to continue to play. Nevertheless, P5 would recommend the game to a friend. The same happened with student P2 that would recommend the game to a friend but did not want to continue to play.

After playing the game, the students reported that they felt happy for having learned and motivated about contributing to disease prevention.

Three teachers and monitors also answered some informal questions after supporting students to navigate the game. Their responses were positive, indicating the approval by these professionals, who expect the game to be a facilitating tool in the learning process of students with Down Syndrome on topics related to Dengue. Two of them made suggestions to improve accessibility: audio for illiterate students and larger font size.

The alert state observed during the experiment can be understood as a state of extreme attention towards the new educational approach. In general, the person with Down syndrome is very dedicated to tasks. Thus, he is not comfortable with the error. The excessive attention can be interpreted as a state of alertness, that generates some level of stress.

During the phase of playing the game, the students had some specific reactions, the participants appeared to be calm and with quick and firm answers without much hesitation or dispersion and with spontaneous answers.
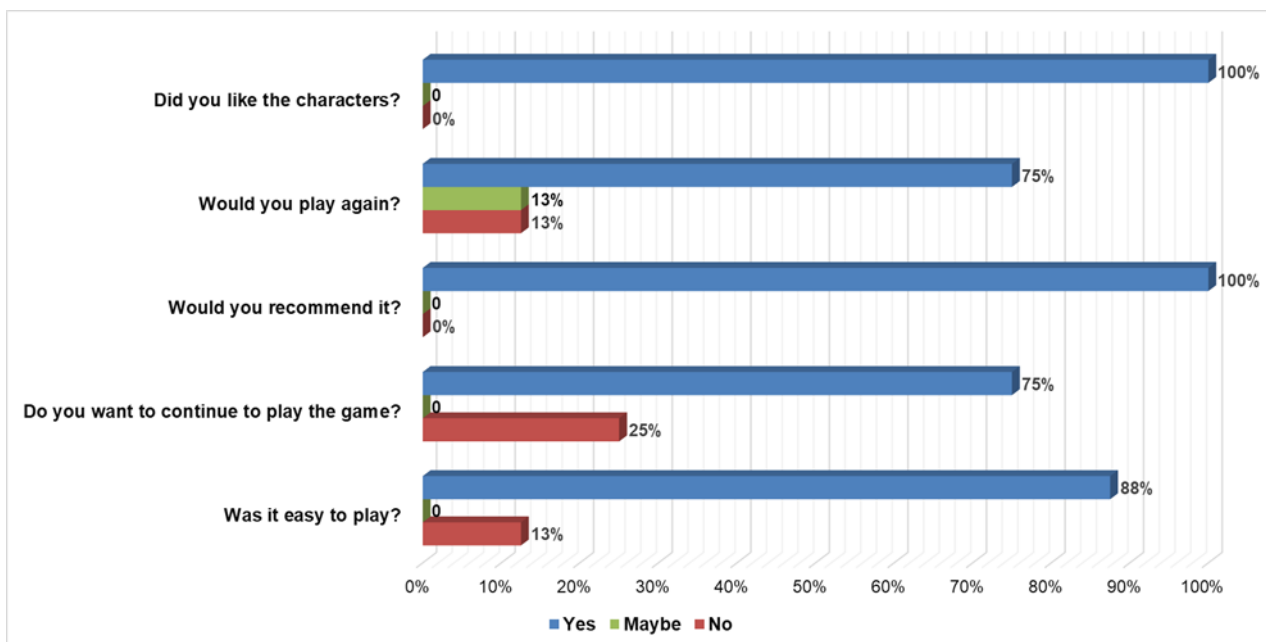

Figure 8: Students' Opinion About the STOP-Dengue Game

Another observation concerned facial expressions and some commentaries: P1 – "it was nice you asked this"; P5 – "…I know this"; P3 – "…I know… I know…".

During the experiment, students were concerned about the difficulties of other participants. Phrases like "Got it?", "I'll help you", "Is it over?" were heard at different times. The interaction favored the discovery of the level of knowledge of the participants in relation to the subject "Dengue", revealing that it is considered good as a basis for other approaches.

Concerning satisfaction, the most recurrent affirmations were about asking for installment in their own smartphones or obtaining the game: P8 – "I want this game, can I?"; P1 – "this is nice, I want to download it!"; P4 – "can I play again?".

5. Conclusion

The objective of this work was to present the development process of a game focusing on the viral Dengue disease transmitted by the Aedes Aegypti mosquito for people with Down syndrome. STOP-Dengue aims at offering essential information about Dengue and ways to prevent this disease in a ludic way.

For the game development, we considered the results of a bibliographic survey and an opinion survey carried out with family members and caregivers of people with Down syndrome.

Dengue is a serious disease and the educational material available does not have language or images accessible to people with Down syndrome. STOP-Dengue uses characters with physical characteristics of Down syndrome, to create a closer relationship with its users.

A two-step evaluation model was proposed for having performance results from end-users. The first considered a pre-test to verify what the players had as prior knowledge and a post-test, after using the environment, to verify the player learning. The second one aimed to identify satisfaction with the interface. The results showed that participants learned the concepts about Dengue, and the majority were satisfied with the game.

Educational games can support teachers and monitors as an educational resource adding to the unprepared environment found in schools in Brazil for teaching Down Syndrome students (Alencar, 2019). STOP-Dengue can be used by students with and without this syndrome and can be a tool for students with Down syndrome inclusion.

Finally, this game can be relevant for children and adolescent with Down Syndrome who need to learn about dengue, enabling them to have a funny experience. They can work their emotional and visual arousing, their interest in interacting with the content and consequently learn from that experience.

Some suggestions based on observation from teachers and monitors are: (i) Increase the font size; (ii) Including more sound guidance features; (iii) More praise and greetings, in order to reduce the state of arousal; (iv) Audiovisual resources for illiterate users; and (v) Overall improvement in accessibility.

The students did not make any critiques, but they were seen putting their faces close to the screen, which confirms the suggestion to increase the font size.

As threats to the validity of the research, we can consider that the number of participants was small. However, if we consider the profile of the sample, we consider that it was a reasonable number given the difficulty of obtaining access to people with Down syndrome. Access depends on approval by the Research Ethics Committee, contacts at schools and authorization from parents or caregivers.

As future work, after making the recommended changes, we hope to develop other experiments with more class days and more students.

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