

Exploring Playful Learning: Development of Interactive Game using Block Calculator

Explorando a Aprendizagem Lúdica: Desenvolvimento de Jogo Interativo Utilizando Calculadora de Blocos

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Abstract

Games have great educational potential and attract people due to the interactivity they provide. Using playful elements in education can be promising, especially considering that the new generation grows up immersed in the digital world, acquiring skills naturally when interacting with technological devices. Technology can be an important ally to bring teaching closer to playfulness, allowing the time spent on electronic devices to generate positive results in education. In this sense, an educational game was developed for the Android platform, using the LUA programming language, the Corona SDK emulator and the Sublime Text text editor. The objective of the application is to help teach Mathematics through the block calculator, stimulating cognitive and social aspects, making studying a pleasant moment through challenges that encourage discovery and creating a pleasant study environment conducive to learning.

Keywords: Educational game. Games applied in teaching mathematics. Android. Lua. Corona SDK.



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Resumo

Os jogos possuem um grande potencial educativo e atraem as pessoas devido à interatividade que proporcionam. Utilizar elementos lúdicos na educação pode ser promissor, especialmente considerando que a nova geração cresce imersa no mundo digital, adquirindo habilidades naturalmente ao interagir com dispositivos tecnológicos. A tecnologia pode ser uma aliada importante para aproximar o ensino do lúdico, permitindo que o tempo gasto em dispositivos eletrônicos gere resultados positivos na educação. Nesse sentido, foi desenvolvido um jogo educacional para a plataforma Android, utilizando a linguagem de programação LUA, o emulador Corona SDK e o editor de texto Sublime Text. O objetivo do aplicativo é auxiliar o ensino de Matemática através da calculadora de bloco, estimulando aspectos cognitivos e sociais, tornando o estudo um momento prazeroso por meio de desafios que incentivam a descoberta e criando um ambiente de estudo agradável e propício ao aprendizado.

Palavras-chave: Jogo educacional. Jogos aplicados no ensino da Matemática. Android. Lua. Corona SDK.

1. Introduction

Currently, the presence of digital technology is undeniable in almost all sectors of society, accompanying us at different times, whether during leisure, study, work, among others. At every moment, new applications appear on the market, enabling the creation of a large number of games, software and equipment available to an ever-widening audience.

Carcarelli (2009) states in his work that “we live the digital, we are the digital, we do the digital. This is part of us, citizens inserted in the contemporary world, and if you don’t do it yet, you should do it, or will do it soon”. In this context, the attraction of children and adolescents to the digital world is justified, since they often choose to use technological resources available on the internet instead of dedicating themselves to learning in the classroom. They prefer to spend time playing on a computer, tablet or smartphone, participating in chat rooms or browsing more attractive websites than dedicating themselves to studying, reading or attending school (COSTA; SILVA; NASCIMENTO; 2010).

Even in schools that already have access to technology and social networks, teachers face difficulties in holding students’ attention in a class. Therefore, it is essential to invest in technology in the educational area, since it is currently more challenging to engage children through traditional teaching methods. According to Guisso et al. (2019), educators and teachers face the challenge of creating a learning environment that is stimulating and enriching.

The ludic activity has the ability to promote development, and at the same time delight children, adolescents and adults, providing pleasure to those who perform it. In a world governed by rules that need to be known, the game not only promotes intellectual development, but also trains the player to live socially in this world. By simulating situations that the player experiences, the game can even extrapolate the concrete, exercising the imagination and enabling experiences that would not be possible in real life (THUROW et al. 2021).

The use of digital games as a teaching tool has become increasingly common around the world, as learning through this resource is a constantly growing trend. According to Ceni et al. (2017), the integration of technologies in the classroom, combined with digital literacy through reading and writing practices, establishes a solid foundation for the development of new educational tools that can be used in the teaching-learning process.

Arruda (2005) presents the relevance of informatics as a learning tool in the educational context. These educational tools are responsible for stimulating and favoring the acquisition of knowledge by children and adults, through a socialization process that contributes to the formation of their personality (BIANCHESSI et al. 2019)

Since its emergence, digital games in their various categories have been used as a form of entertainment, allowing players to exercise reasoning and develop skills. With the advancement of digital technologies, games began to play an important role as learning tools, going beyond simple entertainment and incorporating educational objectives. For example, they offer ways to develop reading and writing skills, practice arithmetic operations and explore interdisciplinary content. From this perspective, through Educational Digital Games it is possible to create an attractive and pleasant teaching environment, associating entertainment with education. In this way, they become pedagogical resources that educators can use to conduct more engaging classes, resulting in a change in the traditional teaching model (SOUZA, 2013; BIANCHESSI et al. 2019).

The advancement of Science and Technology creates a unique opportunity for modern society, where knowledge is the fundamental basis for sustainable development through investment in regional research centers. Today, we have available on the market a large number of equipment with technology suitable for games, easily accessible and mostly using the Android platform. The Android system is open source, which allows modifications and redistributions, which is one of the reasons for the growing use of the system. It received a lukewarm reception when it was first unveiled in 2007, but since then, Android has grown over time to establish itself as the most widely used mobile operating system across the world, as well as being known for providing a faster mobile experience. By the end of 2022, over 5.4 billion smartphones had been sold, making Android the best-selling mobile operating system of all time (Global Mobile Statistics, 2022).

Android applications run on a virtual machine called Dalvik. Virtual machines emulate, via a software layer, the functionalities normally found in hardware, thus ensuring application portability and security. From a conceptual point of view, Dalvik resembles the JVM (Java Virtual Machine) the virtual machine used to run programs written in the Java programming language (LECHETA, 2010).

The continuous advancement of mobile devices, the emergence of new business models related to them and the growing demand for greater access to technology in society arouse the interest of development professionals for the educational games market, mainly applications for mobile devices that have 5.48 billion users worldwide (GLOBAL MOBILE STATISTICS, 2023).

With the wide availability of applications in the current market, the creation of games has aroused the interest of managers, teachers and students. This is due to the fact that this activity offers participants a hands-on opportunity to get involved in the modeling process, strategy development, algorithms and GUI creation. The game "Calculando Blocks" is an example of an application that combines mathematical knowledge and falls into the category of educational games.

2. Theoretical Reference

Technology exerts a great power of attraction on children, young people, adults and the elderly, making it an essential resource for the dissemination of information and communication. In view of this, the use of technology in education has grown considerably. In the context of a society that prioritizes continuous technological innovation, it is essential to use technological resources in education in order to explore different ways of disseminating knowledge, stimulating learning and making the educational process more captivating (THUROW et al. 2021).

Playing, since the beginning of civilization, is an activity of children and adults, as it is not restricted to childhood, although it is predominant in this period. For Thurow et al. (2021), games and recreational activities are present in people's adult lives in the form of games. They aim to stimulate the natural drive to learn.

In this way, the challenge in the development of educational digital games is to guarantee them the necessary characteristics to consolidate them as a didactic-pedagogical resource, on which the educator can rely to extend the teaching of a certain content, uniting fun to the dissemination of knowledge, knowledge, skill acquisition and ease of teaching. The game is a ludic activity in which children or adults participate in a situation of social engagement, in a determined time and space, with its own characteristics, delimited by the rules of participation in the imaginary situation (BIANCHESSI et al. 2019).

Games are efficient instructional tools, because they entertain while motivating, facilitate learning and increase the absorption capacity of what was taught, exercising the player's mental and intellectual functions, also allowing the recognition and understanding of rules. For Caniet al. (2017), educational games are very close to other constructivist learning methods, such as simulations, microuniverses and adventures, and it has been verified that all contribute significantly to placing instructional content in an interactive context, even if restricted by rules and models. of use inherent to their educational objectives (GAIO; PETRY, 2022).

Cani et al (2017) point out some characteristics that must be present in a digital educational game, such as: attracting the interest and enthusiasm of the student; the use of audiovisual resources, maintaining curiosity and fantasy; the exploitation of competitiveness; clear instructions and objectives; help available; performance report; provide richness and complexity in solving problems; and the requirement to apply logical rules and plan strategies.

The development of electronic games has a very broad scenario, where different types of professionals are needed to design the project, generating a widely variable development cost that changes according to the structure of each company or the techniques and platforms used, being that to estimate the same, it is important to separate all parts of the project for a more detailed analysis of the whole (CANIet al. 2017).

Neto (2013) develops an application to be used in Mathematics teaching, where users can develop arithmetic operations and apply fractions. The teaching of mathematics and logic using a digital game for the Android platform is developed with the aim of presenting, in a different way, situations and problems that children need to exercise knowledge introduced in the classroom.

The main idea to be developed is that digital games, as educational tools, can help to develop knowledge and cognitive skills, encouraging strategic thinking and helping to solve problems. To achieve these goals, the project was divided into four stages, namely, Analysis and Planning, Game Modeling, Implementation and Testing with experts. The result demonstrated by the author shows user approvals, stating that the application contributed to the teaching-learning process.

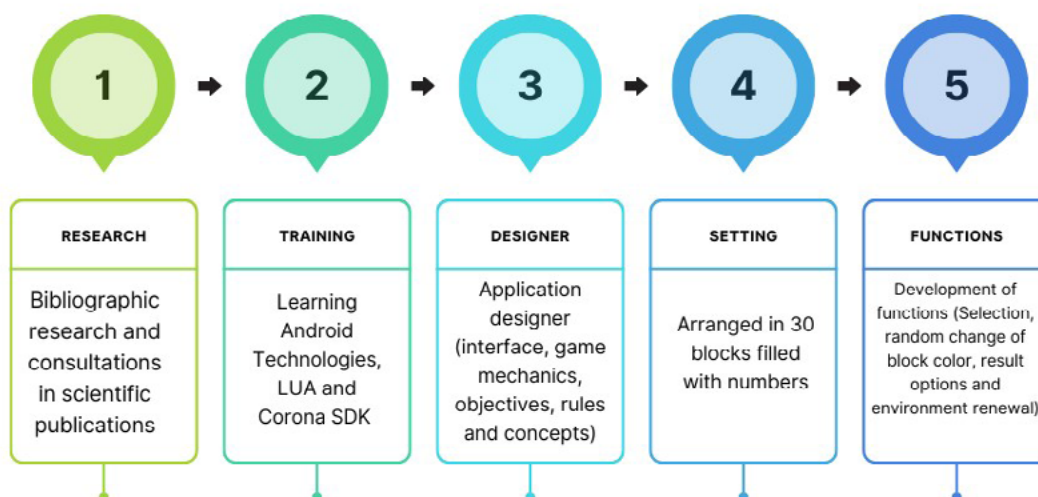
Digital educational games are designed to amuse and enhance the learning of concepts, contents and skills embedded in the game, and can provide the student with a rich and complex learning environment. The characteristics that made digital educational games intrinsically motivating are challenge, fantasy and curiosity.

3. Methodology

According to Figure 1, the research was conducted following these steps. Initially, a bibliographical research was carried out as a starting point for the development of this study. Consultations were carried out in academic articles and scientific journals that addressed the topic of digital game development, with the aim of identifying the possibilities and directions proposed by the authors for carrying out the project (GIL, 2022).

One of the main mechanisms to be used in this project is the Android Operating System for Smartphones and Tablets. It is currently available for several programming languages and integrated development environments for creating applications for the Android platform.

Figure 1: Research Trajectory



Source: Prepared by the authors

The training carried out by learning the LUA language and using the Corona SDK was guided by the book "Creating mobile applications with Corona" by the author Brian G. Burton, which has a friendly and intuitive didactics, in order to facilitate learning (BURTON, 2012).

After learning the programming language, the design part of the application began. At this stage, the game mechanics, objectives, rules, interface and all general concepts were defined. As an initial project, an application aimed at teaching basic mathematics will be developed, in order to serve students in the initial age groups, being later expanded to other age groups, and adding other levels of difficulty, as well as a more comprehensive content.

The development of the game starts with the scenario selection, where a square with a black background was chosen as the initial project. This scenario can later be changed by a background image that is more suited to the game's purpose. Inside the square, 30 multicolored blocks were created, each containing a number.

Next, the necessary functions for block selection, random change of color and number, as well as result options and game environment renewal were developed.

After creating these basic features, the game was tested on the Android platform.

4. Tools and Development Environment

4.1. Android platform

With the creation of the Android Operating System in 2007, the demand for Smartphones and Tablets grew exponentially. This demand was motivated by the fact that devices compatible with the system are cheaper, in addition to being free for application development (LECHETA, 2013).

Along with mobile devices, there is a growing demand for a new teaching aid methodology, and Educational Games are one of the methods that most attract students' attention (CANIET al. 2017; GAIO; PETRY, 2022). These games can be used on mobile devices, devices with less power and processing that allow mobility and are part of people's lives (COSTA et al. 2010).

Every game or application developer seeks to develop for the platforms that most attract users, but the game or application is not always easy to create. However, the Android Operating System is currently an excellent platform option for developers, as it is constantly attracting many users, in addition to being easy and efficient to program (LECHETA, 2010).

Android consists of an Operating System made for mobile devices such as Tablets and Smartphones and runs on the Linux Kernel (BOVET, 2005), in addition to allowing the development of applications in several programming languages.

The Android development platform is open source and can be changed and modified by many users. But regarding this, Android has a very strong security capability. As it runs on the Linux Kernel system, any attempt to access the system requires user authorization, which can be explicitly denied, protecting the user's confidential information (PEREIRA, 2009).

4.2. Corona Simulator SDK

The Corona SDK (Software Development Kit) is a simulator for developing games for mobile devices. It is distributed by the company Corona Labs. This software's basic characteristic is to allow development with little code, less writing, and with a great final result. Corona uses LUA programming language scripts to develop its applications, providing a variety of API's (Application Programming Interface) such as sprites, object orientation, image and sound manipulation, button development, among others (FERNANDEZ, 2012).

Corona's important features make it an excellent simulator for game development, such as the inclusion of physics (gravity, collisions and friction) and commands directed directly at objects. Its simulator faithfully represents platforms such as the iPhone, iPad, as well as Android tablets and cell phones, gaining a large share of the mobile technology market (FERNANDEZ, 2012).

This package has great development potential, its main advantage being that it can generate compilation for both Apple's mobile operating system (iOS) and the Android system (FERNANDEZ, 2012).

Corona is capable of generating applications for the iOS and Android operating systems, however, to generate an executable file for the iOS system, an Apple Developer account is required, and, therefore, a MAC-type device is required. To create an executable for Android, all you need is to have the Corona application properly installed on a machine with a Windows or Linux operating system. In this case, for its distribution, an account with authorization from the Android platform administrator system on Google Play is required (FERNANDEZ, 2012).

4.3. The LUA language

LUA is a programming language created in Brazil in 1993 by PUC in Rio de Janeiro. It had its development carried out at the Computing Laboratory of the Department of Informatics and Computer Graphics at PUC - Rio (TECGRAF). It is currently being developed at the LABLUA Laboratory, at the same university.

This language was developed by Roberto Lerusalimschy, together with Waldemar Celes and Luiz Henrique de Figueiredo, who, in turn, are still working at TECGRAF. Its creation had as its main focus the development of a powerful, light, fast and flexible language that would be used in applications of other languages such as C and C++, trying to incorporate them with the intention of extending their platforms (MANZANO, 2018). language has gained popularity in the mobile games market due to its flexibility, which has facilitated the commerce of these applications both in Brazil and worldwide. Furthermore, it is considered simple, complete and easy to learn, making it accessible to programmers of all skill levels. The best part is that this language is freely distributed over the internet. This language conquered the national and American market through the growth of its platform. The American market surrendered to its mobility and ease of game development (MANZANO, 2018).

Lua is an extension programming language designed to support procedural programming in general with facilities for describing data. It also offers good support for object-oriented programming, functional programming, and data-oriented programming. Lua is intended to be used as a powerful and lightweight scripting language. It is implemented as a library, written in pure C, the common subset of Standard C and C++.

4.3. Sublime Text

Sublime Text has been a text editor chosen by programmers for being light, simple and with a pleasant interface. This program is very friendly and didactic, it has an interface with different colors to facilitate the understanding and construction of codes, unlike programming language editors that tend to be complicated, especially for beginner programmers (PALEG, 2013).

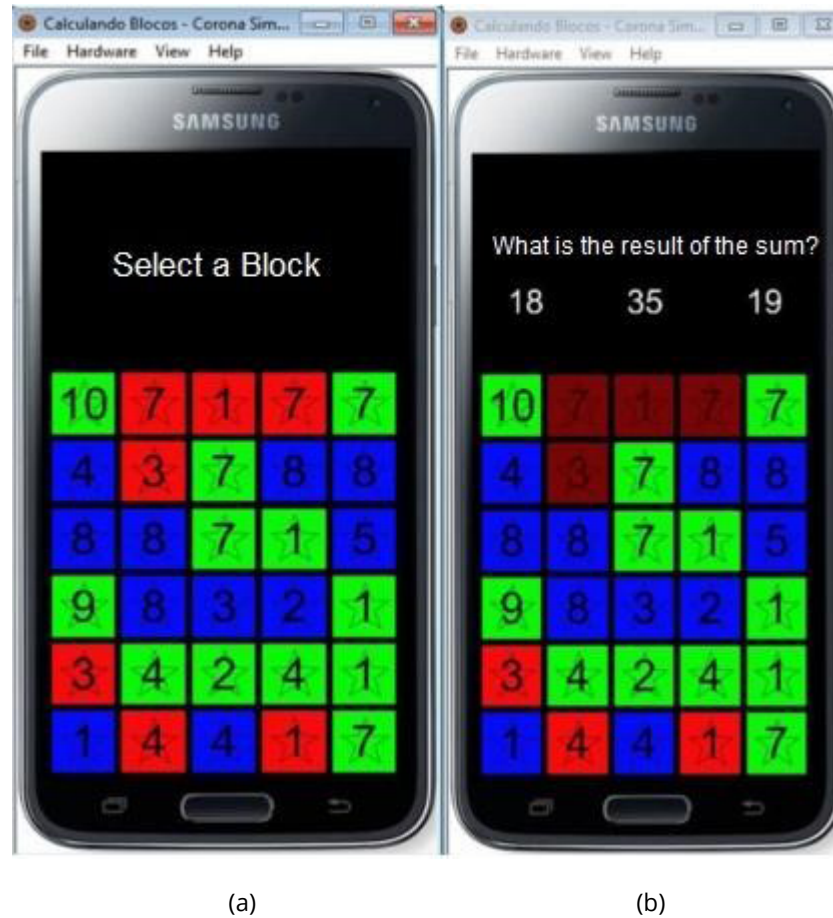
Due to this ease of understanding and favorable characteristics, Sublime Text was chosen to insert the application's source code. This, as its name suggests, is considered a text editor, not an IDE. One of the main points in favor of Sublime Text is the possibility of installing some plugins related to the type of language you want to work with, facilitating the programming stage and making it more agile (PALEG, 2013).

5. Results and Discussion

5.1. Calculating Blocks

Researching the library of mechanisms needed to create an educational game that was ludic and favored the teaching-learning process was quite effective in the development of game strategies, despite the complexity of the problem itself. It became necessary at each stage of creation a new analysis and research for improvement and quality of the content, thus providing a more accurate technique of creation.

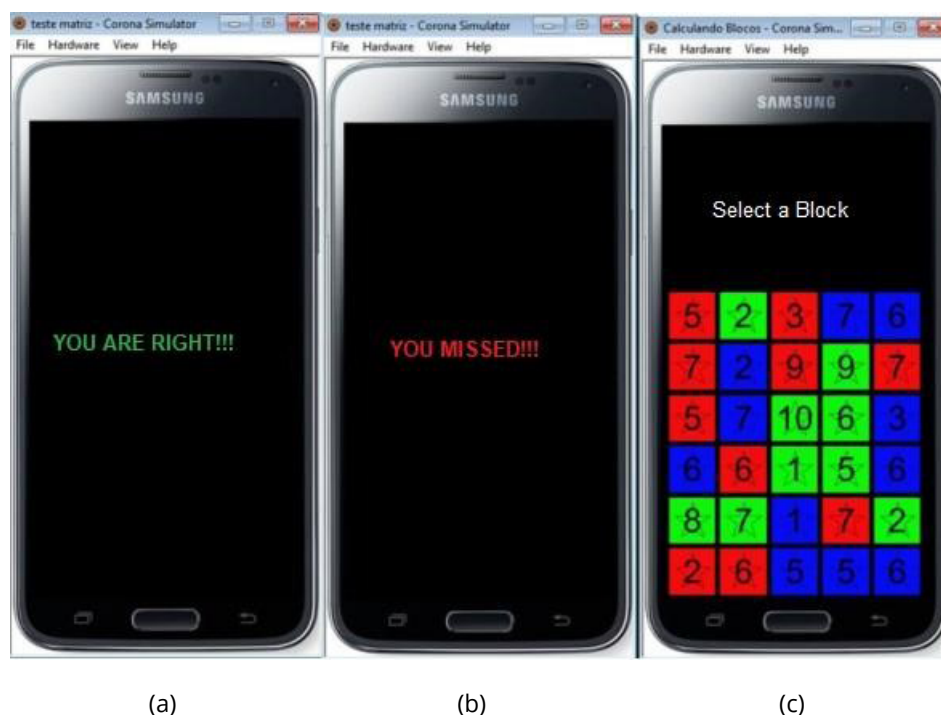
Figure 2: Select a block



(a)

(b)

Source : Authors' image

Figure 3: Right or miss message

Source : Authors' image

The game is very intuitive and interactive, providing learning in a fun way. Initially, the screen shown in Figure 1(a) is displayed, containing thirty (30) colored blocks with a number on each. The block's color, as well as the number, is randomly chosen by a random function. The game prompts you to choose one of thirty (30) blocks ("Select a Block"). By clicking on one of the blocks, the game automatically selects all blocks of the same color that are connected or neighboring, changing their brightness. In Figure 2(b), it is noticed that in the first line the red blocks with the numbers 7 and 1 and in the second line the red block with the numbers 3 had their brightness changed. At the same time, the game asks what is the sum of the numbers of the selected blocks and offers three options to the player, who must perform the operation and choose one of the three options offered. Among the three options there will be one that corresponds to the correct value of the sum. When selecting one of the options, the game will inform you if the choice is correct or not, showing the message "YOU ARE RIGHT !!!", shown in Figure 3(a), or "YOU MISSED!!!", shown in Figure 3(b), and proceeds by refreshing the screen so that a new choice of one of the thirty blocks can be made, as shown in figure 3(c). Note that the distribution of colors and numbers has been modified in relation to the first screen shown in Figure 1(a). The game can be played for as long as the user wants, that is, infinitely. The fact that the game is very easy and intuitive ends up capturing the user's attention, fulfilling the role of entertainment, while at the same time contributing to learning, fixing the content taught in the classroom. In this way, it will really be a tool to help in the teaching-learning process.

5.1. The programation

For the running of this game, there are some predominant functions which are of utmost importance for the functionality of the game. Initially, the function that organizes the blocks and defines their layout in the interface was developed. Along with this function, there are some variables that serve as control parameters for the application.

In the first logical sequence of game programming is the subroutine called 'Table()'. In this function, all program storage tables are created, for example, 'container={}'. Tables created in the Lua programming language differ a little from those created in C++, which are what we call matrices. In Lua, tables resemble what arrays would look like in the C++ language. Variables are dynamically typed. This means that variables do not have types, as only values have types. Thus, there is no loading of variable types, and their own values carry this characteristic. Variables of type 'nil' are defined for variables that do not carry useful values. In this way, the usefulness of this function is to choose one of the three images of different colors at random through a random value and store them in a container, inserting it in a group, similarly, performing the same task for the numeral to be performed the operation sum.

In the 'Position()' function, the task performed is the allocation of each block in its proper position in the program interface. Through the 'for' function there is the positioning of groups arranged in the container. The process of working on programming for Corona is somewhat diverse. At all times, there are indications of positional parameters of structures in the interface, and this position indication is done by indicating the pixels, where this object must be located.

Chart 1: The Analisa function(i)

```
function Analisa(i)
  if aux1[i]==m and aux1[i+6]==m then
    container[i+6].alpha=0.5
  end
  if aux1[i]==m and aux1[i-6]==m then
    container[i-6].alpha=0.5
  end
  if aux1[i]==m and aux1[i-1]==m then
    if aux2[i-1]~=6 and aux2[i-1]~=12 and aux2[i-1]~=18 and aux2[i-1]~=24 and aux2[i-1]~=30 then
      container[i-1].alpha=0.5
    end
  end
  if aux1[i]==m and aux1[i+1]==m then
    if aux2[i+1]~=1 and aux2[i+1]~=7 and aux2[i+1]~=13 and aux2[i+1]~=19 and aux2[i+1]~=25 then
      container[i+1].alpha=0.5
    end
  end
end
```

Fonte: Imagem dos autores

In Chart 1, the 'Analisa(i)' function contains a check to select blocks with the same characteristics. This check includes four contact possibilities - top, bottom, and sides. As storage tables resemble an array in C++, and in the Lua language there is no option to create an array-like structure, it is necessary to make a small code change to resolve this language limitation. If the necessary condition to select one of the blocks directly in contact with the chosen one is true, the structure will be marked with variations in contrast.

Chart 2: The Selecciona function()

```

function Selecciona( )
  for i=1,tam,1 do
    function R(event)
      if event.phase=="began" then
        Reverte()
        if (v1~=nil or v2~=nil or v3~=nil) and (v0==1) then
          v3:removeSelf( )
          v2:removeSelf( )
          v1:removeSelf( )
        end
        container[i].alpha=0.5
      end
      if aux1[i]==1 then
        local m=1
        for i=1,tam,1 do
          if container[i].alpha<1 then
            Analisa(i)
          end
        end
        for i=30,1,-1 do
          if container[i].alpha<1 then
            Analisa(i)
          end
        end
      end
      if event.phase=="ended" then
        Soma( )
        Remover()
        v0=1
      end
    end
    container[i]:addEventListener( "touch", R)
  end
end

```

Fonte: Imagem dos autores

Together with the support of the function 'Analisa()', the function 'Selecciona()', available in Table 2, is used to select the blocks directly beside. In this subroutine is another subroutine that has a very important characteristic for the development of games for mobile devices. The 'R(event)' function is responsible for handling a touch event. This function allows, when touching any part of the device's screen, a block to be selected. This subroutine is considered the main one of the application and is extremely important in the construction and structuring of the application. In the Corona libraries, various activities are carried out. An extremely important function in these libraries is the one that allows us to highlight the blocks in the game's interface with a different contrast. This function is called 'objeto.alpha' and varies the luminous intensity of the object on a scale from zero to one.

In the verification, the subroutine receives the selected color as a parameter and checks if the 'alpha' of the object is less than one. If this condition is satisfied, neighboring objects of identical color are selected.

The subroutine called "Soma()" is responsible for verifying which groups of objects were marked, analyzing the "alpha" value of each block. If the value is less than one, the group numeral is added to the respective values storage variable.

Another extremely important subroutine for the structure of the game is "Restart()", where the arrangement of values in the application's interface is defined. Within this subroutine is the function "Destroi(event)", whose objective is to destroy all groups of blocks when the correct value of the algebraic sum

is selected. This happens to allow the generation of a new series of groups of blocks, guaranteeing the continuity of the game.

The main essential functions for the perfect functioning of the application are those mentioned above. In addition to them, there are also some minor subroutines that contribute to the proper functioning of the game.

6. Conclusion

In the Information Age, educational institutions are increasingly adopting information and communication technologies to enrich the teaching-learning process, with more interactive media and resources. Educational Digital Games emerge as a teaching resource capable of bringing benefits to educational practice, being accessible and effective in disseminating information (BELL, 1973).

However, there are challenges to be faced with adopting these games. Many institutions still do not have adequate infrastructure and educators need to be trained to use these technologies in teaching. Overcoming these challenges is essential to incorporate these resources into everyday classes and virtual learning environments. It is necessary to offer training so that these professionals can incorporate these resources into the daily teaching-learning process. Despite the obstacles, educational digital games have the potential to significantly enrich teaching.

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