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Conscientização de Crianças Sobre o Uso Racional de Água: Uma Abordagem Baseada em Jogos Sérios e Validada por Mineração de Dados

Awareness of Children about Rational Use of Water: An Approach Based on Serious Game and Validated by Data Mining

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Abstract: The water shortage expectation in a near-future proves that the world population must be mobilized, as soon as possible, to face the problem of the water waste in daily activities. This paper presents the development of a web serious game to teach children about that problem which is already affecting the lives of many people around the world. It was developed in JavaScript, HTML5 and, the database communication, with PHP. The tests were made in Brazilian public schools and, after each test, the children filled questionnaires to the game's qualitative analyze. All data that came from the children played were stored in the database, where, after the data mining using the decision tree algorithm, it showed the tables' consistency and the children engaging during the tests. As a result in the educational scope, it was seen better ease on the subject taught to the students.

Keywords: Serious Games. Web Application. Water. Children. Data Mining.

Resumo: A expectativa de falta d'água potável em um futuro próximo indica que a população mundial precisa ser mobilizada, o quanto antes, para enfrentar o problema do desperdício de água nas atividades cotidianas. Este trabalho apresenta o desenvolvimento de um jogo sério pela web para ensinar crianças sobre este problema. Foi desenvolvido em JavaScript, HTML5 e, a comunicação com o banco, em PHP. Os testes foram feitos em escolas brasileiras de ensino público e, após cada teste, foram feitos questionários com os alunos para a análise qualitativa do jogo. Todos os dados oriundos das jogadas foram salvos no banco, onde, após a mineração utilizando árvore de decisão, foi evidenciada a consistência das tabelas e o engajamento das crianças durante os testes. Como resultados no escopo da educação, foi verificada maior facilidade no ensino do tema para os alunos.

Palavras-chave: Jogos Sérios. Aplicação Web. Água. Crianças. Mineração de Dados.

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1 Introduction

The planet Earth is constantly called the "Blue Planet". This fact occurs due to much of its surface is covered with water. However, according to the International Water Agency (IWA, 2017), 97.5% of the entire water is salted, leaving only 2.5% of freshwater. Subtracting the water from rivers and lakes, in caves and frozen at the poles, only 0.034% of the total water could be considered potable and within human reach. In addition, this water is not well distributed to the population, and many countries have water crises. The water shortage expectation in the near future proves that the world population must be mobilized, as soon as possible, to face the problem of water waste in daily activities (DENG et al., 2019; POORTINGA et al., 2018).

Hence, population must be aware of the rational use of potable water. It is believed that the education of children about this problem could change them to the correct use of the water we consume.

According to Piaget (1976), as children are developing and forming their personality, they are more receptive to information than adults. Taking this problem into consideration, there is an urgent need to raise children's awareness of important good preservation. In the education area, serious games are used as tools to help teaching (HUIZINGA, 1955; BAKER, 2000), because they motivate students, facilitating their learning (DETERDING et al., 2015).

An incentive to make children learn is by playing Serious Games. These are defined as games that have as main objective being a learning aid. This abroad is being used in some areas, such as Biology and Math (DETERDING et al., 2015; NETO and FONSECA, 2013).

This paper presents the development of a web serious game to teach children about that problem, which is already affecting the lives of many people around the world. It is believed that education could be the best tool to change cultural habits and, in this way, a bigger awareness and better use of hydric resources.

The paper exposes the game development, the test of it with children in a Brazilian public elementary school and the results obtained, based on questionnaires (qualitative analysis) and game databases that were stored with children's activities during the game tests with decision tree technique (quantitative analysis). It is important to highlight that the children were in elementary school and were between 7 and 11 years old (they should be literate to participate).

The structure of the paper is the following: in Section 2 the theoretical and technical basis of this research are presented. Section 3 presents the game and all the steps for its development. Section 4 presents the results for each step of the game and section 5 shows the conclusions and further work possibilities.

2 Theoretical and Technical Basis

This chapter is going to approach the areas studied for the project development: serious games, data mining and rational use of water, as well as the technologies involved in its progress: Apache, HTML5, CSS3, JavaScript, MySQL and, for data mining, WEKA.

2.1 Serious Games

According to Huizinga (1955), games are part of human being nature and they are essential for the reasoning because playful elements are at the base of the civilization emergence and development. This author defines a game as: "a voluntary activity exercised within certain and certain limits of time and space, following rules freely allowed, but absolutely obligatory, endowed with an end in itself, accompanied by a feeling of tension and joy and an awareness of being different from everyday life".

Following this line of thinking, the technology industry grows, due to the great success of entertainment games and applications being used by almost everyone on their computers and mobile devices. A survey by IBGE (2019) shows that 93.2% of Brazilian houses have at least one mobile device and 43.4% have at least one microcomputer. This way, opportunities also appear for serious games to arouse the interest of players (BAKER, 2000; ARANHA, 2006; DETERDING et al., 2015).

Basically, games are usually studied in four areas of human knowledge: Anthropology, which studies the meaning and context of the games; Sociology, which studies the effects of games on people (learning, cognitive development, aggressiveness, etc.); Technology, that studies the elements that compose games and analyses their usage as vectors of technological innovations; and Commerce, which analyses the creation, evolution and commercialization of games (ALLUÉ, 2016). Therefore, games could be developed with different objectives, according to Fialho (2007): "The game creates a fascination about people, who struggle for victory trying to understand their mechanisms, which constitutes a new way for students to learn by playing".

Therefore, from a general perspective, Serious Games are software developed with the purpose of transmitting the content of educational subject to the user or scientific purposes. The term "Serious" refers, in this case, to related products and situations in areas such as education, scientific exploration, health services, emergency management, urban planning, engineering, religion and politics (PRENSKY, 2003; PERRY et al., 2007; SAVI, 2008).

2.2 Data Mining

Nowadays, technology increases on an accelerated level, requiring computational systems a high degree of data organization due to the large amount of data. Therefore, new and more complex storage structures have been and are being developed, as: database, data warehouses and virtual libraries (LAROSE and LAROSE, 2014; CIOS et al., 2007).

According to Cabena et. al (1998), from a database perspective, data mining is an interdisciplinary field linking knowledge machine techniques, pattern recognition, statistics, database, and visualization, to be able to extract information from large databases. The main objectives of data mining practices are prediction and description. The prediction evolves using some database variables or fields to predict future or unknown values of other variables of interest. The description focuses on finding patterns that describe the data and that can be analysed by human begins. The objectives of prediction and description can be achieved using

a variety of data mining methods (FAYYAD et al., 1996). According to these authors, an important data mining method of classification is the decision trees, which act as a tree-shaped flowchart, where each node indicates a test on the value. This method has the objective of reducing the data impurity or uncertainty to the minimum.

The decision tree model is a supervised classification technique based on the division of a complex problem into several sub problems, repeating this process recursively to generate a tree. In a decision tree, each leaf node receives a class label; nonterminal nodes, which include the root node and other internal nodes, contain attribute testing conditions to separate records that have different characteristics (TAN et al., 2005).

This method was chosen in this research due to its results are to understand, and for presenting quantitative data based on the confusion matrix and the qualitative data based on the graphical tree paths. Besides, it is also considered a good performance technique for large amounts of data.

2.3 Rational Use of Water

About 70% of the Earth surface is covered by seas and oceans, remaining approximately 30% for continents and islands. It is estimated that 96.54% of the world's water is in the sea. There are also many salted lakes and it is assumed that more than half of groundwater is, also, salted. Therefore, we can say that 97.5% of the water that exists is salty. Amongst the other 2.5% that is considered freshwater, 2/3 remains on the glaciers and permanent snow covering the mountains and Polar Regions. And, the 1/3 that remains is confined in the pores or embedded in underground rocks fissures, on formations known as aquifers (IWA, 2017).

Daily, it is thought that exists abundant freshwater to use, but this water distribution is far from homogeneous, with large amounts of water in the tropical jungles, like Amazon, the Congo and Borneo, and a huge variety of fauna and flora. On the other hand, in the Atacama, Gobi and Sahara deserts, water is almost non-existent, with few species of plants and animals (MACHADO, 2002; CARDOSO, 2012).

When discussing the reduction of excessive water consumption, it is common to think concepts and works of watersheds preservation and the environment, as well as protection of fauna and flora. However, it is necessary to reduce household consumption of water, in other words, taking procedures that reduce the volume of water used in homes or the possible losses of water inside buildings.

The implementation of measures to save water in buildings provides a reduction in demand, thus creating a chain of hydro sanitary solutions. The water reuse and its use with conscience may avoid overloads in the systems of water supply in the cities. Consequently, the required uptake of the water sources is reduced and, finally, a reduction of the sewage to be treated is achieved, which increases the treatment efficiency and reduces pollution of the receiving bodies, decreasing degradation of natural water resources and environmental systems (MACHADO, 2002; CARDOSO, 2012).

In addition, there is still an economic advantage due to the reduction in the amounts of the invoices calculated on their consumption values. In economic aspects, it is also possible to consider cost reduction in chemicals required for treatment in Water Treatment Plants, used by the companies and the extension of elevators useful life and water/sewage treatment plants, extending its future expansions and avoiding construction of new hydraulic infrastructures (HAFNER, 2007; FARIA and FARIA, 2004).

2.4 Related Works

Nowadays, more teachers try to present content in a way that can interest their students in schools, in order to encourage better learning. This way, technological resources are being used to try to achieve this goal, raising discussions about the benefits of such resources as well as possible teaching strategies for their application, as they are said to increase motivation and the approximate concepts studied by students (BORGES et al., 2016; SILVA et al., 2017).

This type of game tries to help in the understanding of some problems the students must solve in order for the game to be completed, thus bringing meaningful learning to users and in a ludic way. In Pernambuco and Rio de Janeiro states (Brazil), the "Digital Games and Education Olympics" was created a competition where teams of students hold disputes in educational games, allowing for analyses of the impact that these games have in the learning (SILVA et al., 2017).

A good example of games in the classroom is the biology, where it involves complex and abstract concepts and, in some cases, difficult to understand, where knowledge is covered from many different areas, such as Biology, Chemistry, Science and Physical Education. With that in mind, students of Teaching Initiation Program (PIBID) in Biology of the Universidade Estadual de Feira de Santana (UEFS) developed a physical board game that later was transformed into a digital version, a game called "Body", that looks like the game "WAR", which is a strategy game to conquer territories, but instead of territories, players conquer organs and, to do so, it is necessary to answer questions about the human body (BORGES et al., 2016; SARINHO et al. 2018).

2.5 Used Technologies

Web applications are software that can be used in any browser, being made available through a server. These applications are mostly embedded in Apache HTTP servers, which play the role of a web host, making it accessible to anyone with an internet connection. The most recent technologies used in these applications are HTML5, CSS3, JavaScript, and MYSQL. The user uses the application with the request and response mechanism, the browser sends the user's HTTP request and the server responds with HTML pages, images, PDF documents and data stored in the database (FOURNIER, 1998).

Generally, they are constituted and developed in two stages: front-end and back-end. Front-end is the interface that is shown on users' monitors, which is processed/compiled by the back-end that communicates with the server through processes requested by the user through the front end, thus obtaining communication.

These applications, unlike the most current local programs/applications, try to use the latest technologies as facilitators for access and compatibility, since they can be used independently of the operating system or browser, and the user does not have to install any new software on his computer. It also maintains compatibility with mobile phones and tablets, which are widely used today (RICCA and TONELLA, 2001; PILGRIM, 2010).

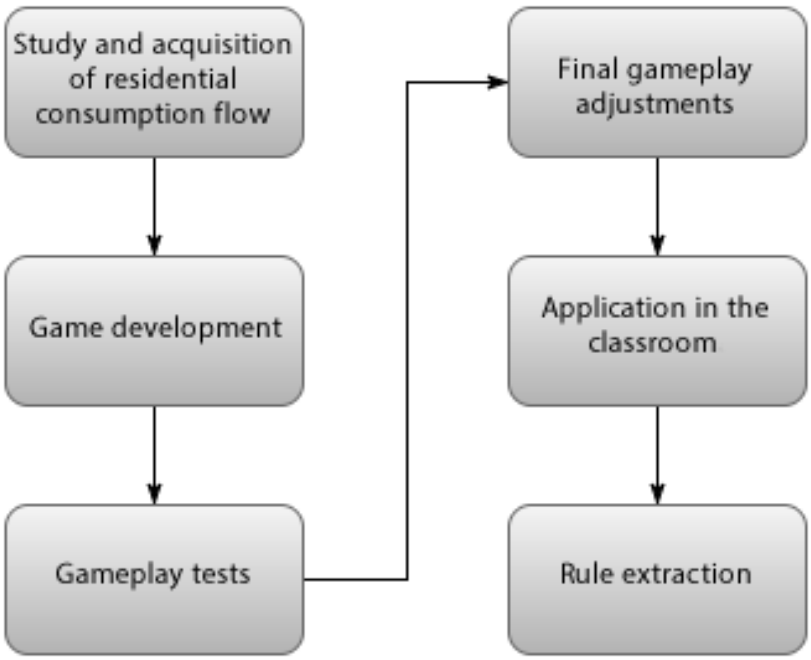
The software Waikato Environment for Knowledge Analysis (WEKA) was used as platform to mine the data and find relevant and helpful knowledge for the project. Weka has a collection of machine learning algorithms to use in data mining, in other words, it has tools for pre-mining of data and classification, regression, cluster, association and visualization algorithms (WITTEN et al., 2011). By using this software combined with the game dataset it is possible to see the actions of the children while playing.

3 Proposed Game

3.1 Methodology

Concerning to develop an educational game for the awareness of potable water, it was defined a methodology, which follows stages so that the game can be developed close to the actual consumption of water in homes. Figure 1 shows the methodology flowchart in stages. Firstly, a study and the acquisition of the water's consumption flow on residences was done to obtain the volume of water that each of the main residential elements consume. With this, it was possible to begin the next step: to develop the game.

Figure 1 – Methodology flowchart



Source: The authors.

The game is a web application, so it can be played on any computer with internet access, regardless of its operational system and browser used in schools. It was developed using HTML5, CSS3, JavaScript and PHP languages, with the canvas graphic element and the help of API Quintus – a game engine of JavaScript that is widely used, because it facilitates the development of 2D games.

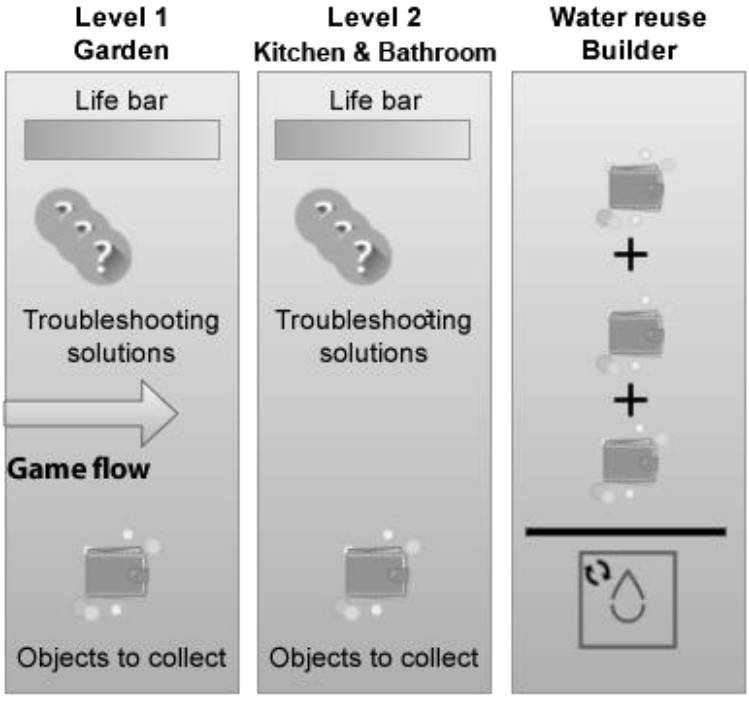
With the game developed, gameplay tests were performed. Firstly, with people involved in the project and consecutively with some students. Hence, it was possible to test and make final adjustments such as functionalities, interactions, and animations. After that, the game was tested again, this time in classrooms, with groups of students. These tests were performed with 6 different classes, which had the average of 20 students each, of the second and third elementary years (in Brazil, third and fourth) for 30 minutes.

The last steps were to extract possible rules of gameplay and analyse, through questionnaires, if the children understood the game's purpose, the subject addressed and the need for conscious use of drinking water available in their homes.

3.2 Gameplay

Throughout the study, the game is functionalities can be observed through the game skeleton, shown in Figure 2. Within the game, children will find real problems of non-water-conscious consumption, as faucets and showers poorly closed and people washing sidewalks and motor vehicles with excessive water, at home environments, like garden, bathroom, and kitchen.

Figure 2 – The skeleton of gameplay



Source: The authors.

At the top of the game screen, there is a bar, which symbolizes the amount of water available for consumption. This bar decreases its value gradually, according to the misused elements consumption's flow. It is an analogy for "water is life". To contain excess consumption, the child should contact the interface element and decide to solve the problem or not. As the child solves these excess consumption, the water bar will take longer to be completely empty. If the water bar becomes empty, the child loses the game and s/he starts all over again. Otherwise, s/he finishes this stage, s/he will move to another home environment (new stage).

Each environment has some collectible items, like pipes, buckets, reservoirs, and gutters. At the end of all stages, the players have the opportunity to assemble equipment that reuses rainwater and, thus, obtain extra scores.

3.3 Residential Consumption Flow

Following the methodology presented in section 3.1, firstly, the development team researched about residential flows of consumer activities and the equipment used. According to Gonçalves et al. (2005), it is estimated that washing a car with a hose can use up to 560 litres of water in 30 minutes, as well as using a hose to water the garden and wash the sidewalk.

In addition to consumption in everyday activities of our daily lives, there are substantial losses of drinking water through possible leaks and equipment failures. In Table 1, we can see the most common leaks with their consumption volumes (OLIVEIRA, 1999; GONÇALVES et al, 2005).

Table 1: Estimated Volumes Lost in Leaks

Equipment	Consumption	Estimated Loss
Taps (washbasin, sink, general-purpose)	Slow drip Average drip Fast drip Very fast drip Fillet ø 2 mm Fillet ø 4 mm Leak inflexible	6 to 10 litres/day 10 to 20 litres/day 20 to 32 litres/day > 32 litres/day > 114 litres/day > 333 litres/day 0.86 litres/day
Urinal	Visible fillets Leak inflexible Log leak	144 litres/day 0.86 litres/day 0.86 litres/day
Showers	Visible fillets Leakage in the crockery Valve fired when operated Log flush Pour into the supply pipe near the wall	144 litres/day 144 litres/day 40.8 litres 0.86 litres/day 0.86 litres/day

Source: Oliveira, 1999; Gonçalves et al., 2005.

With these values, we can develop the logic of the game, where each equipment has a different weight into the game as well as leaks and failures that the player must address to achieve the game goal. For example, if the player finds a leaking tap, s/he will have the

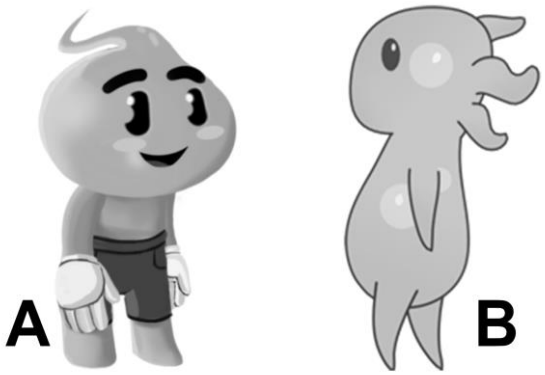
opportunity to correct this problem, or if a hose is used to water the garden, the player can change to a watering can.

3.4 Graphical Interface and Mascot

As discussed in the Section 2, a serious game is not just for entertainment purposes, but it is necessary to look for ways to make the game playing, architecture and aesthetics enjoyable. Therefore, two mascots were created, as shown in Figure 3, to motivate and represent the children within the game environment, also seeking for some similarities with the subject addressed.

Concerning the project to be online and accessible, a website was created. Hence, it is possible to access and disseminate the game, as the website also contains information about the project, its objectives, publications, and results (http://sma.c3.furg.br).

Figure 3 – Mascots

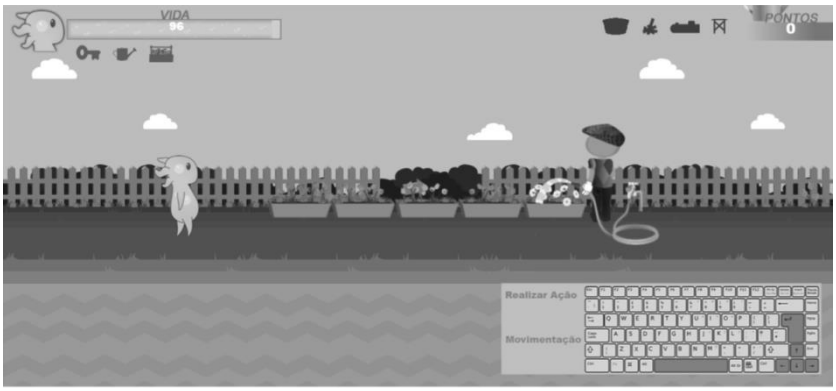


Source: The authors.

In Figure 4, the game's graphic interface is presented. It follows the logic of the skeleton proposed in Figure 2: the player, symbolized by the mascots; In the upper left corner, the bar of life that symbolizes the amount of water still remaining; A gardener watering the garden with a hose, being a problem of waste of water to be solved by the player (one of the situations proposed in this game stage); And a collectible watering can, which, after in the player's possessions, s/he could use to help the gardener, and change the situation. During the stage, other objects are also collectible, so that the player solves other problems, as well as set up equipment for water reuse at the end of stages.

The map was made using the software Tiled Map Editor, which helps to construct 2D maps, enabling to set places where items and objects will be, the frame they will start and also to set attributes to each object[1].

Figure 4 – Graphic interface of stage 1, which represent a garden



Source: The authors.

3.5 Database

Concerning the game to be developed with quality and to obtain more robust versions and even better results, the database that stores the characteristics of the player is being implemented. Therefore, the database has the structure of REM (Relationship-Entity Model), as shown in Figure 5, where the tables are defined:

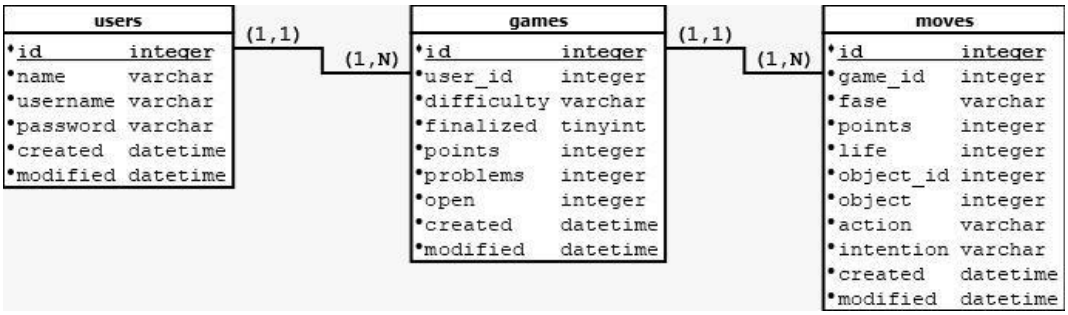
• Games: saves all games played. Therefore, it contains the difficulty selected by the player; whether the game was finalized; score obtained by the player; how many problems s/he has solved in the game; how many problems s/he has not solved; and when the game was created or modified;

• Moves: saves each player's action through the game. It contains if the player closes or opens a faucet and collects an item. Therefore, the game ID; the stage that was played; the score in this game; the player's remains life; the object ID that was made the action; the class of this object; the action performed on this object; if the player's intention was good or bad; and when this movement was made or modified;

• Users: this table was the last one implemented. Once it was not possible to find the data about for one player by the other two tables, the generation of "users" was necessary. Besides, when the first data mining was made, it was noticed the need of get specified data of players, that is, no matter how many times the player played, get the data to study his/her strategies.

Figure 5 – REM of the game database

[1] https://www.mapeditor.org/



Source: The authors.

3.6 Website

For the project presentation goals, a website was the best choice, because it was wanted to reach most children as possible, as well as have easier access to the platform. Besides, it was implemented using the technologies HTML5, CSS and JavaScript for the front-end and the framework CakePHP for the back-end.

Figure 6 – Web home page layout (in Portuguese)

Source: The authors.

Figure 6 shows the main page of game's web page which gives an introduction about the water problem. As shown in the image, the game was created in Portuguese. Log in on the system is needed because of the table Users, created to refine data according to the player.

The communication with the database is done with PHP, through the framework CakePHP. This is an open source framework implemented with MCV (Model-Controller-View) programming pattern (DĀSA, 2016).

The game itself was developed in Object-oriented JavaScript, using a framework called Quintus[2]. This framework has methods which implement physics, interactions between objects, sounds, menus, etc. In tables, try to avoid the use of coloured or shaded backgrounds, and avoid thick, doubled, or unnecessary framing lines. When reporting empirical data, do not use more decimal digits than warranted by their precision and reproducibility.

2 http://www.html5quintus.com/

4 Results and Analysis

4.1 Mascot Names

Two weeks before the tests, a banner was left in a school, in order to promote the "election" of mascots' names. Two mascots (Figure 3) were illustrated on the banner and they were identified with numbers 1 (Figure 3A mascot) and 2 (Figure 3B mascot), since each child would have to vote for a name to each mascot. Next to the banner, a box was provided to serve as a ballot box, allowing the children to deposit their votes in an anonymous way.

Of all the groups, 62 children voted and the choices were "MC Gotinha", for number 1 and "MC Gotão" for number 2. In Brazil, funk music style is very famous, and the funk singers are called MCs. "Gotinha" means 'a little water drop' and "Gotão" means 'a big water drop'. Therefore, these names were used for the mascots, both in the game environment and in the project is documentation.

4.2 Post-game Questionnaire

An online questionnaire was made available through Google Forms (a link to access was provided in the game interface). The main idea was to collect information from children who played the game, being answered after the play. Hence, it is possible to make improvements in the gameplay and to know if the project was reaching its goals. The questions asked on the questionnaire are:

1. Name, age and school level.
2. Do you like computer games?
3. Did you like the water game?
4. Did you experience any difficulty during the water game?
5. If yes, what was it?
6. Would you change anything in the game? What?
7. Would you use what you have learned from the game at your home?
8. If no, why?
9. What do you think the water game wanted to teach you?

Questions 1, 5, 6, 8 and 9 were open (descriptive) questions. Questions 4 and 7 had two options: "Yes" and "No". Questions 2, 3 and 4 use the Likert Scale (Really enjoyed, Enjoyed, Indifferent, Like little, Not Like).

The first tests were carried performed the project is member, to analyse if all features were correctly implemented.

The tests with students were done with the 4th grade of one elementary public school at Rio Grande. About 40 students participated (three different classes), and their average age was 9 years-old. The class teacher was present with them during the tests the whole time. The children played approximately 20 minutes and answered the questionnaire at the end of the tests.

About the post-game questionnaires, Figure 7 shows the sentences of questions 2 and 3, which used the Likert Scale from 1 to 5: 1 = Really enjoyed it and 5 = Did not like it. Most players answered that they liked computer games a lot and that they liked the water game. Figure 7 shows that most of the answers were 1 (really enjoyed). However, there are some answers to numbers 2, 3, 4 or 5. There are also some interesting answers about question 6 (things to change in the game), where some students gave the following suggestions:

"I want to kill someone";

"I did not like jumping in the clouds";

"The clothes";

"Turtles and little critters";

"I wanted to have a game for two people".

The question 9 is about what the students understand about the main goal of the game, some of the answers were:

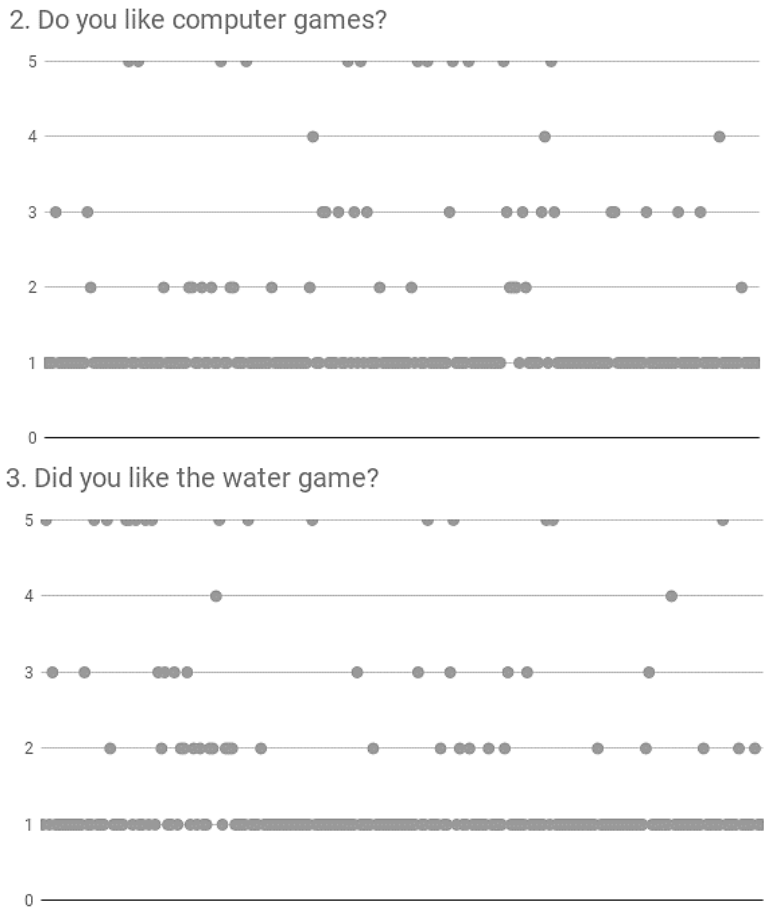
"The game teaches me how to take care of the environment";

"Help the plants";

"Do not waste water".

It can conclude that they have understood the main idea of the game and that it would be more enjoyable if some other enemies – such as critters – were put on the game, to make it more challengeable.

Figure 7– Answers from questionnaire for questions 2 and 3



Source: The authors.

4.3 Data Mining Results

During the tests, 19,784 instances were acquired. In the first data mining, the J48 algorithm for Decision Trees technique was used, in the software WEKA (WITTEN et al., 2011), with its standard metrics and the chosen classifier attribute was the players' action (good or bad action during the game – the attribute "action" in table Moves of REM – Figure 6).

The correct classification of the technique was 98.48%, which shows the database has solid data. The confusion matrix generated, showed on Table 2, indicates that the only false-true value was that the algorithm labelled a collected object as a game loss. These data, though, refer to the tests performed in 2018, due to the game being in development before that year.

Table 2 – Confusion matrix of the tests performed in 2018

Classification	A	B	C	D	E	F
A = Open an object	**574**	0	0	0	0	0
B = Start the rain	0	**334**	0	0	0	0
C = Collect an object	0	0	**4093**	0	**3**	0
D = Close an object	0	0	0	**4459**	0	0
E = Lose the game	0	0	0	0	**8262**	0
F = Finished the game	0	0	0	0	0	**467**

Source: The authors.

In this data analysis, the Users table (shown in Figure 5) was not used, because its inclusion occurred after these tests. These tests were conclusive to create this new table because it was not possible to obtain each personal strategy of the players. Therefore, in the future, it is hoped the results have the personal strategies used for each player after the mine, because the player could change its computer or play more than once, making it impossible, to cross those data.

5 Conclusions and Further Work

It is important to emphasize that this is a project in progress and, based on the results obtained, it is possible to visualize that its progress presents coherent steps and with very promising results, either in the educational scope (serious game) or in the computational scope (data mining analysis).

As contributions of this paper, it is believed that, with tests, the game could help teachers in the classroom to put more emphasis on the subject addressed, which is of extreme relevance. The game was able, indirectly, to show children how to use freshwater in their daily lives and encourage them to disseminate this idea to family and relatives. The results of our tests, basing to questionnaires, prove that the children had fun and learned about the correct use of water. The data mining approach helped us to understand the data (about errors or missing data) to do, in the future, a complete mine and discover the strategies of each player.

In this first version, the game is available only on the web version. However, a mobile game version has being developed, using Unity, a game engine that supports most platforms and virtual reality[3], since it is wanted to make an offline version. The motivation for this new version is because, according to the Brazilian national census in 2014, there are more mobile phones in Brazil than inhabitants. And, even the lowest social classes have access to smartphones. In this way, a mobile system is available to the majority of the Brazilian population. In Wilson et al. (2015), some advantages of this type of system are highlighted, as the ability to set data standards and link it to other systems.

However, one of the main problems faced when developing the mobile version was the pattern values related to speed and character's life, for example, which could not be the same, because of the different platforms used for the web and mobile version (Unity and Quintus, respectively). It was tested with the same parameters and, though the life bar decrease too fast, the character was too slow, being impossible to finish the stage. Also, it was seen that controlling the character on mobile has a different complexity, leaving the question if the points earned in each version should be the same.

On the web version, the database communication is made with CakePHP, which is not accepted on Unity. In this case, the software SQLite[4] is being studied, which is a library used by Unity community for data treatment. Despite that, it was not certain that it can be used to send

[3] https://unity.com/
[4] https://www.sqlite.org/index.html

the data to the project database. This mobile version is going to be important for making the game available offline.

As future work, more tests will also be performed with elementary school classes, as well as, with more instances in the database, do a wider and more concise data mining. The development of the mobile game's version will be complete and a large number of children will play. To have a more complete game, the main idea is defined the main strategies of players, to create, NPCs (Non Player Characters) to help the players in their decision-making.

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