The Design of the Academic Life Game AVENTURA DISCRETA

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***Abstract*—This paper presents the digital game project called AVENTURA DISCRETA which belongs to platform genre. The narrative describes the life of a computer student through the character Pequeno Douglas. During the journey, the hero faces challenges divided in five steps: technician degree, bachelor's degree, master's degree, industry job and career as a teacher. This works clams to (i) report the conception and the game design, (ii) contribute with information about the process of development with the community, and also (iii) share the application and the complete open-source project. Allied with techniques of fast documentation and effective game design for small and medium size projects, AVENTURA DISCRETA was developed using SCRUM, an agile methodology used to manage the job, implemented through Trello platform to follow the progress. The code was written in C++ using the libraries OpenGL, SOIL, freeGLUT and OpenAL. The graphical assets were designed using the image editors GIMP and Adobe Illustrator, and the audio assets were made with tools like bfxr and Audacity.**

***Keywords*-Game design; Digital games project; Platform game.**

I. INTRODUCTION

The hardware evolution and the offer of libraries and frameworks of specialized programming allowed an advance on the development of digital games. Being a very consumed entertainment on several age groups, huge studios and indie developers are responsible for the production of high quality games for distinct platforms. Because of that, video games industry has earned more revenue than the film market [1]. It is a notorious ecosystem and a diversified economic chain that embraces the game industry [2]. The conception and execution of a digital game project, considered as an artistic manifestation [3], automatically motivates the search for knowledge in the fields of math, physics, design and animation, music, software engineering, and computer programming, important parts of the creation process. Specialized knowledge in computer graphics, simulation and artificial intelligence are important and necessary concepts to build a good immersive game [4].

In a craft production, made by a small studio or even by a group of dreamer students, the prototype of an authentic and innovative project that maximizes the chances of highlight in the competitive games market is very important. In order to achieve that, the game project must follow a very well defined management methodology, have an immersive and fluid narrative, present a characteristic visual identity and implement efficient algorithms. Such factors, considered essential, not necessarily imply in an initial high investment. However, owning an engaged and qualified team, even a small one, is fundamental for the project success [5].

The game project AVENTURA DISCRETA is presented here along with its means of production used to meet quality factors. In order to conquer an agile execution, the implementation followed the *SCRUM* methodology [6], divided in design and programming stages. As this project is medium size, the design documentation opted for fast and efficient techniques to record the narrative and scenario, characters and relationships, features of scenes, besides other technical information described in [7]–[9].

The narrative develops an academic and professional journey of the main character, Pequeno Douglas, which represents a hardworking and clever student. However, he suffers with the lack of orientation about his professional future. This platform game has a longing design, inspired by old school games. Notwithstanding, there are modern animation elements that allow smooth movements, making the visual assets more ludic. Besides that, the elaborated narrative and the customized arts contribute with the application immersibility.

Therefore, the goals of this paper intend to:

(I) Present the authentic and comic game project AVENTURA DISCRETA, which relates the academic life in computer field.

(II) Report the planning and the development of the game project executed with an agile methodology, planning and control tools, two image editors, and an IDE with free APIs.

(III) Share the game and its source code, which can be downloaded for free, to contribute with the community of students and interested developers.

The rest of this text is organized in this way: Section II presents related games which are basis of inspiration for the creation of this title; Section III exposes the methodology adopted in the building process of the game; Section IV describes the project AVENTURA DISCRETA; Section V reports the obtained results; and finally, Section VI shows the conclusions, additional comments e announces possible further steps.

II. Related Games

Aventura Discreta had as inspiration in regard to the gameplay the following games: *Super Mario World* [10], *The Legend of Zelda* [11] and *Mega Man 2* [12], besides two indie games called *Super Mario Bros Crossover* and *A Lenda do Herói* [13].

Super Mario World is a classic platform game released by *Nintendo* in 1990. In this title, the player controls the plumber Mario, which needs to defeat enemies and pass through obstacles to save the princess kidnapped by the antagonist *Bowser*. Mario can defeat enemies by jumping on their heads, but he gets damaged when it is touched on his sides. There are items during the way that strengthen the main character, giving him special powers. In some levels, the camera moves forward constantly and if the player stays off-screen, lost one life. This resource inspired one level of Aventura Discreta. Besides that, the mechanics and the obstacles were influenced by *Super Mario World*.

Some combat gameplay, like the direction of the sword adopted in Aventura Discreta, were based on the two dimensional RPG *The Legends of Zelda*. This masterwork shows the adventures of Link, a boy who lives in the fantasy lands of Hyrule, where magic creatures lives. During the story, Link must rescue the princess Zelda from his enemy called Ganon.

In 1988, *Capcom* published the platform game denominated *Mega Man 2*, in which the main character is a humanoid robot that uses a laser bean cannon to defeat the repugnant Dr. Wright. The graphic modeling of Pequeno Douglas was based on Mega Man appearance. Also, the projectile launch was adapted to the Aventura Discreta.

Super Mario Bros Crossover is a web based indie platform game, developed by *Exploding Rabbit*. It consists of the same level design and enemies of *Super Mario Bros*, but the player can control, in addition to Mario, other characters like Link, Mega Man, Samus Aran (*Metroit*) and Bill Rizer (*Contra*). In addition to the comic base, Aventura Discreta closely resembles the fluid, animated movements and mechanics of this title.

The appearance of Aventura Discreta are based on pixel art technique [14] with higher resolution and quality. The bosses are fully animated and with several events. This was made after an analysis of the game *A Lenda do Herói*, which uses various gameplay elements and typical concepts of platform games, in a modern way stuffed with satire.

III. Methodology

The planning and execution of the development actions of this project followed the *SCRUM* methodology for digital games [6]. This allowed a focus on the code and process interactions. The visual organization of the tasks, assignment to responsible people and deadlines were registered on *Trello*[1]

[1]https://trello.com/

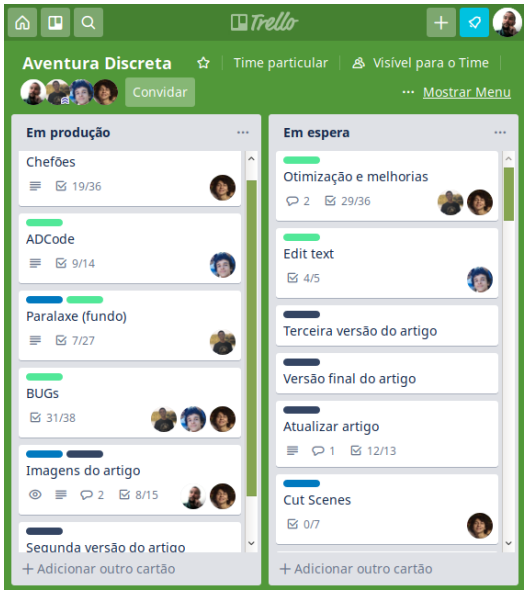


Figure 1. *Trello* boards in one step of the project.

boards. As a consequence, it was enabled the collaborative and effective execution of the work. The usage of *SCRUM* and *Trello* contributed mainly to: (i) improve the organization and asynchronous communication of the team through cards and sprints; (ii) record and monitor activity logs; (iii) reduce the workforce estimates; (iv) simplify the standardization of activities and the review of actions; and, thereafter, (v) enhance the group production. Figure 1 illustrates a clipping of the team activities board.

The project evolution followed the steps suggested in [5]. Initially, it was defined in brainstorm meetings the game concept, genre, scenarios, mechanics, synopsis, conceptual art and audio elements style. Then, the requirements were raised as technological resources like integrated development environment, image and audio editors, bibliographic sources, and design and art documentation. After that, schedules were elaborated and the teams of art and development were defined. Finally, the production cycle was started by implementing the level design, interfaces, characters with artificial intelligence [15], artistic production and programming, until the achievement of the final game version.

The game is designed for personal computers with Windows or Unix based operating systems, also being able to execute on browsers with WebGL. The chosen development language is C++ with object oriented features using the libraries OpenGL, SOIL and freeGLUT, which work with computer graphics elementary forms, and OpenAL to manipulate the audio assets. It was coded each complex or simple game component in order to improve the visual experience. Fundamental functionalities like file loading, user interface components, collision detection techniques, physics system, movement engine, parallax effect and animations

were implemented from scratch by the authors. This was done in order to put into practice studied specialized algorithms, data structures and other consolidated techniques, for example from [16], to understand and tame the soul of a digital game. It was adopted GIMP and Adobe Illustrator to create and edit images. Some sound effects were generated using bfxr [17] and the others, like soundtracks, were recorded by the game makers. Each audio file was treated with Audacity. A map editor was made and included into project to easily create, edit and play custom levels for the game. This task allows the users editing blocks of each level in two layers, changing the background, controlling the camera and map, positioning entities and their behavior through ADCode, the runtime scripts language developed for AVENTURA DISCRETA.

IV. GAME PROJECT

The following subsections describes the concept, gameplay, and narrative of the game AVENTURA DISCRETA.

A. Concept

The game comically portrays the saga with all obstacles of the computing student, Pequeno Douglas, during his academic journey. The narrative reflects and highlights the importance of defining and executing goals. In addition, it proposes implicitly the appreciation of what brings happiness, regardless of the experienced moment. Categorically, AVENTURA DISCRETA is included in the platform genre and brings together elements of action, comedy and adventure.

B. Gameplay

The main character, as it is common in platform games, uses a tool or projectiles to attack opponents. The main enemies are tests, tasks, bugs and other common obstacles in the life of a computer student. The main weapon works like a sword and can be a pencil, pen or memory card, depending on the score and items collected by the player. The usage of directional keyboard arrows allows Pequeno Douglas to jump and control the attack direction.

The enemies found along the level course are simple. They can move and make damage when touching the player. The level construction is also done with several obstacles. At the end of each level, the player encounters a more powerful enemy with many abilities and attacks. In relation to protagonist life, this represents the final challenge of the current stage. For instance, at the end of the technician degree level, at which the main enemy is the ENEM logo, the player must choose the right alternative, attacking on the right place to cause damage. Also, he must arrive at the confrontation place before the gates close.

C. Narrative

The narrative, as mentioned, develops the evolution of Pequeno Douglas, a young man who is attending elementary school and decides to continue in academic life giving focus in the computing area. During the journey, the hero faces several challenges divided in 5 stages: technician, graduation, post-graduation, work in company and career as a teacher.

Figure 2. DoorSOS system logo.

Each stage of the hero's life is represented by a level described in a three-act script [18]. In act one, the hero starts weak and advances from the beginning of the level by collecting items, overcoming obstacles and defeating enemies to strengthen himself. In act two, the hero defeats other enemies and more complicated obstacles until arriving at act three, described by the battle between the protagonist and the main enemy of the phase. The big boss needs to be defeated in order to move on to the next level. Following, more details about the game stages are presented.

1) Technician: Pequeno Douglas decides to join a computer technician course and does the entrance examination. When the result was disclosed, he was notified that he has passed. Then the little boy begins to have contact with a new world. The exercises and homework never ends for Pequeno Douglas. In addition, he has always a lots of practical works and tests to do. In order to stand out among the best and find a internship, he must workhard to keep a good academic grade point ratio. As if that were not enough, he needs to face the bugs of DoorSOS, an operating system full of bugs with logo presented in Figure 2, and still hope to take a sit on the bus to move between the institution campuses.

He was able to go through these first challenges with the passage of time, since he had some help of the teacher and coordinator Poliana Corrêa, who is always available to give advice and guidance. Then, Pequeno Douglas decides to deepen his knowledge. He does the ENEM test to continue in the institution, but as an undergraduate student in Computer Engineering.

2) Graduation: Upon entering college, Pequeno Douglas finds a similar environment as seen before... Tasks, tests, intercampuses bus, everything alike... Even the programming bugs which he has already become used to. He initially conducts this new phase of life just like in technician education, thinking that it will be as easy, until he is surprised. The first test result in discrete mathematics was zero.

He was frustrated with his grade on the most difficult subject of the course. He realizes that things are different now and require much more dedication. Kecia Marques, the course coordinator, trying to help, does her best to stimulate the Pequeno Douglas studies. In order to release the tension and escape from this universe, it became a habit to go to

DCE, Central Directory of Students, to relax and play pool.

In the end, already adapted with the routine, Pequeno Douglas obtained success, except in discrete mathematics. This subject is ministered by professor Sarubbi, that obliges him to realize special examination. In order to pass this phase, Pequeno Douglas must face the challenges proposed by the teacher to be approved.

3) Post-Graduation: After much study, Pequeno Douglas finally overcame discrete mathematics. Now the final step to complete the training is to take a master's degree. After passing POSCOMP (post-graduation entrance exam), the hero starts a course in Mathematical and Computational Modeling. Along with the advisor André da Cruz, he must pass the exams and do the dissertation to become a master. Pequeno Douglas is surprised, but not shaken, and finds a new side of the institution, much more hostile and complicated. However, nothing that can not be overcome.

After a great adaptation period, the time to face the final challenge came. The most difficult part that he will face is the master's examination committee. In order to be named master, Pequeno Douglas needs to show the usefulness of all acquired knowledge. After many text revisions and a lot of effort, he finally manages to get his work accepted.

4) Work in Company: Pequeno Douglas joined a job market. He was hired by the pasta maker and distributor Zilma Alimentos. He takes care of digital security, protects the servers that contain the secret formula of the delicious macaroni manufactured by the company. With support of his boss, Gerson Pai Filho, he spends the days removing viruses that employees have acquired on company computers. For this task, the hero tries to fix DoorSOS flaws, install printers, format disks, and clean the macaroni-covered computers.

Everything went well until the day that Computa Hacker Boy invaded the factory's network servers. Master Pequeno Douglas had to block his attack and defeat him. After this successful server protection, he was tired of macaroni and decided to go back to the institution and become a teacher.

5) Career as Teacher: The hero was accepted into the institution to teach discrete mathematics. Now he is on the other side and has another perspective of the story.

Ending: Master Pequeno Douglas knows the subjects importance. He is very rigid on the classes taught and charges an extremely advanced content, expecting for the students to absorb every word that comes out of his mouth or tip of his brush. He does not get the maximum students efficiency and ends up becoming, without realizing it, a hangman teacher who charges beyond what he should. This made all the students suffer, going through the same difficulty he passed on this subject, leaving them to recover in the special examination.

When hundreds of special exams and problem sets come at him in order to correct them, Pequeno Douglas realizes that perhaps he has exaggerated and sees that he is becoming a type of professor that he did not like. In this way, he begins to correct the exams more fairly with the students. So he got great approval in the subject and the serenity of knowing that even after all, the students had learned even more than they needed to become good professionals.

Alternative Ending: Master Pequeno Douglas, as a discrete mathematics teacher, must overcome the students lack of knowledge. Some are harder to teach than others. Analyzing this, he begins to take passion to teach and sees his reflection on the students with high grades. He sees a promising future for three of these students and started to threat them as pupils. He becomes his masterful teacher to guide them in a scientific initiation.

D. Characters

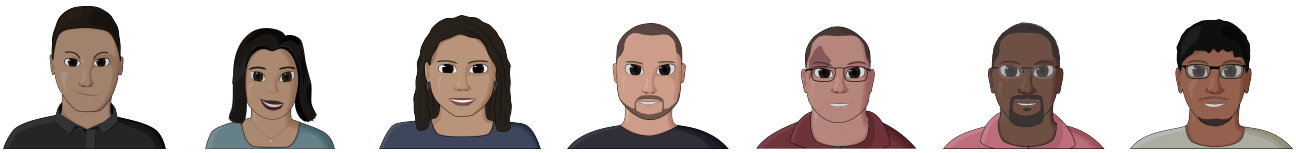
This subsection shows each game character of AVENTURA DISCRETA.

1) Main Character: Pequeno Douglas (Figure 3a) was inspired by people who studied and became professionals in any course in computing area. These are considered real heroes and heroines of the real world by the authors of this paper because of their importance in the modern world. The character was created with the intention of representing these people generically, which is not an easy task due to the diversity of ethnicity, appearances and genres in Brazil. However, a male avatar with brown skin and black hair was chosen.

The personality of Pequeno Douglas, evidenced in the game, demonstrates the willpower and effort to win in life. The character does not speak during the game, but it is possible to notice that, throughout the narrative, he keeps smiling even in the most difficult situations, passing an idea of optimism. This characteristic is highlighted in most Brazilians, who tend to remain optimistic, even when facing various difficulties, a topic discussed in [19]. Also, it is possible to say that he is an intelligent and humorous student, besides a dedicated employee. Another important trait of the protagonist is the maturing throughout life, a factor portrayed in the game, because it presents a long period of the hero life. It is shown on the game his adolescence, youth and an adult periods with different clothes and face styles. The character starts as a student of technician degree and go on until becomes a teacher.

2) Allies: The allies are those characters who help Pequeno Douglas during the journey, guiding him to defeat enemies and explaining the narrative events. Such characters play the role of mentors, as described in [1].

Poliana Corrêa (Figure 3b) is the technician course coordinator and assists the player in the first level. She is patient and attentive, but she does not fail to charge Pequeno Douglas with his obligations. Kecia Marques (Figure 3c) is the graduation course coordinator. She is always willing to help the hero. She is humble and generally smiling. André da Cruz (Figure 3d) is the hero's advisor during master's degree in Mathematical and Computational Modeling. He



(a) Douglas. (b) Poliana. (c) Kecia. (d) André. (e) Gerson. (f) Sandro. (g) Cica.

Figure 3. Characters of AVENTURA DISCRETA.

is irreverent, humorous and passes all his knowledge to the hero, charging him too much effort. Gerson Pai Filho (Figure 3e) is the pasta company manager in which the hero works after the master's degree. Gerson gives orders and helps the protagonist. A striking physical characteristic is the birthmark he has on his right eye. He is funny and often speaks things that no one understands, even being smart. Sandro Renato (Figure 3f) is the Computer Department (DECOM) chief at CEFET-MG, where the hero spends most of his life. He is a good leader, very dedicated and responsible for leading and assisting teachers. Cica (Figure 3g) is the professional pool player who is always at DCE. When the subject is not snooker, he often says many nonsense, and has a habit of never using articles before nouns. Whenever the player pauses the journey to rest, Cica gives snooker tips to him.

3) Common Enemies: The academic life obstacles in the field of computing, represented by the enemies that appear on during the levels, are presented below.

- Tests: The tests of Informatics, Computer Engineering and Mathematical and Computational Modeling appear during the technical, graduate and post-graduate courses, respectively. These are the most common difficulties in these levels. The protagonist must face the subjects to not receive low grades. When Pequeno Douglas becomes a teacher, he has the job of correcting students' tests. Proofs are represented in the game by large papers that walk on the map.
- Practical Works: As if the study for tests was not difficult enough, there are practical works that must be done or corrected. They are represented by compressed files and also chase the player.
- Intercampuses: During youth, Pequeno Douglas must also face the crowded buses every day to arrive in time to study.
- Traffic: When Pequeno Douglas become an adult, he manages to buy a very desired car. However, the enemy is now the flow of cars in traffic that he must often face.
- Error Messages: Errors, such as segmentation faults, chase everyone in computing area over a lifetime.
- Viruses: Viruses are very common in Zilma Alimentos pasta factory due to hackers who constantly try to steal the secret formula of the delicious macaroni and the employees who download without noticing infected files.
- Macaroni: While he is working in the industry, Pequeno Douglas acquired a great dislike of the pasta, which was everywhere in the factory.

4) Bosses: The enemies that appear at the end of each level represents the last major challenge of the stage where the player is.

- ENEM: It is the last challenge of technician education. In order to enter in the graduation, it is necessary to perform well in ENEM test. There are two tests which must be overcome, represented by two enemies. Figure 4 illustrates a cut from the game in which Pequeno Douglas duels against ENEM. It is always necessary to choose the right alternative in the questions to overcome this challenge. Besides that, he must arrive at the place of confrontation before closing the gates.

Figure 4. Pequeno Douglas is fighting against ENEM.

- Sarubbi: The professor (Figure 5) who teaches the most difficult subject of the world, discrete mathematics, according to Pequeno Douglas. He is peculiar and confuses students with complex logical sentences. The teacher is white, tall and wears glasses. He proposes several challenges for the hero, such as complex graphs and algorithms with different complexities. The player must hit the graph vertices during the right time to succeed in this challenge.
- Computa Hacker Boy: a very elder hacker who deployed the most powerful virus on Zilma Alimentos servers, designed to copy the best world macaroni formula. He is not very strong physically, but it is a pretty difficult to challenge since he can defeat Pequeno Douglas with network attacks. The player must login in the system and eliminate all possible viruses until he locates the

Figure 5. Sarubbi, the discrete mathematics teacher.

hacker, who becomes unarmed.

- Master's Examination Committee: the set of two people who will evaluate the Pequeno Douglas knowledge in the presentation of his dissertation. They sit behind the table. The first one has black skin and long hair, and the second has orange skin and short, blue hair. The evaluators have several doubts about the work, which are thrown at the player and remain chasing him until he hits the right spot and causes the doubt to be answered.
- Special Exam: when Pequeno Douglas students goes bad on the tests, he will have many special exams to correct at the end of semester. These are represented by a large pile of papers, which give the impression of forming a face that changes its expression as more examinations are analyzed. To overcome the challenge, you should avoid corrected exams and eliminate them from the stack.
- Pupils: there are three students who will be mentored by Pequeno Douglas in the production of an article about a game that portrays the academic life. However, they will only ask for the guidance of Pequeno Douglas if he is a good teacher. The students have many doubts. Their physical characteristics are: the first student has short black hair and uses clothes in the colors purple and yellow; the second has colorful hair and uses a black shirt with a green hexagon in the middle; and the last one has the long hair and uses clothes in the orange color. As a teacher, Pequeno Douglas never remembers their names, but he must make his pupils get to write an article even when they have other things to dedicate themselves such as college, external projects, and parties, activities that are represented by their attacks.

V. Results

After the implementation and test phase, a stable version has been consolidated as described in Section IV. Aventura Discreta has an initial menu as shown in Figure 6a, with the options "Jogar", "Criação de Mapa" and "Sair". When someone clicks at "Jogar", it is started the standard levels of the game or those created at map editor, an option available by clicking "Criação de Mapa". In addition to the "Sair" button, which terminates the game, there are also buttons to turn off the music, sound effects, and view some game development information (by clicking at any of the lower logos).

As mentioned, Aventura Discreta also includes a map editor, illustrated in Figure 6b. It is possible to elaborate with this feature new levels using the available game assets to create platforms, position enemies, obstacles, ornaments and edit the phase background.

In order to illustrate a level, Figure 6c shows a cutout of the step representing the master's degree stage. It it is possible to perceive the hero Pequeno Douglas and the enemies that represent the intercampuses bus, the DoorSOS bugs and the subject of Parallel Programming, in which the player's current note is F. He must hit the enemy in order to achieve a better grade to be approved in the subject.

Figure 6d depicts a clipping when Pequeno Douglas receives mentoring from Cica inside the entertainment room of the Student Central Directory.

In general, the creation of Aventura Discreta by the team provided a maturation of the knowledge in several areas applied to the creation of digital games. Also, in parallel with the game development, there was a teamwork improvement in concerns of productive and creative discussion of ideas, division and organization of tasks.

The game Aventura Discreta is available for free download on the link https://github.com/SonsOfDlaiton/Adventure-Discrete. The downloadable files include the entire project with source code and its files to generate the binaries for Linux, MacOS, Windows operating systems or to run via internet browsers through the game port for JavaScript with WebGL using Emscripten [20]. This requires a C++11 compiler and the OpenAL-soft and freeGLUT libraries.

It can be highlighted in the results that this project was developed by a group of volunteer and interested students, guided by teachers who enjoy the world of digital games. In addition, this whole process was executed at a zero monetary cost, driven only by the passion for knowledge and entertainment.

VI. Conclusions and Future Works

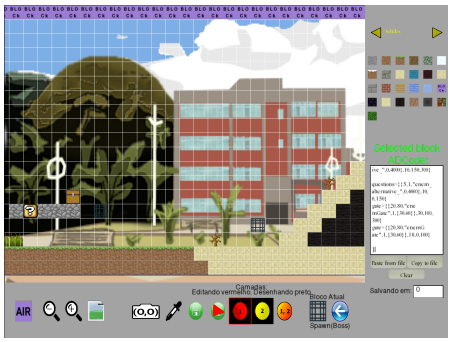
This work reported the game design of Aventura Discreta and information about its development process. The full open-source project and application were disclosed, demonstrating that it is possible to create an application with zero-cost human resources when an engaged team meets.

In relation to software engineering, this project applied fast documentation techniques for medium-sized game designs, adapted to the context of Aventura Discreta. In order to follow up and evaluate the game development, it was used the agile management methodology SCRUM.

The narrative sought to be constructed in a fun way. During the journey, Pequeno Douglas relied on the help of allies and mentors to finally discover that it is important to be happy independently of the life stage.

For future work, the authors intend to (i) optimize the audio-visual resources loading, (ii) implement user-independent camera control, (iii) improve the internal runtime

(a) Menu.



(b) Map Editor.

(c) Post-Graduation level.

(d) Mentoring.

Figure 6. Interfaces of AVENTURA DISCRETA.

scripting language called ADCode, created to facilitate phase customization, media loading, and behavior modeling of entities.

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