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Development of a Serious Game for children with hemophilia

Desenvolvimento de um Serious Game para crianças com hemofilia

Desarrollo de un Serious Game para niños con hemofilia

Roberta Mayumi Matsunaga[1], Regina Lúcia de Oliveira Moraes[1], Marcos Augusto Francisco Borges[1], Márcia Aparecica Piccolotto Matta[2], Margareth Castro Ozelo[2]

Keywords: Hemophilia; Video Games; User-computer interface

ABSTRACT

This work describes the development process of the interface of an educational game that is aimed at children with hemophilia. The development and evaluation process used the dynamic Braindraw, Participatory Heuristic Evaluation and Beta Test and involved the end users of the game: children with hemophilia. The hypothesis is that children learn more about the disease through the game, which motivates them in an interactive practice. The experiments performed confirmed that the children with hemophilia learned more about the disease with the game.

Descritores: Hemofilia; Jogos de vídeo; Interface usuário-computador

RESUMO

Este trabalho descreve o processo de desenvolvimento da interface de um jogo educativo destinado à crianças com hemofillia. O processo de desenvolvimento e avaliação foram realizados através das dinâmicas Braindraw, Avaliação Heurística Participativa e Teste Beta e envolveu os usuários finais do jogo: crianças com hemofilia. A hipótese é que a criança com hemofilia parende mais sobre a doença através de um jogo, que as motiva de foma prática e interativa. Os experimentos realizados confirmaram que as crianças com hemofilia aprenderam mais sobre a doença com o jogo.

Descriptores: Hemofilia; Juegos de video; Interfaz usuario-computador

RESUMEN

Este artículo describe el proceso de desarrollo de un juego educativo destinado a la interfaz hemofilia niños. El proceso de desarrollo y la evaluación se realizó mediante las dinámica Braindraw, Evaluación Heurística Participativa y Pruebas Beta y los usuarios finales involucrados en el juego: los niños con hemofilia. La hipótesis es que los niños con hemofilia parende más acerca de la enfermedad a través de un juego, lo que motiva la foma práctica e interactiva. Los experimentos confirmaron que los niños con hemofilia han aprendido más acerca de la enfermedad con el juego.

[1] Faculdade de Tecnologia Universidade Estadual de Campinas - UNICAMP, Limeira (SP), Brazil.
[2] IHTC Cláudio L.P. Corrêa, INCT do Sangue Hemocentro Universidade Estadual de Campinas - UNICAMP, Campinas (SP), Brazil.

Autor Coorespondente: **Roberta Mayumi Matsunaga**
e-mail: **robertamatsunaga@gmail.com**

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INTRODUCTION

Hemophilia is a disease that affects boys from birth, so it is fundamental that the child learns his limitation in order to have a healthy physical development. This requires special care to avoid episodes of trauma that may compromise the child when he becomes an adult. According to the Brazilian Ministry of Healthy, there are more than 10,000 people with hemophilia, registered in Brazil, and the country is the one with the third highest number of individuals with this disease in the world[1].

However, children who suffer from hemophilia do not have enough quality educational material on hemophilia and it is a problem to make these children conscious about their disease. In order to inform these children in a ludic and motivational way, this project aimed to develop a prototype of an educational game, called Hemotion, with information about the disease. The purpose was to develop a game that could work like an entertaining way to inform, enlighten and encourage appropriate behaviors of children regarding to the disease they will face throughout life.

Educational games should give to the player a critical environment, providing a pleasant way to build their knowledge. The combination of computers with games has become more efficient as it joins the benefits of educational games with the attractive power of computers[2].

This work describes the process of creating the interface of the educational game Hemotion. Hemotion intends to assist children with the disease to obtain a better understanding about hemophilia. The game will emphasize not only concepts about the nature of the disease, but also about how to deal with risk situations that may aggravate the clinical state.

The aim of this educational game is awareness, avoiding punishment for "errors". The game was consciously designed that do not affect children negatively. Some important points of the disease are discussed, such as practice of sports, coagulation factors, presence of inhibitors, the importance of the multidisciplinary team, etc.

This is a multidisciplinary project that was developed in the *Laboratório de Informática, Aprendizagem e Gestão* (Laboratory of Computer, Learning and Management) of The School of Technology along with the IHTC "Cláudio L. P. Corrêa" from INCT do Sangue Hemocentro, both from the University of Campinas, in São Paulo, Brazil. The project developers have the assistance of the multidisciplinary team from Hemocenter composed by doctors, physiotherapists, nurses, educators and psychologists.

The realization of the dynamics was approved by the Ethics Committee in Research of the School of Medical Sciences, UNICAMP (FCM / UNICAMP) in accordance with Resolution No. 196 /96 CONEP (National Committee for Ethics in Research). This work is supported by a grant from the Novo Nordisk Haemophilia Foundation.

HEMOPHILIA

Hemophilia is a hereditary bleeding disorder. Its recessive inheritance is related to the X chromosome. As a consequence, the disease affects almost exclusively males, while women are, in most cases, asymptomatic carries of the gene that causes hemophilia. The disease is caused by a deficiency of the coagulation factor VIII or the factor IX. The lack of the coagulation factor VIII characterizes the hemophilia and the lack of the factor IX characterizes the hemophilia B[3].

The main characteristic of hemophilia is bleeding, especially in the joints and muscles, usually occasioned by traumas. These bleedings, in several times, may cause muscle and bones impairment, pain, osteoporosis, structural deformities, functional limitation and, as a consequence, disability. In order to avoid bleedings, people who suffer from hemophilia have many physical activity restrictions.

As consequence, boys with hemophilia face many difficulties due to their limitation in physical and recreational activities. There is also a need for frequent intravenous administrations of the deficient coagulation factor, and this procedure causes discomfort and pain.

Children with hemophilia need educational material to deal with the questions concerning the disease. The game described in this paper, will teach properly behaviors and self-care management to those who suffer from hemophilia. This category of games, which intends to support learning, is called Serious Games. The development of educational materials, especially in a playful and interactive way, can be an important tool to help the patient to understand, accept and participate in issues related to the disease.

SERIOUS GAMES AND RELATED WORKS

Ludic has lots of influence upon the growth of a child. There are many benefits, such as: learn, make decisions, stimulate the curiosity, increase pro-activeness and self-reliance, verbal and corporal language development, and increase of the concentration [4]. Due to its characteristics and benefits, games can be considered a powerful educational tool.

Games with goals of entertain and educate are called Serious Games[4]. Although there is no precise definition for it, Serious Games aim to stimulate practical day-by-day situations. This kind of game intends to provide the training of professionals, making decision in critical situations as well as the awareness of children, youth and adults, in the education of specific topics. Serious Games use the well-known strategy of the game industry to turn the everyday simulations more attractive. At the same time it aims to stimulate the learning and the construction of concepts.

The medical field, since the 80s, makes use of games to get better results in physical rehabilitation and patient adherence to treatment[5]. Some patients might be reckless during the treatment; therefore, according to Kato[5], games can be used strategically to help them out to become more aware about the treatment. The patient may fail to correctly perform the treatment for different reasons. The most commons ones are pain and discomfort (for example: chemotherapy) and not motivating performing tasks (as examples: taking pills and doing physical exercise at pre-determined schedules). To properly perform the procedures prescribed, the patient has to be motivated and engaged in the treatment. The Hemotion, game presented

in this text, was designed to motivate and engage the children in the treatment.

There are many games developed to help patients in the self care process. SnowWorld[6] is an example: the individual who suffered burns is immersed in a virtual reality while receiving treatments. The aim of that game is to distract the patient in this procedure that causes pain and discomfort. A study of eleven patients showed that the game was able to minimize the pain caused by burns up to 35% to 50% of cases[6]; Packy And Marlon[7], Bronkie the Bronchiasaurus[8] are games developed to help childreen with diabetes and asthma respectively. A study with the game Packy And Marlon realized with 59 diabetic children for six months, proved the effectiveness of the game to aid the management of self-care[7]. Another study, with the game Bronkie the Bronchiasaurus involving 50 asthmatic children aged 6 to 16 years showed that immediately after the game and after a month the children's knowledge about the disease and how to manage it increased[8].These games help children to understand the need of a serious self care and provide knowledge to manage the self care in the treatment routine. HemoAction Cards[9], HemoAction Games[9] and MedPro Kids[10] are computational approaches to help children with hemophilia to know more about the disease and its consequences. There was no assessment of the effectiveness of the use of Hemoaction Card, the Hemoaction Game and MedPro Kids found.

The games discussed above were evaluated and they brought strong evidences that they are good approaches when the objective is to help patients to know more about the disease and the treatment. These evaluation studies show that the children were able to learn more about the diseases by playing these educational games.

CONSTRUCTION OF THE INTERFACE - IMPLEMENTATION OF DYNAMICS

The original idea of having a game for children with hemophilia came from a child having this disease. At the start of the game development process, developers have identified the need to involve end users - children with hemophilia, including the mastermind in the construction and evaluation of the interface. The involvement of end users in the development of the design of a computer system is called Participatory Design[11]. Participatory Design is a methodology that includes end users of a computer system in the process of developing the interface[11]. It is a set of theories, practices and studies that aim to support direct end user involvement in different stages of preparation of the design. It is based on a democratic work environment and it is seen as a potentially positive approach to improve the inclusive design[12].

As described above, Participatory Design can be used at different times of a project from problem identification to design detailing[13]. Throughout the project, participatory design techniques can be used to help the project developers to know the desires and needs of the user. Moreover, users have the opportunity to rethink on their work process. There are many techniques that promote participatory design. Each project has its particularity and specificity: it is up to the project developers to study the need, or not, of using participatory design techniques.

In this project we chose to perform three dynamics with the involvement of children with hemophilia in school and preschool age. The dynamics were designed to bring the child with hemophilia for the development of the game interface and catch their wishes related to the game. The dynamics were entitled Braindraw, Participatory Heuristic Evaluation (AHP) and Beta Test, and all of them were attended with the participation of children with hemophilia who were observed by a multidisciplinary group involving professionals of Health, Education and Computing Science.

The following subsections present the first dynamic based on Braindraw (Subsection A), the second dynamic based on AHP (Subsection B) and, finally, the last dynamic based on Beta Testing (Subsection C).

Braindraw

BrainDraw is a participatory prototyping dynamic. This is a dynamic made in molds of brainstorming round-robin system (tournament or competition where each participant faces every other for the same number of times). In this technique, the user can draw what is on his mind without receiving criticism[14]. The need for conducting dynamic structure is simple. Pencils, pens, paper, etc are required. Tables or seats placed in a circle can be used, so the users can change seats or change the paper sheets.

The Braindraw dynamic was made as follows: each participant performed an initial design on a blank sheet. After a predetermined period of time, each participant passed along their sheet to the participant on his left and, in return, received the drawing of the participant on his right. The participant should then complement the design received. At the end of a set period of time, the participant repeated the transition of sheets. This procedure is repeated until all participants had drawn on all sheets, which characterizing the round-robin. At the end, all participants selected democratically the drawing that most pleases them. With the selected drawing in hand, participants performed a final version.

The dynamics was performed in a treatment center for blood disorders, including hemophilia. Ten children attended the dynamic and they were divided into two groups. The first group, included five children aged between 9 to13 years (mean age 10.8 years). The second one included five children aged between 5 to 8 years (mean age 6.4 years)[15].

To contextualize the children with hemophilia, the developers proposed the following situation : " You are in front of a computer. On the screen you have a game with a character with hemophilia. You can move your character and help him to make the right decisions. The character will face problems related to the disease throughout the game. You should guide him to choose the best way.

After contextualizing the dynamic, and holding all the

material available (sheet of white paper, pencils, colored pencils, crayons, eraser), the dynamic began and it was divided into four rounds: Main Character, the Coagulation Factor, the Inhibitor and Game's Scenario. Each round provided elements that were considered for the development of the whole game interface[15]. Figura 1, 2 and 3 show examples of contributions made in the dynamics.

Figura 1 illustrates the proposed elements for the construction of the Main Character. The characteristic of element 1 provided the skin color of the character - the constructed character (element 5) has dark skin. The element 2, provided the shape of the rounded eyes. From the element 3 it was inspired the model and color of clothing, green shirt and blue shorts. Finally, from the element 4 it was inspired the physical type.

Figura 1 - Selection of some dynamic elements to build the main character.

The drawing in the center of the Figura 2 is the element that inspired the coagulation factor, mostly the drop format and the belt.

In Figura 3, we see another example of children contribution. The contribution came from the round scenario: the children were asked to imagine how would be the game scenario. One of the children drew the scenarios based on a blood vessel, including other elements such as the Coagulation Factor and Inhibitor. This scenario has being used at some stages of the game.

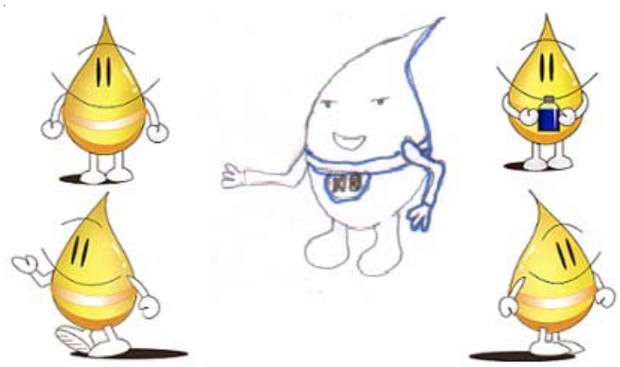

Figura 2 - Compilation of some results for the dynamic formation of Coagulation Factor.

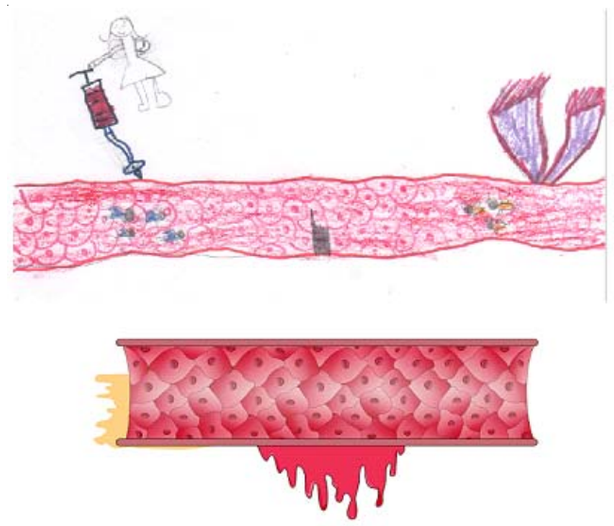

Figura 3 - Compilation of some results for the dynamic formation of a Game Scenario.

Participatory Heuristic Evaluation

The development of the first version of the interface was performed with the aid of end users of the game. Similarly, the developers chose to follow the same approach evaluate the game. Another dynamic was carried out with children that allowed developers to know how friendly and usable the game interface was.

The methodology used was the Participatory Heuristic Evaluation (AHP). AHP can measure the usability of a system through the use of specific rules with the participation of end users. It's a cheap, quick and effective technique to evaluate the interface of a system[12]. It is noteworthy that usability is the term used to define the practicality and convenience with which people access a system, service or product[16]. The evaluation is based on recognized principles of systems interfaces. These principles are called heuristics.

Muller[12] defined a list of heuristics that are subject to review during the Heuristic Evaluation. The titles of the selected group of heuristics is "System Status", "User control and freedom", "Consistency and relevance", "Tasks and supporting the work".

Six children from 5 to 10 years old participated in the AHP dynamic (mean age 7.1 years)[15]. To conduct the dynamic AHP, the project developers gave the same context that was used in the dynamic Braindraw. Following the explanations, each children had access to the game Hemotion in a laptop.

During the dynamic, the observers analyzed the interaction of the children with the game and were able to make notes on behaviors observed. Another positive point of the dynamic was a questionnaire completed at the end. In this questionnaire, the children that were part of the dynamic could give their opinion about what they liked and did not like in the game.

This work shows two major points observed during the second dynamic. The first is an unexpected behavior in the sequence of the game, which was only detected in the dynamic AHP. In the analyzed version of the game, if

the child did not choose to take the Coagulation Factor, and then choose to play football or play catch-up, the main character get hurt and he is directed to the Factor Game, a game in which the Coagulation Factor enters in action to treat bleeding. This sequence of the game can be viewed in Figura 4.

When one child realized that if he chose not to take factor and even so chose to play football, he would be directed to the factor's game, he told the others to do the same: "Cool, do not take factor and play football. You will play the factor's game!". And so it was. All the others followed that example and considered funny and commented: "I want to do it, too." The game developers concluded that the sequence shown led to an inappropriate conclusion. They felt "rewarded" by not following a proper attitude.

When the character takes no factor and plays football / catch-up the game displays the image in Figura 5. Children, in general, expressed feelings of shame and apologized to the character. One child was sad and scared to see the image. The other children used phrases like, "Poor", "Sorry".

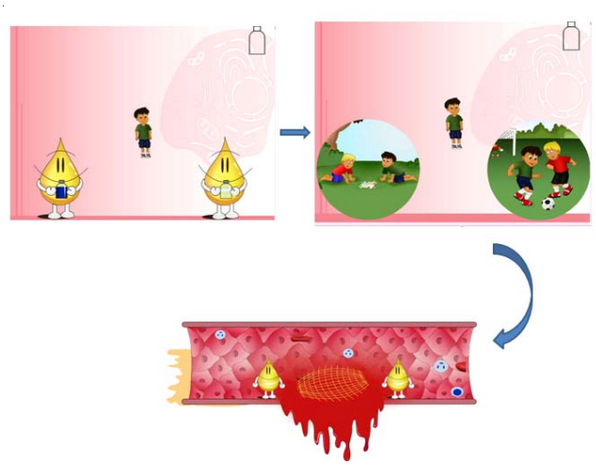

Figura 4 - Following the game performed incorrectly.

Figura 5 - Character with a bruised knee.

Children emphasized in the AHP that the game becomes more interesting the more mini-games it has. Figura 6 shows some of the mini-games built to make the game more interesting and motivating.

Some other points were identified and were corrected by the development team. A new version of the game was built trying to solve the questions of the dynamic. This new version was evaluated in dynamic Beta test. Figura 6 shows some of the mini-games built to make the game more interesting and motivating.

All items observed were analyzed by the multidisciplinary development team and some functionalities of the game were restructured.

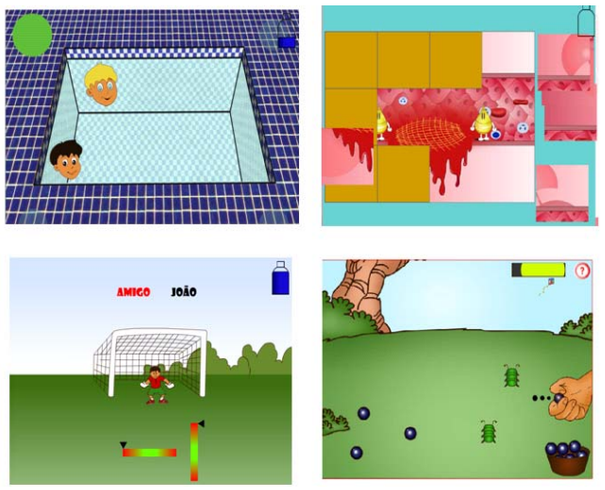

Figura 6 - Mini Games of Hemotion

Beta Test

Within the concepts of software engineering, there are many types of tests that are performed on a product in order to assure their quality, reliability, compliance, etc. Some of this tests are: Unit Testing, Integration Testing, Validation Testing, Systemic tests, and others. At this stage of the game validation process with the users, the project considered the most appropriate is the Validation Testing. According to Pressman[17], validation tests are those performed to confirm that the system complies with the user requirements.

When performing validation tests, one can perform two types of tests: alpha and beta testing. The alpha test is conducted where the software was developed, with the participation of the developer. The beta test is conducted in the user place and without the participation of the developer. Due to restrictions on attendance of end users, the project only made use of the Beta testing.

The latest dynamic required a different approach, counting on children with and without hemophilia. A total of 18 kids aged 5 to 8 years old participated on Beta Test, but just three of them had hemophilia. The result of this dynamic was crucial to the project because it was possible to check what is the understanding that a child who is not a carrier of hemophilia had on the disease after playing Hemotion.

Beta Test aimed at detecting faults and errors while running the game. The observers were also able to check on the child's interaction with the game. Such dynamics showed that children learned the necessary care for hemophilia and the need for factor infusion to prevent and/or treat bleeding episodes.

The Hemotion Screenplay

A child with hemophilia who uses the game, will be responsible for the health and welfare of character with hemophilia. The child with hemophilia should assume the role of 'caregiver' of the character with hemophilia. It is not intended that the player feel like a "player in first-person", thinking the character as himself. During the game, the player will have to help the main character to take the most appropriate action, playing the role of 'guardian'. The player will help the character as a tutor, showing the best way in making decisions among the ones displayed. Each stage represents a day of the week in the life of the character, in order to conduct primary prophylaxis in three days of the week. The player will decide whether or not the character will take clotting factor and the course of the game depends on the attitude taken by the character.

Some mini-games are included in the Hemotion. The player has a stronger interaction with the system in those mini-games. Examples of mini-games are: Puzzle, swimming, soccer and marbles (Figura 6).

CONCLUSION

As described in previous sections, the game design was based on drawings made by children with hemophilia during dynamic Braindraw and were evaluated by dynamic AHP and Beta Testing. It is expected that children have identification with the design, since they participate in the software design.

The first dynamic, Braindraw, allowed developers to meet the wishes of children with haemophilia in relation to the game. The result was that many candidate designs were used as a basis for the construction of the prototype design Hemotion. In the second dynamic, Participatory Heuristic Evaluation was possible to assess the child's interaction with the game. The positives were identified in the game and kept the negatives were worked to prevent negative messages to be transmitted. The third and final momentum, Beta Test, aimed to identify errors while running the game. One of the most interesting points of this dynamic was the involvement of children who were not carriers of hemophilia and the profile of players that this group came to represent the family and friends who do not have hemophilia and want to learn more about the disease.

The involvement of children with haemophilia in the development phases of design, usability evaluation and validation were extremely important to build the game. That's because it can not find the necessary foundation literature that describes the behavior of a child with hemophilia that can be used as a parameter for building a game. The dynamics became necessary because it was a group of children who had a different from other development since the instructions of education they receive are distinct due to the limitations faced since childhood. As a result, these children have a different lifestyle that results in responsibilities regarding prophylaxis and limitations on physical activities that can be practiced. The combination of three dynamic was very positive for the project, the approach of the end user of the game during the construction gave developers a broader picture of how the game content should be addressed.

The experience of using dynamics involving children with hemophilia during the development of the game was positive. The use of three dynamic, in the same project, was an original proposal of this work. The results were interesting, and may be adopted as a framework for other development projects of educational games for children with various diseases.

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