USABILITY ANALYSIS OF VIRTUAL REALITY PROTOTYPE FOR TEACHING HISTORY TO STUDENTS WITH ADHD

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ABSTRACT

Virtual reality (or VR) has increasingly taken its place in various areas, such as industry, tourism and, especially, education. In the educational context, this article proposes an inclusive metaverse-based application for learning History for students with ADHD (Attention Deficit Hyperactivity Disorder). The article focuses on the user interface proposed for the application developed based on the currently accepted theories of usability and the characteristics of people with ADHD. An interface adapted to these users must be attractive, user-friendly and favor the student's attention. Thus, making learning History a fun activity for students with ADHD.

Keywords: ADHD, History, Virtual reality, Education.

INTRODUCTION

Attention Deficit Hyperactivity Disorder (ADHD) in the 90s was widely studied, after analyses, they found that not only children had this condition, adults also started to present it, so in the United States it became a public and economic health problem due to the fact that it started to have treatment, it was also in this decade that neurologists evaluated the action of ADHD and its possible causes, and it was found that the pathology occurs due to biological and genetic conditions [Caliman 2008].

According to [Caliman 2008], the diagnosis of the disorder is made through a psychologist where the clinical history, school history and interviews with parents are evaluated, this for children. For adults, it is done through analysis of their behaviors in childhood and reports from people in their life. In both analyses, the professional evaluates ADHD traits to diagnose.

Thus, the disorder must be better cared for, because currently in a world where productivity is necessary, attention and focus on the processes in any type of relationship

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are needed, so the creation of an environment that attracts the person so that he can live without problems must be thought of. According to [Graeff and Vaz 2008] the main characteristics of the pathology are: "difficulty in maintaining attention, due to agitation and restlessness, which can often configure hyperactivity and impulsivity".

Knowledge of History is extremely important because it allows the understanding of the present, in addition to developing critical skills and preserving identity and culture. In Brazil, History is understood as a mandatory subject in school education at all levels of education. This discipline becomes important as it brings to the student the notion of humanity by revisiting and knowing the evolutionary process over the years, as it creates the notion of citizenship and belonging to a society. The teaching of History has been shaped according to political interests and social movements, currently teaching in Brazil seeks to bring an identification about cultures sometimes present in the country, in this way, when teaching History the teacher becomes an agent of change because he has the mission of showing the roots of the development of societies and the connection between different groups with unique characteristics [Silva and Fonseca 2010].

According to [Bittencourt and Lima 2022] games are a great tool to draw attention to the accomplishment of tasks, since games make the user the center of their choices and actions. Therefore, having these elements as a basis, the convenience of using games as a means for learning History is identified. From this it is possible to think of a graphical interface where usability can reach the target audience, Nielsen's heuristics guide the development of interactive interfaces, one of them talks about ease of use where the *UI* (*User Interface*) is possible to be used by several users easily and without major difficulties.

Through the studies of [Silva et al. 2018], complex interfaces can lead the person to error by becoming confused, this emphasizes the attention to a minimalist interface that is objective and without many images outside the context of the system, another factor is a *UI* that shows in some way the progress of its actions and this is displayed to those who use it because it rewards the person for their attention. In addition, it is necessary to have an easy-to-use interface that has simple interaction mechanisms and is easy to understand, this point can be highlighted by Nielsen's heuristic, which suggests an intuitive interface to avoid overloading the user's memorization.

In recent years, Virtual Reality technology (VR) has been proving itself more and more, with new experiences and activities to be done in the simulated world. According to [Kirner and Siscoutto 2007], *VR* has evolved the concepts of graphical interface when it states that it is a new way of interacting with the virtual world, and this virtual world is made with three-dimensional shapes in which the user can feel part of that environment, in his words "allows you to break the barrier of the screen" is what defines immersion. A concept

that is closely related to Virtual Reality is the metaverse. While Virtual Reality refers to an immersive experience in which an individual is transported to a simulated and interactive environment, the metaverse is a broader and more comprehensive concept. The metaverse is an idea of a social and interactive platform where multiple users can interact and create content. The metaverse can be achieved through *VR,* but it can also be accessed through other means, such as computers, mobile devices, or even augmented reality interfaces.

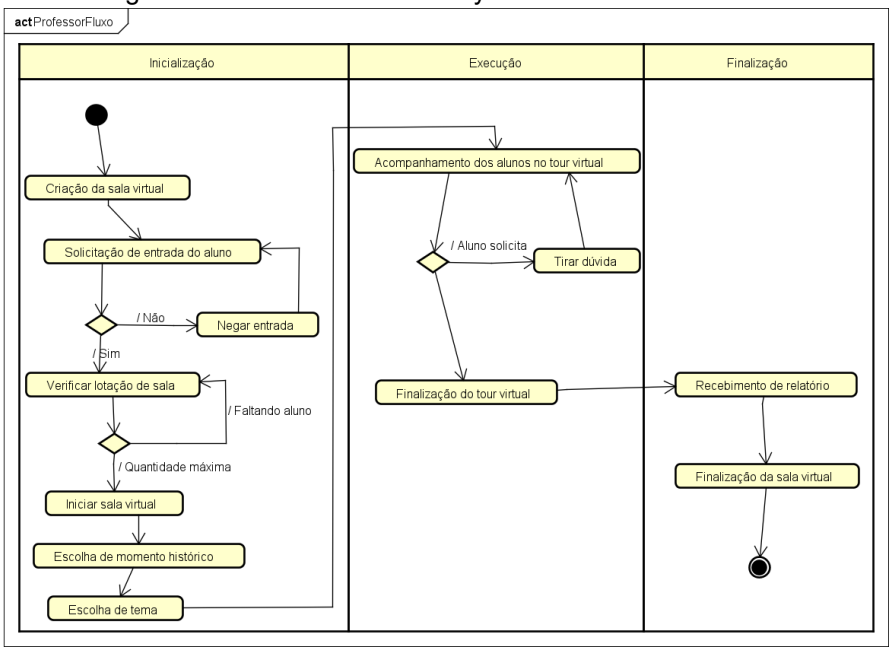
An alternative that will help students with ADHD learn History is the development of a metaverse where the student and the teacher participate in a follow-up and learning experience, in an application with an interface that respects the characteristics of these people. Because as stated [de Classe and de Castro 2023]: "there is a lack of studies on metaverses used as virtual learning environments", it soon becomes interesting to explore this hypothesis with the development of this solution. In this article, the first elements of this application are presented with a focus on the user interface, an interface developed based on the currently accepted theories of usability and the characteristics of people with ADHD, in addition to presenting a comparison of an application developed for this purpose and evidence of the differences that the application proposed in this article can become useful to the context, The methodology for developing this prototype will also be presented.

APPLICATION REQUIREMENTS

The purpose of the application is to generate a virtual environment where student and teacher can interact in order to learn History through a *guided virtual* tour.

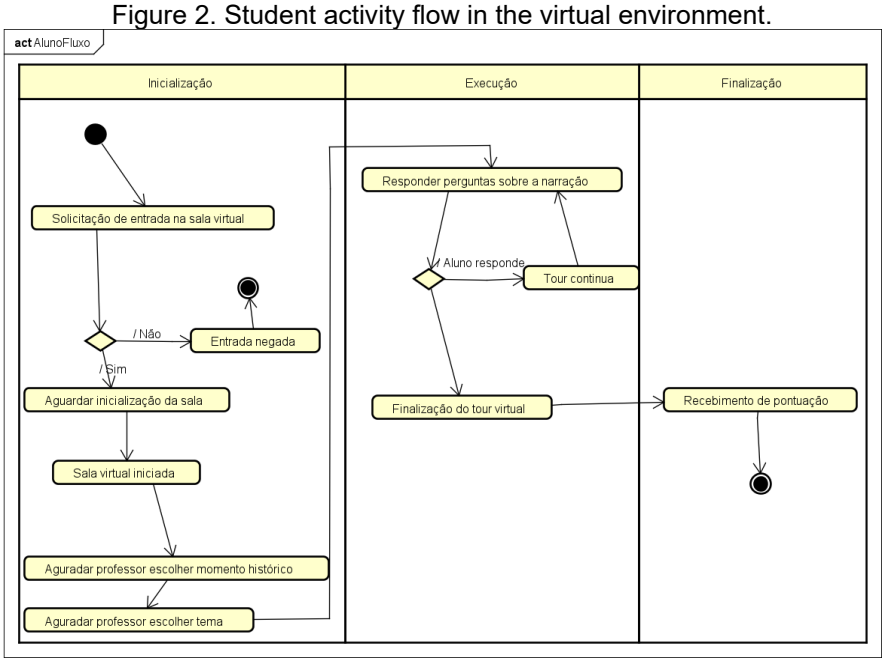
Figure 1 shows how the teacher's activity will be during the use of the application, from the beginning of their activities to the end of all their teaching.

Figure 1. Flow of teacher activity in the virtual environment.



The student also has his or her steps defined to follow (Figure 2).

Figure 2. Student activity flow in the virtual environment.



Some of the main features and requirements of the app are:

- The app is *multiplayer* with five players: four students and the teacher. The students will be the subjects who learn the contents and the teacher will accompany them in this process.
- When the teacher enters the metaverse of the application, he will be able to create a virtual room where students, after entering the application, request to enter the room. The teacher will accept or not the students in the room. Both must be previously

registered.

- The student will have two options when entering the game: enter a room created by a teacher or enter an environment where a virtual gallery of historical objects or characters will be available. The student can select these objects and listen to their description. The student will feel free to listen to all the content made available.
- In a created room, the teacher will select the type of History (General, from Brazil or from Amazonas). The virtual class that is in the room will be transported to a timeline where the teacher can select the historical moment to be visited, after being chosen, a virtual guide will explain in a tour about the events of that period.
- During the tour, the teacher will have a bank of questions and answers related to the historical moment that is being visited and will be able to pause the tour and ask the students a question. The student will have time to select the answer and generate a score. After that moment the tour continues.

In addition to the mechanics and rules designed for the game, the user interface plays a key role in achieving student engagement in the game. Therefore, after defining the general requirements of the game, the game's interface was designed, which is the key focus of this article.

APP USER INTERFACE WITH VIRTUAL REALITY

Graphical interfaces over time adapt according to the objective that the systems need, whether for information purposes or for entertainment, each software suggests an interface style, according to [Mager et al. 2004]. According to [BONSIEPE 1997] the interface is "a medium through which people and the computer communicate", in this way, a good design should convey to the user how he should manipulate the system he is exploring in order to achieve the objectives expected by those who developed it. With the evolution of technologies, new approaches to the use of computer systems have emerged, one of them is VR, which uses special glasses to simulate the eyes and other senses as an experience in a fully three-dimensional world where it is possible to interact with the environment around the user, and with the idea of metaverse interacting with other people. For [Schlemmer and Backes 2008], this virtual world must be able to modify the user's interactions and bring some visual return, this will depend on how the interface was implemented. According to [Kirner and Siscoutto 2007], virtual reality can be used in individual applications and in collective or remote applications, proposing that these applications can be a form of socialization.

USER INTERFACE PROPOSAL FOR THE HISTORY LEARNING METAVERSE APPLICATION OF PEOPLE WITH ADHD

A graphical interface was designed where usability can reach the target audience, students with ADHD, so the guide for this purpose will be Nielsen's heuristics, one of them talks about ease of use where the *UI* can be used by several users easily and without major difficulties. In the work of [Bittencourt and Lima 2022], a question and answer game was developed where it was found that this model was essential to hold the child's attention, where it stimulated the user through a minimalist interface - this point is raised in Nielsen's heuristics - other points were taken into account such as the stimulus by generating potuation and a small number of questions so as not to lose the user's interest in the system, this can be taken as a way to build interfaces that are interesting and have visual novelties for the user with ADHD. In the next section, a comparison between this mentioned solution made by the author [Bittencourt and Lima 2022] and the work done in this article will be presented.

So some screens were designed to be implemented in the study application, seeking student learning through a virtual *tour* where the teacher can participate and guide students, in addition to being accompanied by a virtual guide.

For the initial world, the idea was to create a 3D world in order to simulate the landscape of ancient Greece that is the cradle of History, being a direct tribute to the place where this science emerged. The Greek site chosen was the Parthenon (Figure 3) serving as a virtual museum to access the tours and an exhibition of historical objects.

Figure 3. Parthenon, the main setting to access all the features.

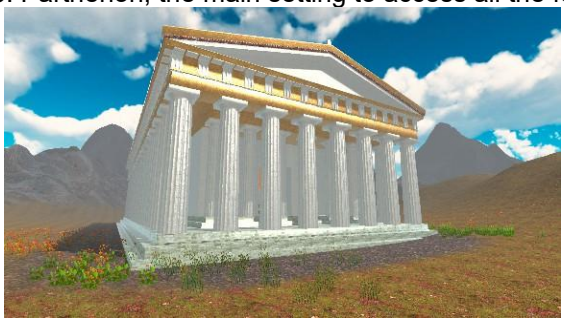


Figure 4 represents a 3D prototype of the access to the type of History to be taught, the teacher can then select to be presented to the students. Here, according to the listing of Nielsen heuristics by [Geremias et al. 2022], the concept of "Consistency and standardization" was applied where all square icons with text and selection icons, such as those displayed in Figure 5, are denoted as clickable icons.

Figure 4. Globes with description of the type of Story.

Figure 5 presents a 3D prototype of the room of historical objects and characters in which the teacher can select for the students to listen to the description. Here the concept of "Recognition in place of memory" has been added, where interactive objects are denoted by the interactive object warning [Geremias et al. 2022].

Figure 5. Prototype of the room of historical objects and characters.

For the timeline environment (Figure 6) the idea is to add the user (teachers and students) in the middle of the universe having an interactive timeline to access the *tour*. As the idea is to have a "minimalist interface", intuitive icons for interaction were designed. The choice would be made by the teacher to explore a historical event of his preference.

Figure 6. Timeline for *tour selection*.

The world of the *virtual tour* was designed to represent in a playful way what that environment was like in the selected period. During a brief narration of certain events, questions are asked about specific points previously mentioned to verify learning, the

number of correct answers can be passed on to the teacher to evaluate the retention of what was taught and the student earns a score to pass the level of expert. Figure 7 shows an example of a *tour* in Ancient Egypt with one of the questions during the *tour*. In it, the concept of "Minimalist aesthetics and design" was applied, where it says that the interface should contain only what is necessary and that it is comfortable [Geremias et al., 2022].

Figure 7. Example of a question from the *tour* during Ancient Egypt.

In addition, in Figure 8 it is possible to see in the upper right corner the student's score visualization that indicates their progress during the learning path, this point shows among other heuristics the concept of "Equivalence of the system and the real world" where in a school context students are already familiar with scores of their activities and tests, therefore, it becomes necessary to present this accuracy information to the player [Geremias et al. 2022].

Figure 8. Student score during the learning path.

BENCHMARKING ADHD-ORIENTED SOLUTIONS

In this section, a comparison will be made between the application made by the author [Bittencourt and Lima, 2022], where he presents MyADHD as an alternative for the learning of children with ADHD, taking into account usability issues through a questionnaire. The target audience of the project is children aged 7 years and a research related to the interests of these children in this age group was carried out to prepare the questions. With this, some comparisons will be made between the aforementioned solution and the one presented in this article (see Table 1).

Table 1. Project Comparison

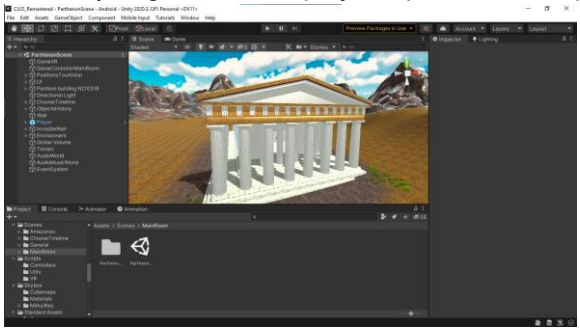
Projects	Prototype	MyADHD
Technology	Unity e Google Cardboard	Unity
Target audience	Elementary school students	7 Year Children
Purpose	Teaching History through a *virtual tou* with the accompaniment of the teache	Stimulate children's curiosity with general questions
Resources interaction	Interaction between teacher and student within the platform	Without Resources from Sharing Information
Virtual Guide	Character created to narrate the events of the period visited	No information about

In this comparison, some points are interesting. Starting with the use of Virtual Reality as an attraction for students and a way to place them within the selected historical period, in the MyTDAH application this feature was not implemented but was not limited to the use of a flow of simple questions and answers. Both applications have as their main objective to serve the public with ADHD respecting usability issues. A differential of the prototype is the character who teaches and asks the student questions, in addition to having the company of the teacher for any doubts and to receive a report on the students' assertiveness for the questions. Another differential is the possibility of having other students in the same virtual room to propose to the teacher a specific assessment tool for students with ADHD.

DEVELOPMENT METHODOLOGY

The application was developed in the *Unity Engine* environment (Figure 9), a platform that offers cross-platform game development tools for various segments, with the standard programming language of the C# tool, the chosen for this work was *VR* to work on Android operating system cell phones that have a gyroscope [Unity 2024].

Figure 9. Unity engine with the project open for development.



In addition, the *Google Cardboard* SDK *(*Software Development Kit*) was used* due to the fact that its features are free and allow more *smartphones* and have the minimum need to use a virtual reality glasses made only of cardboard [Google 2024]. Other resources such as assets and 3D models were purchased by Unity's own store, and audio files

recorded with the permission of the voice owner for dubbing the virtual guide.

The development methodology adopted for the construction of the software was Iterative and Incremental [Mognon et al. 2017] adapted according to the guidelines of the article by [Clua and Bittencourt 2005], where it is divided into 7 stages: Planning, Game Design, Routing and Production of assets, Level Design, Implementation and Validation Following these phases in small cycles, it is being possible to evolve and receive feedback from people who have ADHD, it is worth mentioning that these feedback from the interviewees does not express a significant value for evaluating this prototype in a real scenario, this process is similar to Lean UX where MVPs (Minimum Viable Product) are made and suggestions for improvements are collected [Gothelf and Seiden 2021].

CONCLUSION

From the study surveyed and the project proposal, the strategy of making the visual elements minimalist was applied, meeting one of Nielsen's heuristics in this process. The purpose of the work was to develop an application in the metaverse using this *UI* to teach History. Some of the future activities include testing this application in a real school environment, involving students with and without the condition of ADHD, in order to validate the study presented in this work. Other activities are aimed at verifying relevant themes of the History discipline for teaching, such as, for example, searching for content and creating a *virtual tour* to show moments in the History of Amazonas, thus enriching the teaching materials of the History of the region, in addition to disseminating the local culture and presenting how Amazonas has developed over the years.

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