

Por Dentro do Computador – Aprendizado Digital: An Educational Web Environment for Digital Literacy

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Abstract. *This Work in Progress presents "Aprendizado Digital", an educational web environment for introductory computer literacy. It combines theoretical hardware materials with an interactive operating system simulator for safe skills practice, guided by a virtual assistant. Developed via User-Centered Design (UCD), the prototype prioritizes accessibility and simplicity for novice users. A preliminary heuristic evaluation showed positive usability, noting interface consistency and clear navigation. Future work involves functional web implementation and empirical user testing.*

Keywords— *Digital Literacy, Digital Inclusion, Simulator, User-Centered Design.*

1. Introduction

Digital inclusion is currently an essential element for active participation in society. Knowing how to use a computer and understanding its basic features has become a fundamental competence to access information, exercise citizenship, and keep up with the transformations of the contemporary world [Martins et al. 2023]. However, many people without prior contact with digital technologies face significant challenges in the initial processes of digital literacy [Andrade Filho et al. 2024].

Given this scenario, the creation of accessible educational resources capable of promoting meaningful learning for those taking their first steps in using a computer is indispensable. In this context, the website "Por Dentro do Computador - Aprendizado Digital" emerges as an online platform to support the development of basic digital competencies. The prototype is an expansion of the actions of a university extension project focused on popularizing knowledge about hardware and the functioning of computers [Beleti Junior et al. 2020].

The learning environment is structured into two main sections: (i) Computer Parts and Devices, featuring theoretical content on physical components accompanied by explanatory videos; and (ii) Virtual Machine Simulator, which allows the user to practically explore the features of an operating system. The entire experience is guided by the virtual assistant Sofia through an interface designed to be simple and welcoming for beginners.

Characterized as a Work in Progress, this article presents the initial outline of the project, the architectural conception of the high-fidelity prototype, and the results of a formative interface evaluation, setting the stage for future technological implementation and field validation.

2. Digital Literacy and Inclusive Technologies

The advancement of digital technologies has profoundly transformed social dynamics [Souza 2022]. The ability to use these technologies has become a requirement for full participation in society [Silva et al. 2022]. However, as highlighted by Helsper (2021) and Silva, Ziviani, and Ghezzi (2019), this advancement is not distributed equally. Systematically marginalized groups, such as the elderly and individuals with low literacy, face significant barriers regarding access and usage [Souza 2022].

Digital literacy, according to Lima Neto and Carvalho (2022) and Coscarelli and Ribeiro (2011), is not limited to operational capacity but involves cognitive skills to search for information, manipulate files, and solve problems autonomously. The lack of development of these competencies generates social exclusion [Souza 2022]. For novice audiences, the first obstacle is understanding the logic behind how machines work, from identifying components to understanding operating systems [Viviani et al. 2023].

In this sense, virtual learning environments that adopt simulators and virtual assistants facilitate the development of operational skills and reduce anxiety, allowing practice without the fear of making irreversible mistakes [Viviani et al. 2023]. Still, studies indicate that virtual environments do not entirely replace face-to-face support for highly vulnerable users [Helsper 2021, Souza et al. 2023], requiring the design of these tools to incorporate high accessibility, multimodal support, and respect for the learning pace.

3. Methodology and User-Centered Design

The development of the proposed educational environment was guided by the User-Centered Design (UCD) approach. This methodology is particularly suitable for projects intended for users with low levels of digital literacy, as it prioritizes the needs, characteristics, and limitations of the target audience throughout the design process [Lalji and Good 2008]. By focusing on accessibility, simplicity, and usability from the early stages of development, UCD contributes to the creation of interfaces that are easier to understand and interact with, especially for novice users.

The development process was organized into three main stages: (1) requirement analysis and target audience characterization, (2) iterative prototype development, and (3) formative interface evaluation.

3.1. Requirement Analysis and Target Audience

The target audience consists of individuals with little or no previous experience with digital technologies, including both younger and older users. The definition of this profile and the extraction of system requirements were informed by qualitative observations and field notes accumulated during the face-to-face activities of the extension project [Beleti Junior et al. 2020]. Specifically, requirements were derived from direct interactions and informal feedback gathered while teaching computer hardware to school students and conducting intensive training bootcamps for public school teachers.

Throughout these hands-on sessions, recurring difficulties were systematically identified among participants. These included uncertainty regarding basic computer concepts, fear of making mistakes while using digital devices, and challenges in

understanding the relationship between physical hardware components and software functionalities.

Based on these field observations, specific requirements were established for the platform: the use of clear language without excessive technical terminology, intuitive navigation supported by simple interaction flows, accessible visual resources featuring high contrast, and a guided learning approach supported by continuous assistance. These requirements directly influenced the design decisions adopted throughout the project. The emphasis on guided learning motivated the inclusion of the virtual assistant Sofia, while concerns related to usability led to the adoption of simplified navigation structures and clear visual cues. Furthermore, accessibility requirements encouraged the incorporation of multimodal learning resources, including text, audio, subtitles, and interface customization options.

3.2. Iterative Development

The prototype was developed following an iterative process that enabled continuous refinement of both pedagogical and interface elements. This approach allowed adjustments to be made throughout the design process, improving the organization of content, the visual hierarchy of information, and the effectiveness of user guidance mechanisms.

The development activities included the definition of the information architecture, the organization of navigation flows, the production of educational content, and the creation of instructional materials. Particular attention was given to reducing interaction complexity and minimizing cognitive load, ensuring that users with limited technological experience could navigate the environment with confidence.

The prototype was created using Canva and resulted in a high-fidelity interactive model composed of 128 interconnected screens. Although not yet functional as a web application, the prototype simulates realistic user interactions and use cases, enabling the evaluation of navigation structures, instructional sequences, and accessibility features before the implementation phase.

3.3. Interface Evaluation

A formative evaluation was conducted through Nielsen's Heuristic Inspection method [Nielsen 1994]. Because the platform is currently available only as a high-fidelity prototype, the evaluation focused on identifying potential usability issues before the development of the functional version. The inspection was carried out by undergraduate students enrolled in a Human-Computer Interaction course at Universidade Federal do Paraná (UFPR) - campus Jandaia do Sul, who analyzed the prototype according to established usability principles.

The inspection considered the overall interaction flow, the clarity of information presentation, the consistency of interface elements, and the support mechanisms available to users throughout the learning process. Special attention was given to characteristics that are particularly relevant for individuals with low digital literacy, such as guidance, predictability, and ease of navigation.

The analysis focused on three main heuristic dimensions: visibility of system status, represented by the continuous guidance provided by the virtual assistant;

consistency and standards, reflected in the uniformity of visual elements and navigation patterns; and error prevention, supported by the simulated environment that allows experimentation without real-world consequences.

The results indicated positive usability characteristics, particularly regarding navigation clarity, consistency of interaction patterns, and the availability of support mechanisms. These findings suggest that the design decisions adopted during the development process are aligned with the needs of the intended audience and provide a suitable foundation for future empirical evaluations involving end users.

4. Prototype Architecture

The prototype translates face-to-face digital literacy methodologies into an online learning environment structured around the principles of clarity, accessibility, and guided learning. It was conceived as an integrated educational space that combines conceptual understanding and practical experimentation, allowing users to alternate between theoretical explanations and simulated activities. This architecture seeks to promote both declarative knowledge, related to understanding computer concepts and terminology, and procedural knowledge, associated with performing basic digital tasks. By integrating these complementary dimensions, the platform aims to provide a more meaningful, accessible, and confidence-building learning experience for novice computer users.

4.1. Home Page and Accessibility

The home page is straightforward, offering the two study modules ("Computer Parts and Devices" and "Simulator"). The page introduces the virtual assistant Sofia, who welcomes the user and guides the navigation (see Fig. 1).



Figure 1. Home screen of the digital literacy prototype presenting the main sections and the virtual tutor

To promote inclusion, the top menu features a centralized "Accessibility" button, activating features such as read-aloud, contrast adjustment, font enlargement, and keyboard navigation.

4.2. Computer Parts and Devices

This module is divided into input/output devices (keyboard, mouse, monitor) and internal parts (processor, RAM). The interface uses colored buttons with simple visual language (Fig. 2).

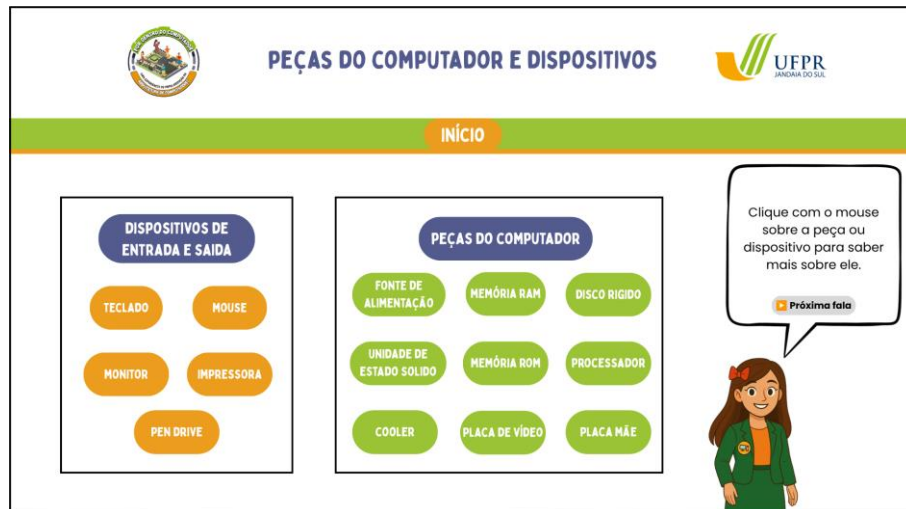


Figure 2. Main interface of the "Computer Parts and Devices" section

Upon selecting an item, a new screen displays an accessible explanatory text and an educational video with synchronized subtitles. The tutor Sofia introduces the topic through speech bubbles and audio, welcoming the user and explaining the importance of the component, as shown in Fig. 3.



Figure 3. Content screen about the "Power Supply", illustrating the combination of text, video, and the virtual assistant's mediation

4.3. Simulator – Virtual Machine

The second section emulates the interface of an operating system, creating a practical, risk-free environment. The desktop contains fundamental icons, such as Browser, File Explorer, and Recycle Bin (Fig. 4).



Figure 4. Virtual Machine's home screen, presenting the desktop and practical activity icons

Through activities guided by Sofia, the user learns to manage directories, such as the Downloads folder, access system settings, and create texts in Notepad, as demonstrated in Fig. 5.

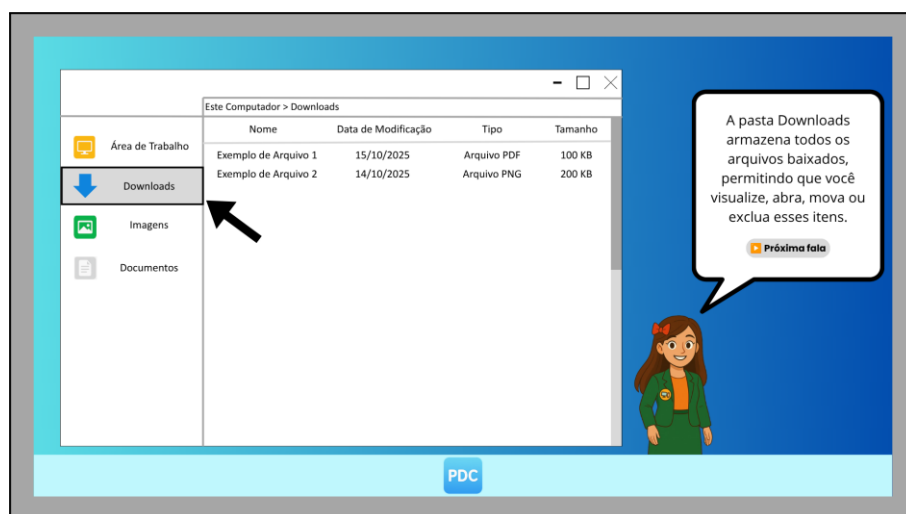


Figure 5. Simulator use case, demonstrating file management activity in the "Downloads" folder

This simulation helps reduce the fear of "breaking" the computer by allowing experimentation and trial-and-error without real consequences, thereby encouraging autonomy and confidence during the learning process.

4.4. Design and Accessibility

The interface development prioritized simple visual elements, with clear icons, a pleasant color palette, and accessible typography, focusing on comfortable reading. As an additional differentiator, all of Sofia's speeches are provided in audio format, recorded by a real person. This seeks to provide a natural intonation, a more humanized communication, and a closer connection with the target audience. Furthermore, considering that part of the target audience may lack the autonomy to access the website

for the first time, the proposal includes an introductory support stage. An upcoming module titled "How to access the site" will be available in printed and video formats aiming to support any user, even without prior experience, in accessing the platform.

5. Conclusion and Future Work

The prototype outlined here represents an ongoing initiative aimed at promoting digital literacy among individuals in their first contact with computers. By articulating theoretical content about hardware with the practical experience of a simulator, the project aims to offer a robust educational proposal. The interface, grounded in User-Centered Design, seeks to mitigate barriers, while the virtual assistant Sofia is intended to humanize the interaction and reduce technological anxiety.

As a research in the development stage, the preliminary evaluation focused on ensuring visual consistency and interactive clarity before field testing. As future work consolidated within the project's scope, the conversion of the visual interfaces into a fully functional web platform stands out. This future implementation will leverage modern web frameworks, such as React and Next.js, supported by a scalable cloud infrastructure like AWS, to ensure high availability for public school networks.

Above all, the crucial next step will consist of conducting empirical usability tests directly with the final target audience. Ultimately, the explicit contribution of this work lies in offering an integrated environment that bridges theoretical hardware concepts with safe, simulated procedural practice. This validation will be decisive in measuring the pedagogical impact of the tool, ensuring its role as a robust and replicable educational resource for democratizing access to digital technologies.

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